Cultivating healthy places and communities: evidenced-based nature contact recommendations

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Cultivating healthful places is an important public health focus. This paper presents evidence-based recommendations related to nature contact. A multidisciplinary review was conducted in several fields of study and findings were organized into public health recommendations: (1) cultivate grounds for viewing, (2) maintain healing gardens, (3) incorporate wooded parks and green space in communities, (4) advocate for preservation of pristine wilderness, (5) welcome animals indoors, (6) provide a plethora of indoor potted plants within view, (7) light rooms with bright natural light, (8) provide a clear view of nature outside, (9) allow outside air and sounds in, (10) display nature photography and realistic nature art, (11) watch nature on TV or videos, and (12) listen to recorded sounds of nature. The findings should inform public health promoters in the design of healthy places and communities. Future research needs are highlighted.

Keywords: healthy communities; healthy places; nature contact; public health promotion

Environmental health

Physical environments influence health in a myriad of ways through psychological, behavioral, social, and biological pathways (Lawrence and Hartig 2001; Northridge et al. 2003). The current mainstream conceptualization of environmental health is the study of built environmental factors or exposures that may threaten human health through biological pathways. Sources of water pollution, chemical containments commonly found in water, solid and hazardous waste removal procedures, radiation concerns, and air pollutants are common focal points of environmental health study and intervention (Chiras 2001). Indoor environmental science, a branch of environmental health, primarily focuses on building-related air pollutants and toxins and their related illnesses and respiratory conditions, such as Sick Building Syndrome (Kreiss 1990; Samet and Spengler 2003).

In addition to negative biological effects, physical environments can threaten human health through psychological pathways. Environmental psychological demands, such as crowding and noise, increase the likelihood of perceived stress (Brennan et al. 2002; Raffaello and Maass 2002; Huang et al. 2004). Previous research has shown that cortisol and other indicators of perceived stress were related

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to density and numbers of individuals in a room among samples of toddlers and children (Evans et al. 2001; Legendre 2003; Maxell 2003). In addition, regular exposure to noises, such as traffic or ambient noise at work, was associated with annoyance and stress (Ouis 2001; Leather et al. 2003b).

“Urban ills”, as described by Stephen and Rachel Kaplan (2003), also represent how physical environments can threaten human health. Physical environments typified by poor, inadequate housing (Leventhal and Brooks-Gunn 2003; Seagert et al. 2003) and urban sprawl (Frumkin 2002) are unhealthy environmental conditions.

In summation, built environments can harm health in many ways, not limited to biological pathways as the mainstream conceptualization of environmental health suggests. Unhealthy physical environments are places typified by toxins, pollutants, environmental demands, low environmental control, crime, poverty, urban sprawl, reliance on automobiles, and over or unwise consumption of natural resources.

Environmental health promotion

Just as unhealthy physical environments can threaten health, healthy places or “health-promoting environments” (Frank and Engelke 2001) may enhance health. Environmental health promotion is the study and promotion of healthy places. Healthy places are void of unhealthy environmental characteristics previously described. In addition, healthy built environments are characterized with health-promoting factors that promote behavioral, social, psychological, and biological health (Ulrich 1991; Frumkin 2003; Leather et al. 2003a; Srinivansan et al. 2003).

Availability of healthy choices, safety, mixed designed land-use, environmental sustainability and stewardship, and the opportunity for nature contact are characteristics of healthy places and communities.

The availability of healthy choices is likely to promote healthier behaviors (Kaplan and Kaplan 2003). Ecological health behavior models recognize the comprehensive determinants of behavior, especially the physical environment (Satariano and McAuley 2003). Findings from a recent study suggested that healthier food choices in the workplace’s eateries, such as greater space devoted to fruit and vegetable food items, resulted in healthier diets among employees (Engbers et al. 2005). Healthy places offer healthy choices.

There has been an influx of scientific evidence on the influence of the built environment on physical activity (Giles-Corti and Donovan 2002; Sallis et al. 2002). Healthy physical environments that facilitate physical activity are places characterized by safety, mixed-use design, and natural aesthetics or nature contact (Saelens et al. 2003). Safety has been measured in a variety of ways including crime rates, width and quality of sidewalks, presence and brightness of street lights, and low automobile speed limits (Cervero and Duncan 2003; Egan et al. 2003; Saelens et al. 2003). Healthy places are safe.

Mixed use design is the reverse of urban sprawl and refers to land-use diversity (i.e. using land for varied reasons such as residential, retail, and employment in one area) and connectivity (i.e. characterized by short distances between places of interest with means to get from one place to other). Physical activity and social capital are fostered in environments where distances between places of interest is short, connectivity is high, and land-use diversity is great (Frumkin 2002; Cervero and Duncan 2003; Saelens et al. 2003). Healthy communities are compact and well-connected.
Environmental sustainability is another component of healthy built environments (Frumkin 2008). Healthy communities and places provide the opportunity for and encourage stewardship of our natural resources through the opportunity to recycle, reduce, and reuse. A healthy workplace, for example, may institutionalize policies to promote double-sided paper copying and recycling. The protection of natural resources is critical for public health in its relation to food sources, water supply, air quality, and biodiversity. Healthy communities and places protect natural resources.

