Urban Nature, Open Space, and Human Health and Well-Being

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Introduction

This report is an introduction to research on the relationship between urban nature and human health and well-being. The idea that physical and mental health can be made better through contact with natural environments is not new, but recent studies are providing a broader perspective and better empirical understanding of what this means as they bring new relevance to this concept. For people living in cities this may be especially timely, given the "extraordinary disengagement" from nature attributed to urban living.[1] An emerging paradigm of "people and nature" in conservation biology[2] gives further weight to a connection between urban nature, health and well-being that can be mediated through urban policy, planning, and social justice initiatives. With nearly seven of every ten people worldwide projected to live in cities by 2050,[3] there is a growing need to ensure that urban environments are designed and built to meet public health needs and improve the quality of people's lives while conserving and protecting urban biodiversity and the ecosystem services biodiversity can provide.[4] This report is intended to cover some of the basic science relevant to that need.

Background

William Pitt the Elder (1708 – 1778) is credited with coining the aphorism that parks are the "lungs" of the city.[5] This and other metaphorical constructs relating urban open space to good health came to be widely adopted by the end of the eighteenth century, not just in medical science, but in popular literature, poetry, and treatises on ethics and philosophy as well.[6] By the

nineteenth century the concepts of “therapeutic landscape” and “restorative walks” were firmly held by urban planners, underpinning effort to promote urban green space infrastructure, as reflected in enterprises such as the Garden City and City Beautiful movements.[7]

The idea that health benefits could be attributed to exposure to the natural environment received a substantial boost in 1984 when Roger Ulrich published the results of an experimental study comparing two groups of patients recovering from identical surgeries.[8] The groups differed only in postoperative care, with one assigned to rooms with windows looking out on a natural scene while a control group was assigned similar rooms with windows facing a brick building. Those with the natural scene had a significantly reduced postoperative recovery period, a finding that galvanized medical research to further explore the connection between the natural environment and human health. The result has been what are now literally hundreds of studies aimed at teasing apart some of the complex factors involved. Some of that complexity can be attributed to the nature of open space itself, some to the many physical and mental health variables involved, and some to the need to establish more than simple correlational relationships among these variables, as discussed below.

Urban Open Space

There are many types (as well as definitions) of urban open space, but all generally refer to land that is not intensively developed for residential, commercial, industrial or institutional use. As subsets of open space, the terms green and blue spaces are commonly used to differentiate “natural” terrestrial and aquatic environments, while gray space is applied to the built environment or infrastructure of cities. Gray space itself can be used to support plant and animal life, as seen in the green building concepts associated with biophilic design.[9] While there

is no consensus yet on how green infrastructure can be comprehensively classified, general categories such as tree canopy, green open spaces, green roofs and vertical greenery (facades/walls) have been proposed in initial generic schemes.[10] In many cities, private gardens may comprise the major component of green space,[11] but vacant lots, small and large parks, greensward, stream corridors, wetlands, hedgerows, railroad corridors, and curtilage, to name just a few, all have distinctive ecological properties with potential to help sustain plant and animal communities. Collectively, these spaces comprise the natural component of a *landscape mosaic* that serves as a dominant model in contemporary urban ecological theory.[12] The urban landscape represents a complex, dynamic system heavily dominated by human activities, yet increasingly recognized as having its own attendant ecological properties.[13] Satellite imagery quantification of different aspects of greenness and open space (such as tree canopy coverage or distance to nearest park) can be used to provide a basis for objectifying greenspace, while metrics such as the Normalized Difference Vegetation Index (NDVI) provide standards that can be used in comparative overviews of the health and density of vegetation in cities.[14]

