



The health benefits of nature-based solutions to urbanization challenges for children and the elderly – A systematic review



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ABSTRACT

Urban green and blue spaces promote health by offering areas for physical activity, stress relief, and social interaction, which may be considered as cultural ecosystem services. They also provide a number of regulating ecosystem services that can be regarded as nature-based solutions to mitigate impacts from urbanization-induced challenges. Urban trees and other vegetation provide cooling through shade and evapotranspiration, which reduce the impact of the urban heat island on hot summer days. Urban vegetation may improve air quality by removing air pollutants. Open areas in cities, such as parks, gardens, playgrounds and cemeteries, are unsealed spaces that also improve infiltration during extreme precipitation events providing water regulating functions. All these services have the potential to improve the health of urban residents, particularly of specific vulnerable groups such as children and the elderly. The aim of this paper is to provide an overview of the current state of evidence on the relationship between the health of children and the elderly and urban green and blue spaces that can account as nature-based solutions to urbanization-induced challenges. We discuss potential confounding factors and refer to the different green space metrics used to identify associations to health. From the results, we cannot conclude on a universal protective health effect of urban green and blue spaces for children and the elderly. While the association trend is positive, the results remain inconclusive, context dependent and are partly overridden by socioeconomic confounders. However, the research area is consistently increasing, and we advance important prospects for future research on urban green and blue spaces in the face of global challenges such as urbanization.

1. Introduction

Urbanization is a global phenomenon that affects modern-day society in different ways. Defined as population growth and the increase in densification of built-up areas, urbanization is accompanied by environmental threats such as increase of traffic, air and noise pollution, intensification of the urban heat island effect, and a loss of open green and blue spaces (Haase et al., 2013; Seto and Reenberg, 2014; Wolff et al., 2016). These processes present substantial challenges to ecosystem functionality and human health and well-being worldwide (Lafortezza et al., 2009; Lafortezza and Konijnendijk, 2018). As with many major societal shifts, the most affected are vulnerable populations, such as children and the elderly.

Contemporary urban living is associated with a sedentary lifestyle

and chronic stress for the entire city population. This contributes to the increasing burden of non-communicable diseases, such as diabetes, obesity, and depression (Vos et al., 2015). Many of these diseases can be prevented by societal interventions, such as investments in healthy environments for physical activity and recreation (World Health Organization, 2012). Such investments are particularly efficient for children, as health behavior and environmental impact in early years affect health across the entire life course (Van Landeghem et al., 2002; Chan, 2013). Equally, a focus on the elderly is important due to the high prevalence of chronic disorders, including multi-morbidity, in later life (Boyd et al., 2005).

Toxic environmental exposure in cities is also a major public health issue. For example, air pollution from traffic and industrial sources has a severe impact on human health, counting an estimated 381,000

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premature deaths annually in Europe (Lelieveld et al., 2015). Poor environmental and economic conditions during childhood and adolescence is an cumulative biological risk factor in the individual, with life-long impacts on health (Lindström et al., 2014). The issue is more pronounced in destitute urban areas, which are often situated close to traffic or industry with sparse vegetation and few high-quality green spaces (Wolch et al., 2014). Urbanization can thus impair urban ecosystems significantly, with negative impacts on both the environment and human health.

Flooding is another urbanization-related risk factor, which is exacerbated in dense cities with high sealing rates and scarce infiltration and groundwater recharge. The situation is expected to worsen with climate change (Ciscar et al., 2011). Extreme precipitation events can cause flooding and lead to economic and infrastructural damage with risks to the health of local residents (European Environment Agency, 2017). The characteristics of a city, including green space cover, determine the amount of damage and impact flooding may cause to infrastructures and human life (Liu et al., 2014).

Certain demographic groups, such as children and the elderly, are more sensitive to the health issues associated with urbanization and urban living, particularly in combination with climate change (Global Humanitarian Forum, 2009). For example, children with a reduced capacity to physiologically adjust to environmental stressors, with developing organ systems and relative low weight, suffer more from the negative effects of air pollution as shown by, for instance, the increasing prevalence of childhood asthma in urban areas (Clark et al., 2009; Annesi-Maesano et al., 2012). Likewise, the elderly, often with compromised health conditions, are more vulnerable to the effects of heat waves because reduced mobility makes it more difficult for them to escape heat (Benmarhnia et al., 2015). This disproportionality in risks deserves greater attention in light of an unprecedented growth of the world's older population (He et al., 2015). With increasing knowledge concerning the epigenetic and early life impact on health throughout a life course, an improved understanding of early exposures and possible preventive measures are of utmost importance. However, health-promoting interventions are particularly important for these groups besides the reduction of risk factors and prevention of disease. Lifestyle behaviors established early in life, such as physical activity, tend to be maintained throughout the life course and thereby improve health also into adult life (Gluckman, 2004). Analogously health promotion, for example through attention restoration, may contribute substantively to life quality among the elderly who often, to a higher extent than the general population, suffer from anxiety, especially in cities (Beekman et al., 2000; Wu et al., 2015).