Nature contact is an aspect of healthy places and communities. Previous research has demonstrated that nature contact was related to greater physical activity, lower perceived stress, and quicker and better recovery from surgery (Irvine and Warber 2002; Saelens et al. 2003). Nature contact is achieved when humans interact with plants, animals, landscape views, or the outdoors (Frumkin 2001). A plant in an office, a fish tank in a dentist waiting room, a window and natural light in a classroom, nature photography in the home, and a neighborhood park are all examples of health-promoting nature contact. Healthy places provide the opportunity for nature contact.

**Nature contact recommendations**

The remainder of this review of literature focused on nature contact, a specific component of healthy places and communities. Nature contact is the focus for three main reasons. First, previous findings and theory suggest that nature contact is healthful, but to date there has been little awareness or inclusion of nature contact in the paradigm or discussion of healthy places and healthy communities (Frumkin 2001).

Second, nature contact may offer a practical approach for population-based health promotion, especially related to stress and stress-related health outcomes. Lasting perceived stress has been shown to cause disease states through biological pathways (i.e. alterations to immune function) and behavioral pathways (i.e. increase in risk behaviors) (Poluszny and Baum 1999; Cohen et al. 2001). Stress occurs when perceived demands are greater than perceived resources (Lazarus and Folkman 1984). According to environmental restoration theories, nature contact reduces stress by restoring resources necessary to cope with stress (Wilson 1984; Ulrich et al. 1991; Kaplan 1995). Taken together, theory and previous findings suggest that “...contact with nature may provide an effective population-wide strategy in the prevention of [stress]...” (Maller et al. 2005, p. 45) and related health outcomes.

Third, although there is 30 years of research from varying fields, nature contact is a relatively new concept in public health. There is a need for future study in public health. This article presents evidenced-based recommendations for public health and future public health research needs.

In this manuscript, nature contact was organized into categories of potential contact: outdoor nature contact, indoor nature contact, and indirect nature contact. Public health promotion professionals should collaborate with healthcare professionals, design-related professionals, and urban planners to apply these findings and promote healthful environments.

**Outdoor nature contact**

Outdoor nature contact offers the most direct and likely the most concentrated dose of health benefits (Rossman and Ulehla 1977; Mayer et al. 2009). This form of nature
contact takes place outside and includes interaction with plants, animals, the land and water, and or wilderness. Vacationing in beautiful natural places and taking an outdoor work break for a fresh air are intuitively restorative practices. The relationship between health and outdoor nature contact has been studied with varied research methods and outcome variables including physiological responses, psychological stress, and physical health and recovery. See Table 1 for a summary of major quantitative research findings.

**Preserve and protect our wilderness**

Health educators may serve as advocates for land and wilderness conservation with the goal of protecting resources necessary for health (i.e. biodiversity, clean water, clean air, product-based resources, agriculture). In addition, pristine land may be the ultimate intervention for human restoration. Wilderness therapy is a clinical intervention that has been employed for substance abuse and at-risk teenagers and traditionally involves individual or group activities in remote or pristine outdoor settings (Ulrich and Addoms 1981; Ulrich et al. 1990). Wilderness experience has been associated with spiritual health and growth, self-actualization, and psychological health (Young and Crandall 1984; Hartig et al. 1991; Fredrickson and Anderson 1999). Williams and Harvey (2001) conducted a qualitative study in Australia on experience in the forest. Principal Components Analysis (PCA) revealed that transcendence, described as a lack of stress and enhancement of spirituality, occurs in forests due to a complex human-environment transaction. The transcendence was not dependent on activities performed in the natural environment, but rather it was dependent on the qualities (i.e. nature contact) of the forest.

**Plan for and incorporate wooded parks and urban green space**

Outdoor nature contact should be cultivated in communities and cities where people live, work, and play. Regular experience with outdoor nature contact may contribute to reductions in crime, aggression, violence, and road rage (Parsons et al. 1998; Kuo 2001; Kuo and Sullivan 2001a, 2001b; Cackowski and Nasar 2003). Hartig and others found that “green exercise” and walking in natural settings such as parks fostered a greater physiological stress recovery following a stressor than walking in an urban environment (Hartig et al. 1991, 2003; Bodin and Hartig 2003).