Nature and Human Well-being

Within the scientific community, there is a broad[15]—but not universal[16]—consensus that a positive relationship exists between urban green space and physical and mental health. In a 2016 overview the World Health Organization (WHO) concluded that such benefits were especially relevant for "deprived communities, children, pregnant women and senior citizens".[17] That report also concluded that benefits could be expressed through diverse pathways and suggested proposed indicator measures, such as accessibility and connectivity, as ways in which urban planners might directly provide improved health services. Pathways could be direct or

indirect with, in some cases, natural environments simply believed to provide an environmental setting for an activity (such as exercise) that itself had health benefits, while in others intrinsic qualities of natural environments were said to promote positive emotional states and reduce stress.[18] Other scholarship has focused on individual pathways such as air quality, physical activity, social cohesion and stress reduction in articulating more specific relationships.[19]

The scope and number of the health outcomes involved is considerable. One meta-analysis reviewed 103 observational and 40 interventional studies that addressed some 100 health outcomes to conclude that greater exposure to green space was associated at least with decreased salivary cortisol, heart rate, diastolic blood pressure, HDL cholesterol, risk of preterm birth, low frequency heart rate variability, type II diabetes, all-cause mortality, small size for gestational age, and cardiovascular mortality, making for an impressive range of health outcomes.[20] Similarly, another 'review of reviews' found beneficial association of greenspace to extend to all-cause and stroke-specific mortality, cardiovascular disease morbidity, cardio-metabolic factors, mental health, low birth weight, physical activity, sleep quality and urban crime, while reporting no significant associations for systolic blood pressure, total cholesterol, low-density lipoprotein cholesterol and glycosylated hemoglobin.[21] Yet another review found a "remarkable breath" of health outcomes, including reduced all-cause mortality, mortality from cardiovascular disease, improved healing times, self-perceived general health, reduced stress, reduced respiratory illness, allergies, and risk of poor mental health, and improved social cohesion, cognitive ability and self-reported well-being.[22] At a local level, evidence suggests that individual components of greenspace, such as the density of street trees in a neighborhood, can be associated with the perception of higher health and significantly less cardio-metabolic conditions.[23]

Mental as well as physical health benefits of nature have long been claimed through popular works and, increasingly, empirically grounded research. In 1897, Charles Skinner wrote about nature in a city yard as serving "to renew mental and spiritual strength"[24] and was certainly not the first to do so. Rachel Kaplan argued that the urban natural environment could provide both physical and conceptual restorative experiences similar to those of wilderness experiences,[25] establishing both a detailed psychological perspective for this as a field[26] as well as a reason for design and planning initiatives for its furtherance.[27] Evidence of a positive relationship between levels of neighborhood greenspace and mental health is claimed to include less mental distress, less anxiety, greater well-being and healthier cortisol profiles compared to areas with less greenspace.[28] The mental health values of engaging with nature have been framed as "psychological ecosystem services," [29] aligning with the increasing focus on the role of biodiversity and ecosystem services in larger health contexts. Therapeutic aspects of natural environments have been elevated as cultural constructs through social movements, such as "forest bathing" (Shirin-Yoku) originating in Japan and the love of outdoor life (Friluftsliv) in Norway.[30]

Biodiversity and Ecosystem Services

The benefits to health and well-being that might derive from natural environments also fall under the broad remit given to the term biodiversity.[31] Biodiversity, as a concept, overlaps with nature and greenspace but differs by encompassing the details of living organisms and ecosystems, allowing, it is argued, for a more mechanistic approach to elucidating causal pathways and connections to health.[32] This applies as well to the increasingly cited notion of ecosystem services, whereby an ecosystem activity provides benefits (and, occasionally, dis-

benefits) to humans.[33] For example, it is argued that because trees serve as oxygenators and bio-accumulators through removing particles such as dust and chemical pollutants from the air, they provide an ecosystem service.[34] Efforts to typologize ecosystem services are ongoing but run against the headwinds seen elsewhere in attempts to deal with variability. Currently, some of the strongest evidence may be found in exposure to microbial diversity and the potential to reduce certain allegoric and respiratory diseases.[35]

