



STATE OF THE ART

[B@SEBALL - B2/191/P3/B@SEBALL]
[Biodiversity at School Environments Benefits for ALL]

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[Introduction]

B@SEBALL aims to contribute to more equal health opportunities for children, by investigating the health contribution of biodiversity at school environments, and how this is distributed among children with different socio-economic and cultural backgrounds. Reducing health inequality is an important challenge of primary health care. According to the biodiversity hypothesis (Hanski et al. 2012), microbial contact of people with biodiversity is important for human health, especially in childhood. Access to environments with biodiversity, such as urban green spaces and nature sites, are not evenly distributed among children.

Chronic health conditions associated with urban lifestyle are on the rise (Dye 2008). Especially mental health appears to be lower in urban environments (Pelgrims et al 2021). One of the main current challenges in this field of research is unravelling the importance of the specific quality of nature (Frumkin et al. 2017) and biodiversity (Aerts et al. 2018). Enhanced immune functioning emerges as one promising candidate for a central pathway between nature and health (Kuo 2015). The relation between the diversity of the environmental microbiomes and the human microbiome of the people exposed to this environment is currently underexplored, particularly in children.

[State of the art]

Key research foci in the field of the research project

B@SEBALL will focus on the following research foci:

- 1) How biodiversity in the school environment affects children's health and mental well-being and can be linked to human microbiome diversity
- 2) How this knowledge is relevant to school management and design
- 3) How this knowledge is relevant to reducing health inequality among children

Main findings of past research

Residential green space has been linked to lower rates of mortality (Bauwelinck et al 2021). Many studies report positive effects of nature on mental health, stress reduction and attention restoration (e.g. Alcock et al. 2014, Thompson et al. 2012, Mitchell and Popham 2008, Van den Berg et al. 2014, Hartig et al. 2003, Ulrich et al. 1991). Convincing evidence points towards the contribution of exposure to nature during childhood in improving cognitive development and mental health, varying from reducing children's emotional and behavioral difficulties (Vanaken and Danckaerts 2018) to lowering the risk of developing mental health disorders later in life (Engemann et al. 2019). Residential green areas and their potential health benefits have thus received increasing attention, also in the context of environmental health inequalities, where an unequal social distribution of these resources may contribute to health inequalities. Vulnerable population groups lack both individual green space (such as gardens and green street segments) and community resources (green public place, such as parks, playgrounds and green schools) (Schüle et al. 2019). This inequality is exacerbated by the findings from the leisure sciences that certain social groups may be less likely to visit green spaces or to be less likely to use them for active recreation (Cole et al. 2019, Hunt et al. 2016). This observation heightens the importance of green school environments. The existing literature on the health



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benefits of green school environments is limited, but growing (van den Bogerd et al. 2020a, b; van Dijk-Wesselius et al. 2018, 2020; van den Berg et al. 2017; Maas et al. 2013) There are sufficient indications to warrant further research on this topic (Browning et al. 2019). There are however few studies comprehensively investigating biodiversity and its influence on health and mental wellbeing (Aerts et al. 2018). Furthermore studies are not conclusive: while some studies found a positive relation between plant species richness and well-being/reflection (Fuller et al. 2007, Carrus, et al. 2015) others found a negative association (Dallimer et al. 2012). Recently, a link is emerging between environmental microbial biodiversity, the microbiome of children and positive effects on immunological and other health outcomes (Gisler et al. 2021, Roslund et al. 2020). Especially during childhood, exposure to specific microorganisms and/or a diverse environmental microbiomes has been associated with a lower risk for developing inflammatory conditions, such as allergies and asthma (Kirjavainen et al. 2019, Fyhrquist et al. 2014, Ege et al. 2009), although the exact link is yet to be elucidated.

Existing gaps of past research

A recent study indicates that nearby green space can determine the diversity of environment microbiota (Dockx et al 2021), but further research can provide more detail in this relation, as well as their contribution to health benefits. Despite mounting evidence that people with a diverse microbiome or who interact with green spaces enjoy better health, studies have yet to directly examine how biodiverse urban green spaces might modify the human microbiome and reduce chronic disease. Another challenge is to enhance access to nature for all, which is unevenly distributed among social groups with different socio-economic and cultural backgrounds. We will also investigate how child behavior and parent attitude with respect to playing in nature are of influence. In this project, the environmental microbiome, defined as the microbes in soil, on plants, and associated with air dust, will be targeted, as well as its social distribution and link with the microbiome of children. Limited environmental, social, and behavioural data on study participants continue to be an important limitation in the interpretation and generalizability of many published results (Soga and Gaston. 2020). In our study, all these data will be collected in a sample of schools from a study design that as much as possible controls for possible confounding variables. This study will also address the adverse effects of green space, looking into the occurrence of allergic disease caused by aeroallergens (Aerts et al 2018), which is often overlooked, and which can also be influenced by the surrounding green space. The study design entails a comparison of schools with low naturalness playground (control) versus schools with high naturalness playground (case). Each case-control will be matched to have similar location, outdoor air pollution levels and socio-economic status. Although this is a cross-sectional study (within the timeframe of the project only a single survey can be undertaken), the design can be easily repeated so that it becomes a longitudinal study. When combined with interventions this can further improve the understanding of possible mechanisms behind the associations.

New research contributions

The B@SEBALL project will be conducted in the school environment with different playground types, because children spend a significant amount of time in this environment. By collecting and integrating a wide range of data, including environmental biodiversity and microbiome data, child microbiome and allergic sensitization measurements and a detailed health and socio-economic status questionnaire, B@SEBALL will contribute to knowledge linking biodiversity and health, and to knowledge about social distribution effects.

B@SEBALL contributes to the capacity of Sciensano and other involved research institutes in building capacity in this promising field of research. B@SEBALL will also contribute to tackling the prominent problem of health inequalities among children, due to unequal health access to natural surroundings.



B@SEBALL particularly focuses on the socially vulnerable group of young children, who are more vulnerable to unequal opportunities and risks for their health. In order to enhance chances for fair treatment in relation to the benefits of contact with green spaces, B@SEBALL will investigate how resulting health inequalities for these groups of the population can be partly compensated by green playgrounds at primary schools. B@SEBALL will particularly investigate the health potential of microbial contact with biodiversity of green spaces for children's health. Recently Finlay et al. (2021) have even suggested that covid19 protection measures may have long term impacts on human microbiome, which can complicate matters.

Discussion on what is expected in terms of policy maker recommendations

Based on the research outcomes of B@SEBALL, stakeholder groups, families and policy makers will have additional practice relevant knowledge and arguments for enhancing a more equal distribution of children's access to nature for their health. Knowledge on the health benefits of environmental biodiversity within different school playgrounds can contribute to optimal school playground design and environmental contact recommendations for children.

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