Outdoor nature contact is also, and perhaps especially, important for children. Richard’s Louv recent book titled *Last child in the woods: Saving our children from nature deficit disorder* emphasized the importance of green play, outdoor play in natural settings, for health among children (Louv 2005). He coined the term “nature deficit disorder” to describe the dangerous divide between children and nature and the subsequent health problems associated with that disconnect. Findings have confirmed Louv’s thesis. The opportunity for outdoor nature contact nearby the home, places where children play, has been correlated to incidence of Attention Deficit Disorder (ADD) symptoms (Taylor et al. 2001), perceived stress, and personal resources. In a rural setting, vegetation nearby the home was associated with less stress among rural children (Wells and Evans 2003). In a city environment, parents’ ratings of the naturalness of the views at home, a measure of nearby nature, predicted 20% of the variance in the total self-discipline score comprised of test
Table 1. Selected findings on health benefits of outdoor nature contact.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample</th>
<th>Design</th>
<th>Major findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cimprich 1993</td>
<td>Women after breast cancer surgery (n = 32)</td>
<td>Experimental</td>
<td>Controlling for pre attentional capacity, green intervention had greater mean gain in attentional capacity over time (F_{3,87} = 12.02, p &lt; 0.0001)</td>
</tr>
<tr>
<td>Grahn and Stigsdotter 2003</td>
<td>Random sample of residents in 9 Swedish cities (n = 953)</td>
<td>Cross-sectional</td>
<td>More a person visits urban open green space, the less likely report stress-related illness (F = 6.26, p &lt; 0.01) (no difference in visiting based on socio-demographic variables)</td>
</tr>
</tbody>
</table>
| Hartig et al. 2003            | College students \(n = 112\)    | Experimental    | 1. Participants with tree views had lower blood pressure during seated treatment than without view \(F_{1,90} = 8.94, p < 0.005\)  
2. After initial increases due to physical activity, blood pressure was lower when walking in nature reserve than city \(F_{1,102} = 12.97, p < 0.001\)  
3. Post walk, participants with tree view had lower blood pressure than those without view \(F_{1,100} = 2.84, p < 0.10\)  
4. Those walking in nature reserve had more positive emotion than those walking in urban environment \(F_{1,49} = 7.40, p < 0.01\)  
5. Nature reserve had a significantly greater increase in positive emotion pre-to-post compared to city walk \(F_{1,100} = 56.83, p < 0.001\)  
6. Anger and aggressiveness declined at nature reserve but increased in city walk from pre-to-post \(F_{1,99} = 8.19, p < 0.01\)  
7. Attentional capacity performance increased in the natural environment from pretest to the walk \(F_{1,98} = 13.15, p < 0.001\) |
| Hartig et al. (study 1) 1991  | Physically fit outdoor backpackers \(n = 68\) | Quasi-experimental | Follow-up (after initial post-test) revealed that wilderness backpackers had greater overall happiness \(F_{4,130} = 3.07, p < 0.01\) |
| Hartig et al. (study 2) 1991  | College students \(n = 51\)  | Experimental    | Nature group had higher overall happiness \(t_{90} = 1.68, p < 0.05\), higher positive affect \(t_{95} = 2.37, p < 0.01\), and lower anger/aggression \(t_{62.51} = 2.69, p < 0.005\) than the other groups and 56.5% fewer cognitive errors detected in nature setting compared to urban and relaxation conditions \(t_{94} = 2.45, p < 0.01\) |
| Kuo 2001                     | Urban public housing residents \(n = 145\) | Cross-sectional | Procrastination with dealing with issues, and issues assessed as more severe higher in barren as opposed to nature contact surroundings \(t_{138} = 2.4, p < 0.01\) |

(continued)
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<th>Source</th>
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<th>Major findings</th>
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<tbody>
<tr>
<td>Kuo and Sullivan</td>
<td>Urban public housing residents ($n = 145$)</td>
<td>Cross-sectional</td>
<td>Violence and aggression higher among residents in buildings with less nature contact surroundings. Aggression against partner higher in barren than green surroundings ($t_{140} = 1.68, p &lt; 0.05$)</td>
</tr>
<tr>
<td>Kuo and Sullivan</td>
<td>Residents in inner-city public housing</td>
<td>Retrospective</td>
<td>Vegetation was inversely related to total crime ($R^2 = 0.08, p &lt; 0.01$), property crime ($R^2 = 0.07, p &lt; 0.01$), and violent crimes ($R^2 = 0.07, p &lt; 0.01$) (held true when controlling for population density)</td>
</tr>
<tr>
<td>Mayer et al. (study 1)</td>
<td>College students ($n = 76$)</td>
<td>Experimental</td>
<td>Participants in the outdoor nature walk condition demonstrated significantly better greater positive affect $F_{(1, 57)} = 12.67, p &lt; 0.001$ than those in the virtual (video) nature walk condition</td>
</tr>
<tr>
<td>Mayer et al. (study 3)</td>
<td>College students ($n = 64$)</td>
<td>Experimental</td>
<td>Participants in the outdoor nature walk condition demonstrated significantly better attentional capacity (restoration) ($F_{(1, 67)} = 8.49, p &lt; 0.01$) and greater positive affect ($F_{(1, 69)} = 5.04, p &lt; 0.05$) than those in the urban walk condition</td>
</tr>
<tr>
<td>Parsons et al. 1998</td>
<td>College students ($n = 160$)</td>
<td>Experimental</td>
<td>Recovery following stress was quicker and more complete in nature driver vs. urban drive according to EKG ($F_{3,112} = 2.75, p &lt; 0.05$) and skin conductance ($F_{1,109} = 10.11, p &lt; 0.05$)</td>
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<tr>
<td>Taylor et al. 2002</td>
<td>Inner city children ($n = 169$)</td>
<td>Cross-sectional</td>
<td>Girls with more green outdoor surroundings scored higher on concentration ($F_{1,76} = 10.09, p &lt; 0.01$), impulse inhibition ($F_{1,76} = 3.8, p = 0.05$), delayed gratification ($F_{1,76} = 12.7, p &lt; 0.001$), and overall self-discipline ($F_{1,76} = 19.4, p &lt; 0.001$)</td>
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<tr>
<td>Taylor et al. 2001</td>
<td>Children with ADD ($n = 4$)</td>
<td>Cross-sectional</td>
<td>Greener child’s play environment during previous week, the less severe ADD symptoms ($R^2 = 0.08, F_{1,91} = 8.18, p &lt; 0.01$)</td>
</tr>
<tr>
<td>Wells and Evans 2003</td>
<td>Rural children grades 3–5 ($n = 337$)</td>
<td>Cross-sectional</td>
<td>Children with more nearby nature have less stress ($F_{2,335} = 6.27, p = 0.05$)</td>
</tr>
<tr>
<td>Whitehouse et al. 2001</td>
<td>Hospital patients/staff family members ($n = 83$)</td>
<td>Cross-sectional</td>
<td>The most reported well-being change as a result of visiting the garden was “more relaxed, less stressed, content” 54%</td>
</tr>
<tr>
<td>Young and Crandall 1984</td>
<td>Adults ($n = 503$) and wilderness users ($n = 222$)</td>
<td>Cross-sectional</td>
<td>Wilderness users more self-actualized than non-users ($t_{611} = 2.23, p = 0.026$)</td>
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</table>
concentration, impulse inhibition, and delay of gratification among the girls in the study (Taylor et al. 2002). Poor urban children ranked high vegetation neighborhood parks and playgrounds and backyard gardens as favorite and liked places in comparison with other nearby places (Castonguay and Jutras 2009). Parks and green spaces are important aspects of healthy communities and places.