Marselle, et al. propose a conceptual framework that includes four pathways to link biodiversity to human health, accounting for both beneficial and injurious aspects: the reduction of harm (e.g., decreasing exposure to air and noise pollution), restoring capacities (e.g., stress reduction), building capacities (e.g., promoting physical activity) and causing harm (e.g., allergens).[36] Broader frameworks for biodiversity and ecosystem services have been conceptualized through initiatives such as Planetary Health[37], One Health[38] and Ecohealth,[39] and these can serve as a basis from which local efforts can be justified and mounted.[40]

Child Development

The relevance of experiencing the natural world for child development has been of special and long interest to many. Contemporary works such as Richard Louv's *Last Child in the Woods,*[41] which introduced the concept of "nature deficit disorder," and Robert Michael Pyle's *The Thunder Tree*,[42] which introduced the concept of "extinction of experience," aim at illustrating a growing loss of the freedom for children to directly roam in and experience natural environments. Peter Kahn has similarly researched and published on what he terms "environmental amnesia" in children,[43] linking this to the concept of shifting baseline[44] to caution that the loss can be associated with a generational shift in the experience of normality.

For example, if a woodlot in which twenty species of warbler were to be encountered a decade ago now has only ten, these ten are the baseline condition for the current generation and accordingly accepted as the norm. The overall loss of diversity and abundance can be insidious.

In all, a significant body of evidence exists to suggest that natural areas are essential elements of a healthy community environment for children that need to be integrated at a number of scales, including landscaping around homes and schools, access to systems of urban trails and greenways and, significantly, ‘‘rough ground’’ that allows for creative play.[45] These factors can be especially important in urban environments because so much of childhood learning is experiential, and cities often provide scant opportunity for outdoor experiences.

Environmental and Social Justice

The social disparities of urban living are eminently on display when considering green space. Affluent urbanities have greater and more immediate access to green space than those less fortunate, creating what has been termed a ‘luxury effect,’ whose elimination is argued to be a worthy societal goal.[46] Efforts to address this disparity, however, confront a paradox in that low-income residents may be displaced through the process of ‘green gentrification,’ as property values climb beyond their reach when better availability and access to green space occurs.[47] Design interventions, such as developing urban spaces that are “just green enough,” have been proposed as approaches that potentially could promote social as well as ecological equity.[48]

Ensle and Kabish propose a framework for socio-environmental justice consisting of three dimensions: *distributive* justice as the fair allocation and availability of urban green and related ecosystem services, *interactional* justice as the availability of inclusive design elements and ease of access, and *procedural* justice, especially to include older people in planning

processes.[49] Like the deeper problem of urban poverty itself, access to green space and green environments represents a major policy and planning hurdle to be surmounted.

Policy and Planning

Despite the evidence demonstrating clear links between nature contact and human health in urban settings, this information rarely has a direct influence on how cities are planned.[50] One reason for this might be that urban design has been a victim of "archaic" planning processes.[51] Whatever the case, the greening of cities is viewed as "crucial" in the eyes of the World Bank[52] and essential for them being sustainable and resilient in the eyes of others.[53] The wholesale loss of green space in some cities—Cairo being a prominent example[54]—looms then as a serious matter for their residents. The rapid growth and global dominance of cities points to a need to elevate consideration of this issue and incorporate green space concepts into policy directives and planning initiatives. The Ottawa Charter, a product of the First International Conference for Health Promotion in 1986 that was adopted by the World Health Organization, specified a "stable ecosystem" as an elemental component of health in everyday life, presaging further efforts to embrace holistic approaches to human health promotion.

Subsequently, a variety of initiatives have been promulgated through the United Nations, including a 2030 Agenda for Sustainable Development and the 2050 Vision for Biodiversity, while others have been advanced through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[55] and the Millennium Ecosystem Assessment.[56] These represent broad-based efforts to establish a foundation upon which regional and local efforts can be supported, efforts such as initial baseline inventory and monitoring efforts, as well as community outreach and education.