A growing body of evidence supports the notion that access or exposure to natural environments can contribute significantly to human health and well-being through several mediating pathways and direct effects (Carrus et al., 2013). These pathways can act to either promote health, encourage healthy behaviors like social interaction, or to decrease risk factors such as air pollution or urban heat. Urban green spaces can, for example, contribute to reduce stress, improve moods and increase the level of physical activity, which in turn prevent cardiovascular diseases and mental disorders and reduce mortality (Hartig et al., 2014; Triguero-Mas et al., 2015). Depending on the context, management, and planning, urban green and blue spaces can also help to reduce air pollution levels (Morani et al., 2011; Baró et al., 2014; Derksen et al., 2015; Cameron and Blanuša, 2016) and heat (Bowler et al., 2010; Burkart et al., 2015) as well as improve storm-water run-off (Liu et al., 2014). These benefits protect individuals from diseases related to harmful environmental exposures, such as respiratory diseases, heat stroke, and drowning, or infections from contaminated drinking water (Benmarhnia et al., 2015). For children and the elderly, two groups that are at increased risk of negative effects of urbanization, green spaces may play a particularly important role. Previous research has shown that children's cognitive, emotional, and motor development may be associated with exposure to nature (Amoly et al., 2014;

Dadvand et al., 2015). These developmental effects of nature exposure may explain why many studies have suggested that nature exposure reduces symptoms in children suffering from attention deficit hyperactivity disorder (ADHD). Previous studies have also found that stress levels are lower among children exposed to nature (Wells and Evans, 2003) and that physical activity levels may be higher (Almanza et al., 2012; Sanders et al., 2015). In addition, street tree density and other urban greenery have been associated with less childhood obesity and asthma (Kim et al., 2014; Sbihi et al., 2015). Similarly, the health of older people can particularly benefit from the quality and quantity of urban green spaces (Takano et al., 2002; Barbosa et al., 2007). Proximity to green space (near the homes of residents) may improve the longevity of senior citizens (Takano et al., 2002). A study by Kawachi and Berkman (2001) indicated the potential to be outside in a green space to increase older people's health. Sugiyama and Ward Thompson (2007) have demonstrated that neighborhood environments are likely to contribute to the health of the elderly by providing opportunity spaces for being active.

As shown, urban green and blue spaces provide various health benefits that can be categorized within the ecosystem services concept as cultural and regulating ecosystem services (Millennium Ecosystem Assessment, 2005; Haase et al., 2014). Cultural services often act to promote health by, for example, increasing physical activity, while regulating services rather prevent disease by reducing risk factors. In particular, regulating ecosystem services attenuate urbanization-related health challenges by reducing air and noise pollution (Baró et al., 2014; Madureira et al., 2015) and mitigating heat stress (Alexandri and Jones, 2008; Bowler et al., 2010). To provide these services urban ecosystems must be managed in a sustainable manner, securing a biodiverse environment (Lafortezza and Chen, 2016). The provision of ecosystem services through urban green and blue spaces can be seen as nature-based solutions (NBS), contributing to tackle several of the challenges urban planners and decision-makers face in times of urbanization and climate change (McHale et al., 2015). As 'actions inspired by, supported by or copied from nature' (European Commission, 2016), NBS are receiving increasingly greater attention and being invested in by the European Union's Horizon 2020 program in order to address these challenges (Maes and Jacobs, 2017). The integration of NBS in urban design and planning can improve the health conditions of urban dwellers through the implementation of urban green spaces, thus offering a number of co-benefits, while making cities more resilient and sustainable (Raymond et al., 2017).

The ample environmental and health benefits that urban green and blue spaces provide have already been reviewed in research (Hartig et al., 2014; Gascon et al., 2015; Van Den Berg et al., 2015; Triguero-Mas et al., 2015). However, the existing evidence focuses mostly on general populations and adults (Hartig et al., 2014). Research and evidence on the variety of population subgroups, such as children or the elderly, in response to green and blue spaces as a NBS to prevent disease through the reduction of urbanization-related risk factors is insufficiently synthesized (Hartig et al., 2014). Thus, a more comprehensive summary of and evidence-base for how urban natural environments may affect children and the elderly are urgently required to provide a more specified orientation for urban planners and decision-makers. If the effect size of NBS proves to be higher for these population groups, investing in natural environments in areas with many children and/or the elderly may be particularly cost-efficient. In addition, specific gaps in our knowledge of the health benefits of urban green spaces for children and the elderly must be identified for developing targeted research projects in the future. In this study, we, thus, aim to review the current state of evidence on the relationship between the health of the two population groups of children and the elderly and urban green and blue spaces that can account as nature-based solutions to urbanization-induced challenges.

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