*Cultivate grounds for stress reduction*

Healthy places can be cultivated. Workplaces with landscaped grounds and seating, for example, provide a health-promoting opportunity for its employee. Researchers from New Zealand found that quietly relaxing and enjoying nature was related to less work stress compared to active leisure such as challenging, exciting, and goal-driven activities. “Organizations, if they are committed to employee health and well-being, may now need to consider the benefits of providing recuperative-therapeutic opportunities in much the same way as they have considered and provided opportunities for employees to engage in social, sporting, and health-related activities” (Trenberth et al. 1999, p. 100).

Health-promoting landscaping should include seating for comfortable viewing and may include native wild flowers, trees, and plants, water elements, or a combination. Native plants are an important component of health-promoting landscaping because: (1) native plants are hardier, require less maintenance, and are cost efficient; (2) native plants are beautiful and highlight the unique, natural aspects of the region; and (3) perhaps most importantly for health, native plants require less resources (water, nutrients) to thrive (i.e. xeriscaping) (Tallamay 2007).

*Maintain ‘healing’ gardens*

Previous studies have suggested that interacting with outdoor plants has healing and stress-reducing benefits among various clinical and healthy populations. Horticulture therapy is a healthcare intervention that involves planting or gardening. Elderly people, young patients, healthcare employees, family members of patients, and adult patients have shown an improvement in health as a result of exposure to gardens or gardening experience (Cimprich 1993; Whitehouse et al. 2001; Irvine and Warber 2002; Frumkin 2004; Milligan et al. 2004; Soderback et al. 2004). Women who participated in horticulture therapy for 20–30 min three times a week for three months following a breast cancer surgery, for example, showed significant improvement in resources to deal with stress over time compared to the control group (Cimprich 1993). Hospitals and other settings interested in healing and stress-reduction may provide the opportunity for gardening on site.

*Outdoor nature contact summary*

Health educators should include nature contact in healthy communities and places. Health educators can increase outdoor nature contact by: (1) advocating for the protection and preservation of pristine wilderness, (2) incorporating wooded parks and green space in communities and urban settings, (3) cultivating workplace, hospital, school, home grounds for viewing, and (4) maintaining healing gardens and promote gardening.
Indoor nature contact

Florence Nightingale, the founder of modern nursing, first recognized the importance of indoor nature contact for patient recovery and healing (Parsons 1991). Healing hospital design is a well studied topic in environmental psychology and design-related fields (Coile 2002; Devlin and Arneill 2003). The concept of “wellness by design” has started to receive attention in health-related fields as well (Ulrich 1991; Voelker 2001; Irvine and Warber 2002). Healing and health-promoting indoor environments are functional, free of environmental demands such as noise and discomforts, and have the opportunity for indoor nature contact (Ulrich 1991; Frumkin 2001, 2003; Devlin and Arneill 2003; Leather et al. 2003b). Indoor nature contact is interactions with plants, animals, or landscape views that may be achieved inside of a built environment such as the home, hospital, school, or work place. Indoor plants, fish aquariums, contact with other animals such as pets, natural lighting, and natural views from the windows are examples of nature contact that may be achieved indoors (Ulrich 1991). See Table 2 for a summary of major quantitative findings.

Encourage animal contact indoors

Unlike European business owners, indoor American establishments do not welcome or allow pets, with the exception of service dogs. The research findings on the human health benefits of known and unknown animals, a type of nature contact, may explain the European hospitality towards pets (Beck and Katcher 1996). Perhaps health promoters should focus on pet ownership and friendly pet policies, similar to those in many European countries, and welcome animals and pets indoors when appropriate.

Allen (2003) found that participants exposed to a stress-invoking condition of mental arithmetic showed significant reduction in blood pressure in the presence of their pet (dogs and cats) compared to in the presence of their human support (friends and spouses). Research findings have also pointed to the health benefits of unknown pets as well. Pet therapy or animal-assisted therapy is a field of study that examines the health-promoting impact of exposure to benign animals such as another’s pet. Animal visitation has been shown to reduce physiological reactivity and self-reported perceived stress (Ulrich 1991; Barker 1999; Louv 2005). The presence of birds, fish, or other small animals, unknown or less known animals, may promote health as well. Katcher and others (1984) (reported in Ulrich 1991) found that dental patients who viewed fish swimming in an aquarium had significantly lower anxiety and discomfort and increased patient compliance than their counterparts. Because even brief exposure to unknown animals such as fish in an aquarium or an unfamiliar dog appear to promote health, some of the health benefits of animal contact are likely due to the innate relaxing and restorative properties of nature contact.

