Introduction

Sustainably designed landscapes, especially those that replace hardscaped areas with vegetation, can positively impact human health. The following elements are known to generate public health benefits when they are integrated into the urban landscape: trees, regionally adapted plants, living soils and rainwater harvesting features such as bioswales and raingardens. Collectively these landscape elements directly improve environmental health and indirectly improve human health by performing such services as filtering particulates from the air and reducing carbon dioxide, filtering pollutants from stormwater runoff and in turn improving surface water quality, generating oxygen, and cooling off the ambient temperature (Polonsky et al. 2018; CNT 2010). In short, as Tzoulas, et al. (2007) notes: "The link between ecosystem health and public health is the set of ecosystem services provided by the Green Infrastructure."

Time spent in urban nature, such as parks or other areas that integrate GI, is correlated with a number of public health benefits, including improved physical health, mental health and well-being, and community related benefits like social cohesion, defined by Hartig et al 2014 as "shared norms and values, the existence of positive and friendly relationships, and feelings of being accepted and belonging". For example, by making cities more walkable, Wolf et al. (2008) explains that "urban greening" can prompt exercise because "people make more walking trips when they perceive that there are many natural features in their neighborhood. In less green neighborhoods, people judge distances to be greater than they are, perhaps leading to decisions not to walk." White, et al. 2014, evaluated data from more than 10,000 panelists and found that, "on average, individuals have both lower mental distress and higher well-being when living in urban areas with more green space." Similarly, Wolf et al. 2008 claims that studies have shown, "views of nature rapidly reduce physiological stress response," and relatedly, others have demonstrated, "heart rate, blood pressure, and other body function measures return to normal levels more quickly when people view nature after a stressful experience." De Vries et al. (2003) found that both the quality and quantity of greenery along streets were associated with perceived

social cohesion within neighborhoods, with quality being responsible for the strongest association.

Methods

Studies that report nature's effects on human health utilize methods that yield both quantitative and qualitative results. Typically, these methods can be summarized as follows:

- *Quantitative* methods utilize a number of metrics reported by the health field (i.e. measures of heart rate and blood pressure reported in epidemiological studies)
- *Qualitative* methods rely on self-reporting by surveyed populations (i.e. descriptors of personal wellbeing)

In 2013, Hartig et al., conducted an extensive "review of reviews "and summarized findings from 59 review articles addressing the link between nature and human health. They made the following key observations:

- Researchers "represent nature with diverse physical and spatial variables, encountered in diverse activity contexts," where, "much research does not accept exclusion of the artificial as a basis for defining nature or natural environment. The nature of interest is often situated in built environments, as with indoor plants and trees."
- Human health is assessed in many ways, including forms of morbidity, causes of mortality, longevity, self-reported health, and changes to emotional and mental health.
- The following *effect modifiers* can influence health impacts derived from contact with nature: gender, age, socioeconomic status, occupation, societal/cultural context.

Hartig et al. (2014), notes that more recent studies have utilized digital technologies to advance studies that investigate the association between contact with nature and health. For example, MacKerron and Mourato (2013) using a smartphone app that signaled, "participants at random moments, presenting a brief questionnaire while using satellite positioning (GPS) to determine geographical coordinates," were able to generate over one million data points from more than

20,000 participants. This data was utilized to develop a model relating land cover to subjective wellbeing.

Additional Considerations

Although sustainable landscape design principles encourage either complete removal of turf or limited use of turf in the landscape, urban nature, such as parks, utilize turf in the landscape. Therefore, health benefits attributed to urban greenery in general, rather than a specific landscape features, are likely influenced by the presence of turf.

The quality and design of a landscape can moderate associations between urban greenery and social benefits like perceived well-being and social cohesion. For example, parks must be maintained to help facilitate social ties within a community (Hartig et al. 2014). Fleming et al. (2016) demonstrated that judgements of neighborhood safety directly impact the psychological benefits derived from access to green space, where neighborhoods deemed "unsafe" to "very unsafe" diminished these benefits almost entirely.

Primary Resources

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