Local efforts are critical to actually implementing green space initiatives, and examples are becoming more numerous. Seattle, as one example, has established Green Factor Standards as code requirements for development and landscaping.[57] The District of Columbia has promulgated a sustainable growth framework that includes nature as one element.[58] Initiated in 2011, the plan is currently in its third revision. It addresses seven topics: the built environment, energy, food, nature, transportation, waste and water. Among the goals set by the plan is one to enhance access to parks and open spaces for all residents. While efforts such as these may seem more aspirational than practical, they are a start. In the face of potential irreversible loss, a minimal policy for urban green space might be articulated around the idea of there being no net loss, and gains wherever possible. This would follow from the precautionary principle established at the 1992 Earth Summit, which argues that despite existing scientific uncertainty, the consequences of postponing actions would arguably be more injurious than taking them.[59] That said, it can still be argued that the information available at this time cannot as yet be widely used in evidence-based approaches to planning[60] and that until causal connections can be shown, simplistic interventions by landscape redesign remain at best speculative.[61]

Limitations and Challenges

There are a number of reasons why this seems the case, most relating in one way or another to the complexity and variability of factors and effects involved. For example, contact with nature can range from exposure to potted plants indoors to immersion in remote wilderness.[62] Green space itself takes many forms and varies in spatial scale, while those experiencing it vary in the duration of their engagement or immersion, as do the sensory pathways through experiences are mediated, their individual activities and their level of

awareness in natural settings, in addition to other factors.[63] There is the considerable demographic variability expressed through the effects of age, sex, initial health status, cultural and regional background, as well as variation in the amount of time spent in any of the activities individuals may engage in, not to mention the purposefulness with which that activity occur. Also, the effects of nature contact are salutogenic;[64] they tend to focus on improved health and well-being, rather than disease or syndrome identification and targeted care—making them less available to empirical verification.

There is also a great deal of methodological heterogeneity between studies themselves.[65] This has led to warranted criticism that the evidence for linkages is weak and limited by poor study design, failure to exclude confounding bias, and subject to inadequate statistical methods.[66] Perhaps most importantly, the great majority of studies conducted to date have been correlational, leaving causal relationships undetermined.[67] Establishing causal relationships remains a paramount challenge given the complexity of the relationships involved.[68]

Clearly, future research needs to involve efforts to tease apart causal mechanisms, as research shifts to addressing the how, not whether, benefits exist.[69] One potential direction in addressing this lies in determining what has been termed a "nature dose,"[70] employing the familiar dose-response modeling used in health sciences, to calibrate "exposure" as a function of intensity (how much), frequency (how often) and duration (how long) as a framework for elucidating effects.[71] As an example, one recent study looked at time spent in nature and self-reported health and well-being to argue a maximum positive effect at a mid-range, with less effect below or above that.[72] Such studies could then be followed by prospective cohort, longitudinal and experimental work to further tease out variables.

Summary and Conclusions

In an apt characterization, urban nature has been called an "underutilized resource"—one that could lead to a "potential gold mine for population health promotion."[73] One might also say that the role that nature can play in the city is underappreciated, undervalued and under-recognized. There are, of course, compelling reasons why green space and urban nature tend to be undervalued, starting with the obvious fact that undeveloped land is not as available to commodification as that which is developed, nor does it generate taxes to help cities stay afloat financially. To this, we can add resistance from a dominant medical orthodoxy that focuses on symptomatic treatment of individuals in clinical contexts and abjures more holistic approaches to health. The issue of causality looms large as well, not to mention the highly complex interdisciplinary cooperative relationships that would be needed to create the broad-based coalitions of health professionals, environmentalists, planners, policy specialists, politicians and citizens needed to bear on the issue.

An impetus to fully engage this concept, from science to policy to planning and practice, likely depends on concrete, specific causal connections between provision of nature access and economic benefit. This is unlikely to come soon and may in many cases come too late. Still, cities are planned environments, and established science disciplines, such as restoration ecology, can offer potential pathways if remediation is deemed to be warranted. Time is important but may not be critical, as many cities already have and value green infrastructure enough to provide basic protection. What is most needed is public awareness and engagement to provide the impetus for political and policy decision-making. Hopefully, that will be forthcoming as the considerable evidence for public benefits accumulates on this issue.

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