Bring potted plants indoors (the more, the better)

Indoor plants are health-promoting for several reasons. First, indoor foliage plants (such as Kentia Palm, Peace Lily, Janet Craig, and Devil’s Ivy) improve indoor air quality by reducing volatile organic compounds (VOC) concentrations, airborne pollutants originating from carpets, paint, glues, varnish, and wall fixtures. Even regular exposures to low concentrations of VOCs have been linked to
Table 2. Selected findings on health benefits of indoor nature contact.

<table>
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<tr>
<th>Source</th>
<th>Sample</th>
<th>Design</th>
<th>Major findings</th>
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<tbody>
<tr>
<td>Beauchemin and Hays 1996</td>
<td>Inpatient Major Depressive Disorder (n = 174)</td>
<td>Quasi-experimental</td>
<td>Patients in bright natural light rooms had less hospitalized days (M = 16.9 days) than patients in dim sunlit room (M = 19.5 days) Z = 1.4, 1-tail, p &lt; 0.05</td>
</tr>
<tr>
<td>Dijkstra et al. 2008</td>
<td>College students (n = 77)</td>
<td>Experimental</td>
<td>Participants exposed to the hospital room with indoor plants reported less stress than those exposed to the same room without plants t(75) = 2.34, p = 0.022</td>
</tr>
<tr>
<td>Kaplan 2001</td>
<td>Resident of apartments in Midwest (n = 188)</td>
<td>Cross-sectional</td>
<td>Nature view from apartment window predicted 35% of variance in satisfaction in neighborhood (p &lt; 0.05); effective functioning was predicted by weather view (sky) (R² = 0.05, p &lt; 0.01), time and activities outdoors (R² = 0.08, p &lt; 0.05); nature view (R² = 0.11, p &lt; 0.05); views of trees and fields specifically predicted less distraction (R² = 0.07, p &lt; 0.05)</td>
</tr>
<tr>
<td>Kaplan (study 1) 1993</td>
<td>Employees (n = 168)</td>
<td>Cross-sectional</td>
<td>Office staff with a view of nature from window had less health ailments (t₁₀₀ = 1.99, p &lt; 0.05) and higher job satisfaction (t₃₄ = 2.07, p &lt; 0.05) than counterparts no nature view</td>
</tr>
<tr>
<td>Kaplan (study 2) 1993</td>
<td>Random sample of employees (n = 615)</td>
<td>Cross-sectional</td>
<td>Office nature view had greater satisfaction than built environment view (F₁,₅₂₅ = 29.07, p &lt; 0.0001) and those with a window view had greater job satisfaction (F₂,₆₀₇ = 20.12, p &lt; 0.001), more enthusiasm (F₂,₆₀₅ = 12.82, p &lt; 0.001), and general health (F₂,₆₀₇ = 3.74, p &lt; 0.05) than those without</td>
</tr>
<tr>
<td>Kearney 2006</td>
<td>Community members in northwest (n = 261)</td>
<td>Cross-sectional</td>
<td>Natural view elements accounted for 13% variance in life satisfaction p &lt; 0.05</td>
</tr>
<tr>
<td>Keep et al. 1980</td>
<td>ITU patients (n = 150)</td>
<td>Retrospective</td>
<td>Hallucinations and delusions were twice as common among patients in windowless room compared to natural light patients (48.3%, 23.6%)</td>
</tr>
<tr>
<td>Kuller and Lindsten 1992</td>
<td>School children (n = 90)</td>
<td>Quasi-experimental</td>
<td>Windows and natural light rooms showed more hormone consistent with healthy annual variations compared to no windows (F₁,₈₀ = 5.52, p = 0.02), but no difference in sick leave</td>
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Table 2. (Continued).

<table>
<thead>
<tr>
<th>Source</th>
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<th>Major findings</th>
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<tbody>
<tr>
<td>Larsen et al. 1998</td>
<td>Paid students, faculty, and staff ($n = 81$)</td>
<td>Experimental</td>
<td>No plants had highest productivity and high plants (22 plants in office) lowest ($F_{2,78} = 3.41, p = 0.04$); moderate plants (11 plants) reported highest assessment of experience ($F_{2,78} = 4.15, p = 0.02$); and high plants had more positive comments about office than moderate or no plants</td>
</tr>
<tr>
<td>Shibata and Suzuki 2004</td>
<td>College students ($n = 146$)</td>
<td>Experimental</td>
<td>Males preformed better on task with plant (direct view) compared to no plant ($F_{2,67} = 2.81, p &lt; 0.10$)</td>
</tr>
<tr>
<td>Shibata and Suzuki 2002</td>
<td>College students ($n = 90$)</td>
<td>Experimental</td>
<td>When completing cognitive task, mood better in room with plant ($F_{9,160} = 2.4, p &lt; 0.05$) or magazine ($F_{9,160} = 1.93, p &lt; 0.10$) compared to nothing and plants better than magazine for females ($HSD = 14.77, alpha = 0.05$)</td>
</tr>
<tr>
<td>Tennessen and Cimprich 1995</td>
<td>College students living in dorm ($n = 72$)</td>
<td>Cross-sectional</td>
<td>Students with all natural view scored better on 3 of 4 cognitive tests than students with other views combined (mostly natural, mostly built, and all built) ($t_{71} = 3.29, p &lt; 0.01$; $t_{71} = 3.12, p &lt; 0.01$; $t_{72} = 2.02$, $p &lt; 0.05$), but no difference in demographics</td>
</tr>
<tr>
<td>Ulrich 1984</td>
<td>Cholecystectomy patients ($n = 46$)</td>
<td>Retrospective</td>
<td>Patients in hospital room with window nature view spent less days in hospital ($T_{17} = 35, z = 1.965, p = 0.025$), less drugs used for nature view ($T^2 = 13.52, F = 4.3, p &lt; 0.01$), and less negative comments made for nature view ($T_{21} = 15, z = 3.49, p = 0.001$) than patients in identical room with brick view</td>
</tr>
<tr>
<td>Wells and Evans 2003</td>
<td>Low income children ($n = 17$)</td>
<td>Quasi-experimental</td>
<td>Families moved from housing 1 (less nature) to housing 2 (more nature) and naturalness change score predicted 19% variance in post-move attentional capacity beyond 50% of pre-move capacity ($p &lt; 0.01$)</td>
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</table>
irritation of the eyes, skin, airways, and nose, rhinitis, asthma, headache, and fatigue among office workers. Plants serve as a “flexible and attractive biofiltration system for the future that can be used in any indoor space” (Wood 2003, p. 7).

