



Review article

Nearby green space and human health: Evaluating accessibility metrics

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HIGHLIGHTS

- Contact with nature positively contributes to the health of people.
- For the design of healthy cities, empirically substantiated metrics are required.
- Type of nature, size, distance and quality are discussed.
- Cumulative opportunities-based indicators of urban green space seem preferable.
- For future research, more functionally oriented accessibility indicators are needed.

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ABSTRACT

There is growing scientific recognition that contact with nature in general, and contact with urban green more specific, have the potential to positively contribute to human health. For the purpose of developing healthy urban neighbourhoods, this raises the question how to take scientific evidence about these health benefits into account. Accessibility metrics that are well substantiated by empirical evidence are needed. This paper reviews the quantitative and qualitative aspects relevant for accessibility metrics and empirical studies addressing these aspects in relation to health. Studies comparing different types of green space indicators suggest that cumulative opportunities indicators are more consistently positively related to health than residential proximity ones. In contrast to residential proximity indicators, cumulative opportunities indicators take all the green space within a certain distance into account. Comparing results across studies proved to be hard. Green space accessibility was measured in a variety of ways and the green space indicator that was chosen was often not problematized. We feel that it is time for a more function-oriented approach. How precisely does contact with nature impact health and what type and qualities are relevant in this regard? We think this will lead to a new generation of more evidence-based accessibility metrics that will help to advance the field.

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1. Introduction

In previous decades, scientific interest in the relationship between nature and health has increased considerably, as shown by the rising annual number of papers on this topic (Hartig, Mitchell, De Vries, & Frumkin, 2014). A wide range of health aspects has been studied, from cardiovascular health (Paquet et al., 2013) to mental health (Sturm & Cohen, 2014), as well as from self-reported general health (Maas, Verheij, Groenewegen, De Vries, & Spreeuwenberg, 2006) to mortality (Mitchell & Popham, 2008). The variety in health aspects is paralleled by variety in defining access to nature or green space. Viewing nature through a window (Ulrich, 1984; Honold, Lakes, Beyer, & van der Meer, 2015), living in environments with a high percentage of green space (Maas et al., 2006) and having access to nearby green areas and parks (Cohen-Cline, Turkheimer, & Duncan, 2015) have all been positively associated with health aspects. However, relatively little attention has been paid to the differences between these metrics and how the choice of a metric affects the relationship with different health aspects.

The issue of metrics is not only relevant from a scientific perspective, but also from an urban policy perspective. With increasing numbers of people living in urban areas, daily contact with nature is becoming less self-evident. Space itself is costly, especially in an urban context, and the maintenance costs of the greenery add to this. Therefore, whether one is involved in restructuring existing urban areas or in designing new neighbourhoods to make efficient use of the health benefits of nature, it is important to know what sufficient access to nature in residential environments for health and well-being looks like.

In this paper we will review types of accessibility metrics that are commonly used in the literature. We do so by looking at what type of nature and what type of contact with nature is considered according to the metric at hand. Largely, this depends on the mechanism or pathway that is, sometimes implicitly, assumed to link nearby nature to human health. Hartig et al. (2014) review four of the most frequently suggested mechanisms: improving air quality, reducing stress, stimulating physical activity and facilitating social cohesion. Other mechanisms might be added, such as preventing heat stress (Lee, Mayer, & Chen, 2016). Accessibility metrics assume that access matters. We will therefore focus on the three mechanisms that require contact with or visits to nature, rather than on those for which the mere presence of nature suffices: stress-reduction, stimulating physical activities and stimulating social benefits. As far as possible, we will substantiate our arguments in favour or against certain metrics and underlying assumptions with empirical studies.

This review paper is largely organized by the following issues related to accessibility metrics:

- which types of nature have to be included?
- are there minimum size requirements?
- when is nature considered accessible?

Subsequently, we will compare two types of accessibility metrics, 'residential proximity' and 'cumulative opportunity' based ones. Residential proximity indicators are based on the nearest qualifying green area. Cumulative opportunities indicators also include other nearby areas and, depending upon the exact spec-

ification, small natural elements (Coutts, Horner, & Chapin, 2010). Finally, we will briefly consider relevant qualities of the natural environment for health and well-being. The quality aspect is usually not included in accessibility metrics, other than by limiting the type of nature to be included in the metric. In the discussion we will return to the question of what constitutes a suitable metric for research purposes as well as a basis for (preliminary) guidelines that address urban greening policies. We will end with some recommendations for future research.

2. Types of nature

A primary question relates to which types of nature are relevant with regard to health and well-being. Quite often nature is limited to public urban green space, such as urban parks (see e.g. Gražulevičienė et al., 2014; Rundle et al., 2013; Van Cauwenberg et al., 2015). When it comes to contact with nature, this indeed seems like a highly relevant type of nature, explicitly meant to be used for recreational purposes. However, are other types of nature irrelevant? One might think of agricultural areas, surface waters, private gardens, and all kinds of small natural elements, such as street trees and green verges. The possible relevance of such other types of nature will be addressed here by looking at whether or not they are likely to offer a suitable environment according to any of the three mechanisms requiring contact with or visitation of nature, mentioned above (De Vries, 2010).

2.1. Countryside

The countryside, often largely consisting of agricultural areas, is usually regarded as a relatively 'slow' region, compared to the dynamic and 'fast' city. From the perspective of the Attention Restoration Theory (Kaplan, 1995) it possesses the relevant qualities 'extent' and 'being away' and, although perhaps to a lesser extent than nature and forest areas, also that of 'soft fascination' and 'compatibility'. It is therefore reasonable to assume that, from a theoretical perspective, the countryside in itself has stress-reducing and attention restoring capacities. Depending on its accessibility, which may differ by country, it is also a type of environment that is conducive to recreational walking and, perhaps even more, to cycling (Curry & Ravenscroft, 2001). So, this type of nature may also be used for (recreational) physical activity. However, it is unlikely to be an environment in which members of the same neighbourhood are likely to meet one another. It is therefore a type of environment that is unlikely to facilitate social cohesion within the (urban) neighbourhood.

As for empirical results with regard to agricultural areas, Triguero-Mas et al. (2015) looked at whether or not a green space was available within 300 m distance. Besides urban green areas they included agricultural areas and forests and nature areas outside the city in their definition of green space. This green space indicator was associated with some of the health indicators they used in their study. However, it is unclear whether this association would have been stronger or weaker if only urban green areas had been included. More conclusive evidence is offered by several Dutch studies using a different type of green space indicator, namely the percentage of green land use within a certain distance from one's home (1 km and 3 km). Green land use included not only

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