Furthermore, indoor plants, like outdoor vegetation, are restorative. Larsen et al. (1998) tested the effects of plants in an office space on mood, comfort, perceived attractiveness, perceived productivity, and actual productivity. Eighty-one participants were randomized into a 140 square foot office space with three plant conditions for the experiment: high (22 plants), moderate (11 plants), and no plants (0 plants). Participants were given a task and questionnaires. The results suggest that participants in the high plant condition (22 plants in 140 square feet office space) reported greater well-being, greater perceived office attractiveness, and comfort than the other conditions (Larsen et al. 1998). Participants exposed to the hospital room with indoor plants reported less stress than those in the control condition (Dijkstra et al. 2008). Live indoor plants promote healthy air quality and stress reduction in a “dose-dependent” relationship.

Let bright natural sunlight shine in

Some researchers have commented that office windows are valued status symbols because people and societies intuitively understand the health benefits of windows (Kaplan 1993, 2001). Others proposed that windowless rooms in hospitals, workplaces, and other public places should be outlawed because they make occupants suffer (Keep et al. 1980). People prefer rooms with windows that cover about a quarter of the wall space (Devlin and Arneill 2003). Windows provide the opportunity for natural light and allow for a view of natural elements and landscapes (reviewed in the next section).

Lighting is an important factor for health and performance (Winterbottom and Wilkins 2009). Natural light promotes normal physiological functioning and regulation, maximization of visual performance, and mood enhancement. Sunlight is a preferred, attractive, and practical source of light in indoor and work environments (Boyce et al. 2003). Beauchemin and Hays (1996) examined the relationship between bright natural light rooms (direct sunlight from window) and dim natural light rooms (structure or position preventing direct sunlight from window) on psychiatric inpatient recovery. The results indicate that patients with bright sunny rooms had significantly shorter average hospital stays (16.9 days) than patients in dimly lit rooms (19.5 days).

Previous studies support the notion that natural light is important for normal physiological functioning among children as well. Kuller and Lindstein (1992) conducted a study of the effect of natural light and artificial florescent light in four classrooms on stress hormones, academic performance, body growth, and sick leave on school children. The children with exposure to natural light had the healthiest chrono-biological response throughout the seasons. These findings suggest that windows, which allow natural sunlight, are an important fixture in schools for child health and development. In addition, artificial daylight florescent tube lighting were associated with healthier hormone regulation than the artificial soft-white florescent tube lighting.

McColl and Vietch (2001) conducted a review of the literature on the physiological benefits of full-spectrum florescent lamps (FSFL). They concluded that natural sunlight is polarized, more intense, and has greater correlated color temperatures than any indoor electric light source. Although there appears to be
a consensus in the literature about the health benefits of natural light in all indoor environments, there is not a clear best alternative to sunlight.

**Incorporate windows and a view outdoors**

The first studies on health benefits of window views were natural experiments with the equivalence of participant randomization. Moore (1981) evaluated environmental characteristics of a depression-era, Michigan prison on prisoners’ physical health. Findings suggested that prisoners with an outside view from their cell window of rolling farmland and trees had 24% less sick visits than prisoners with a courtyard view from their cell window. There were no other differences in cell design and prisoners were randomly assigned cells upon entry. Windows and natural light alone do not fully account for the health benefits of nature contact; the naturalness of the view matters.

Wells (2000) conducted a longitudinal study that examined the influence of a move from poor quality housing with low quality nature window views to better quality housing with better quality nature window views among 17 low-income children’s cognitive functioning. The researchers assessed and quantified the child’s directed attention capabilities (DAC) and nature views from both the poor quality (pre move) and improved quality (post move) homes. The results indicated that the children whose window view of nature from the home improved the most had the most improvement in cognitive abilities months after the move. “That the change in restorativeness [window view of nature from the home] explains 19% of the variance in post move DAC is striking, particularly considering the modest sample size of 17” (Wells 2000, p. 790). Results suggest that access to a view of natural elements at home and work even for brief moments, were associated with satisfaction, resources necessary to combat stress, restoration from stress, and health.

**Let outside air and sounds in**

Generally, indoor air has higher concentration of health-compromising pollutants than outdoor air. Buildings with less ventilation along with higher concentrations indoor contaminants (i.e. carpet adhesive, indoor paint off-gas, traditional insulation) are less healthy than buildings with open windows and less chemical concentrations. “Sick building syndrome” suggests that regular, prolonged exposure to unhealthy indoor environments, such as workplace or home, make people sick (Jones 1999). Regularly opening the window to allow outdoor air to flood in (even in extreme weather months) is an important way to rejuvenate and manage the health of indoor air quality.

In addition, there may be restorative benefits of open windows. Open windows as a form of indoor nature contact warrants research attention, but previous findings support the hypothesis that open windows are stress-reducing. Outdoor nature contact literature suggests that being outdoors is healthful and restorative and indirect nature contact studies suggest that recorded nature sounds are relaxing (Frumkin 2001). The feel of the outdoor air and movement (if the air is a comfortable temperature) and the sound of the outdoors (if sounds are relatively natural such as breeze or birds), may enhance nature contact indoors and thus promote health. Health educators should open the windows to “air out” the rooms to manage air quality and provide the opportunity for nature contact.
Indoor nature contact summary

Health educators should include nature contact in healthy indoor built environments. Health educators can increase indoor nature contact by: (1) welcoming animals (fish tanks) and pets (dogs) inside, (2) providing a plethora of indoor potted plants within view, (3) lighting rooms with bright natural light, (4) providing a clear view of nature (plants, water, trees, open space) outside, and (5) allowing outside air and sounds to flood inside.

Indirect nature contact

Indirect nature contact has been described as abstract representations of animals, plants, landscape views, or outdoors (Parsons 1991) or a surrogate of nature contact (Ulrich 1981). Nature photography, art, and recorded sounds are examples of indirect nature contact that have been shown to be health-promoting. See Table 3 for a summary of major quantitative findings.

Display nature photography and paintings

Ulrich (1981) first tested the intuitive hypothesis that visual representations of nature were relaxing. Participants viewed photograph slides depicting nature with water, nature with plants and vegetation, or urban, built environments without plants or water. Participants who viewed photographs of nature with water or vegetation showed more physiological (alpha magnitude and heart rate) and self-reported relaxation than participants who viewed urban scenes. Similar findings were found among patients waiting in a hospital waiting room (Leather et al. 2003a) and among pre-surgical patients (Ulrich 1991). The findings suggest that nature photography is relaxing among unstressed and stressed individuals. In addition, non-abstract nature paintings have been show to improve mood among psychiatric patients (Ulrich 1991) and social capital among community members (Semenza 2003). Recent findings suggest that views of dramatic, photographed natural scenes have greater perceived restoration than actual views of mundane nature and built environments (Felsten 2009). Healthy indoor places should display personal or professional nature photographs or paintings (i.e. flower, animal, sunset, or natural landscape view).

Listen to recorded nature sounds

Researchers at John Hopkins University conducted a prospective, randomized clinical trial to test the effectiveness of indirect nature contact to control pain associated with a bronchoscopy, a diagnostic procedure which involves inserting a tube down into the lungs. Patients randomized into the nature therapy group were exposed to a bedside curtain with a large nature landscape photographic printed on it and listened to a tape of recorded nature sounds of a flowing stream or birds chirping through headphones during the procedure. The nature therapy group showed a 43% increase in the self-reported pain control compared to the control group (Diette et al. 2003). Playing nature sound CDs in hospitals, workplaces, or schools may contribute to a healthful environment.
<table>
<thead>
<tr>
<th>Source</th>
<th>Sample</th>
<th>Design</th>
<th>Major findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cackowski and Nasar 2003</td>
<td>College students (n = 106)</td>
<td>Experimental</td>
<td>Higher frustration tolerance (in completing a cognitive task) after exposure to vegetation-rich road side simulation video compared to moderate vegetation ($F_{1,65} = 4.84, p &lt; 0.05$) and mostly built road-side videos ($F_{1,67} = 5.66, p &lt; 0.05$)</td>
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<tr>
<td>Diette et al. 2003</td>
<td>Adult patients undergoing flexible bronchoscopy (FB) with conscious sedation (n = 80)</td>
<td>RCT</td>
<td>Nature intervention group (42 × 52-in photograph of mountain stream and nature CD playing by beside) were 43% more likely to report pain control as being very good or excellent and odds of better pain control were greater in the intervention patients than in the control patients (OR = 4.76, 95% CI, 1.35–16.7, $p = 0.015$)</td>
</tr>
<tr>
<td>Leather et al. 2003a</td>
<td>Neurology outpatients (n = 145)</td>
<td>Quasi-experimental</td>
<td>Nature contact waiting room more relaxing, comfortable, positive than traditional ($T_{14,116} = 10.644, p = 0.000$); self-reported stress decrease over time in nature waiting room whereas stress increased over time in tradition ($F_{1,132} = 5.83, p = 0.017$); pulse rate higher in nature room ($t_{143} = 4.332, p = 0.001$)</td>
</tr>
<tr>
<td>Ulrich 1981</td>
<td>College students (n = 18)</td>
<td>Experimental</td>
<td>Participants view color photo slides (1) nature with water (water), nature dominated by vegetation (vegetation), urban without nature or vegetation (urban):</td>
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<tr>
<td></td>
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<td>1. Sadness greater after viewing urban compared to water ($p = 0.005$) and vegetation ($p = 0.07$)</td>
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<tr>
<td>Ulrich 1979</td>
<td>College students (n = 46)</td>
<td>Experimental</td>
<td>After exam stress condition, participations randomly assigned to view 50 photographs of unspectacular nature (vegetation) or urban scenes (no vegetation):</td>
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<td></td>
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<td>4. EKG heart rate higher during water and vegetation than urban (water = 71.3 bpm, vegetation, 71.1, urban = 70.2; $p &lt; 0.02$) consistent with belief nature provoke attention</td>
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Table 3. (Continued).

<table>
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<tr>
<th>Source</th>
<th>Sample</th>
<th>Design</th>
<th>Major findings</th>
</tr>
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</table>
| Ulrich et al. 2003 | Blood donors (n = 872)  | Quasi-experimental | 1. No difference between groups pre scores  
2. Nature group felt less fearful (Pre = 1.57, Post = 1.30, $p < 0.05$) and more carefree and playful (Pre = 1.87, Post = 2.35, $p < 0.05$) after nature photography exposure  
3. Urban group felt more sad (Pre = 1.83, Post = 2.30, $p < 0.025$) and less attentive (Pre = 2.61, Post = 2.0, $p < 0.01$) after exposure to urban scenes  
4. Pre-post change scores for feeling elated and pleased were more positive in nature group (urban change = $-0.22$, nature = $+0.57$, change between groups = $0.79$, $p = 0.002$)  
Nature tape and no TV donors had lower pulse rate ($F = 9.53, p < 0.01$) and blood pressure ($F = 3.43, p = 0.06$) than doors watching urban tape and daytime TV; nature tape lower pulse rate than urban tape ($F_{1,864} = 5.63$, $p < 0.05$) |
Watch video or show of a natural environment

Those who watch Discovery Channel’s TV documentary, *Sunrise Earth*, would probably agree that the un-narrated show is relaxing and restorative. Recent research has supported this notion (de Kort et al. 2006). Blood donors who viewed a video tape of nature scenes and sounds or no TV had significantly lower blood pressure and pulse rate than participants who viewed daytime TV or a video tape of urban scenes and sounds during a blood donation (Ulrich et al. 2003). Nature videos (green vegetation and fast moving stream) have been shown to be more relaxing than built environment videos (busy mall) based on physiological and self-reported data (Ulrich 1991). Nature shows or videos may be a component of a healthful indoor environment.

Add more representations of nature

The combined findings suggest that indirect nature contact is health promoting. In addition to nature sounds, photography, and art, artificial plants and sculptures of animals are representations of actual nature and may also be healthful. Future researchers should test this assumption.

Indirect nature contact summary

Health educators should include nature contact in healthy indoor built environments. Health educators can increase indirect nature contact by: (1) displaying nature photography and realistic nature art, (2) watching nature on TV or videos, (3) listening to recorded sounds of nature, and (4) perhaps displaying other representations of nature such as artificial plants.

Future research

Although there is 30 years of research on the positive association between nature contact and health outcomes, there are limitations to note. Perhaps the most noteworthy limitation is that many of the significant findings presented here have small effect sizes, which may suggest that nature contact contributes little to health outcomes. This may or may not be the case, as there are other limitations that may be responsible for the small effect sizes. Many of the studies presented here had small sample sizes and examined health outcomes exclusively from self report. In addition, there are inconsistencies with nature contact measurement and conceptualization. Future research should focus on developing valid and reliable tools to measure nature contact comprehensively with large samples and experimental designs.

The effect size of these future studies should be examined to further evaluate the relative “worth” of nature contact in the paradigm of healthy places. Because the findings in this paper suggest a consistent relationship between nature contact and health, it is likely that well designed and controlled future studies would yield stronger findings. In addition, the application of these findings (increasing nature contact exposures to promote health) may be more practical with a greater potential to reach large populations in comparison to many other public health efforts, which may also be an important practical consideration when evaluating the effect sizes of the previous findings.
In addition, there are several specific unanswered research questions. There is a need to: (1) test effectiveness of nature contact interventions on health and stress outcomes, (2) compare the forms and doses of nature contact to best inform interventions and practice, (3) assess nature contact and related health among health disparities populations, (4) test the hypothesis that artificial plants and open windows are restorative, and (5) develop and test practical tools to quantify nature contact. The implications for this research are to understand, design, and promote healthy communities and healthy places to foster the public’s health.

Conclusion

Healthy places and communities are characterized by safety, availability of healthy options, mixed use design, environmental sustainability and stewardship, and the opportunity for nature contact. The purposeful use of nature contact to improve communities, workplaces, hospitals, schools, and homes is an important component of healthy places. Public health professionals should collaborate with healthcare and policy professionals, design-related professionals, and urban planners to apply these findings and promote healthful environments. Public health promoters can cultivate healthy places through the purposeful use of nature contact in the following ways: (1) cultivating workplace, hospital, school, home grounds for viewing, (2) maintaining healing gardens and promote gardening, (3) incorporating wooded parks and green space in communities and urban settings, and (4) advocating for the protection and preservation of pristine wilderness, (5) welcoming animals (fish tanks) and pets (dogs) inside, (6) providing a plethora of indoor potted plants within view, (7) lighting rooms with bright natural light, (8) providing a clear view of nature (plants, water, trees, open space) outside, (9) allowing outside air and sounds to flood inside, (10) displaying nature photography and realistic nature art, (11) watching nature on TV or videos, and (12) listening to recorded sounds of nature.

References


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