B@SEBALL

Biodiversity at school environments benefits for all

Contract - B2/191/P3/B@SEBALL

SUMMARY

Context

B@SEBALL aimed to contribute to more equal health opportunities for children, by investigating the health contribution of biodiversity at school environments, and how this was 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.

Objectives

B@SEBALL focused on how biodiversity in the school environment affects children's health and mental well-being and can be linked to human microbiome diversity. B@SEBALL also aimed to interpret how this knowledge can be relevant to school management and design, and how this knowledge can be relevant to reducing health inequality among children.

Methodology

The B@SEBALL project employed a stratified matched case-control design to compare primary schools, with schools having high greenness playgrounds as cases and those with low greenness playgrounds as controls. Schools were recruited from either low or high naturalness landscapes, with matching of cases with controls based on location proximity, outdoor air pollution levels, and socio-economic status. The study protocol was approved by the Medical Ethical Committee of Antwerp University Hospital, and informed consent was obtained from participants. From an initial sampling frame of 600 eligible schools across Belgium's French and Dutch speaking communities, 167 were contacted in 2021, resulting in 37 participating schools with 527 fifth-grade children consenting to

participate in at least one test. Participant inclusion criteria required attendance in the fifth grade of primary school and parental agreement to provide background information and allow children to complete questionnaires.

The data collection included environmental, microbial, health and social assessments. Comprehensive environmental assessments were made at multiple scales, providing a multi-faceted view of the environmental conditions surrounding the participating schools. This included classroom air quality measurements, playground biodiversity characteristics evaluated by students, school-level and landscape-level greenness calculations using land cover data, and air pollution data at landscape level. The B@SEBALL project mapped microbial diversity in schools by collecting samples from dust, sand, soil, strawberry plant leaves, and children's cheeks. Strawberry plants were placed in school playgrounds for 8 weeks to allow microbiome stabilization. Samples were collected by children and teachers following a detailed protocol, with skin samples taken by project researchers. This sampling approach provided a thorough assessment of microbial communities in various school environments. Several health assessments were made using validated tools. Child-reported well-being was measured using the KIDSCREEN-27 questionnaire, which evaluates health-related quality of life across five dimensions. Cognitive skills, particularly attention, were assessed using the D2 Test of Attention, which measures attention in terms of speed, accuracy, and consistency. Respiratory health and allergies were evaluated using the ISAAC (International Study of Asthma and Allergies in Childhood) questionnaire, focusing on eczema, wheezing, and rhinitis. Additional allergy information was collected through parent questionnaires as well. For the social assessments, we used a combination of validated and newly developed surveys. Parent-reported data included socio-economic status, cultural background, living environment, and children's outdoor play preferences. Parents also completed the Risk Engagement and Protection Survey (REPS) and an independent mobility survey. Child-reported data focused on Attitude Towards Outdoor Play (ATOP) and Nature Connectedness (NC), using validated scales. All surveys were translated into Dutch and French, with an English version available for parents, and were tested for clarity and understandability before implementation.

A variety of statistical methods were employed to analyze and integrate the collected data. Generalized linear multilevel models were used to relate outcome variables to school context and landscape type, accounting for clustering of children in schools and adjusting for potential confounding variables. To handle missing data, a Bayesian framework was implemented, allowing for multiple imputations and protecting against bias. Structural Equation Models (SEM) were constructed to investigate relationships between latent factors from the ATOP, NC, and REPS surveys and exogenous variables such as gender, socio-economic status, and environmental factors. For microbial data analysis, an extension of generalized linear mixed models was used to account for the compositional nature of DNA sequencing data.

Results and recommendations

B@SEBALL evidence supports the importance of a green school environment for some health and well-being indicators. Our children spend an important part of their life at school. The B@SEBALL study highlighted several positive impacts of the presence of nature and biodiversity at school on children's health and well-being. B@SEBALL contributed to a growing body of scientific evidence showing that a green environment in and around the schools can contribute to the children's mental well-being and healthy immune system development. This is especially true for the urbanised areas where exposure to pollution is increased and exposure to nature is decreased. We found that children in schools from urban environments that were greener had fewer allergic symptoms (wheezing, rhinitis or eczema) reported. Policy Recommendation: Schools should be targeted for greening, especially in urban landscapes (or other types of landscapes with low naturalness), in order to contribute to children's physical and mental well-being. Practice recommendation: Promotion of children's physical and mental health through greening of school environments.

B@SEBALL evidence supports the importance of diverse natural elements and plant-associated bacteria on the playgrounds for some physical health parameters of children. In addition to the general importance of a green school environment, the presence of a greater variety of natural elements such as wood chips, gravel, hedges, trees, flower beds, ponds and grass were associated with less reported rhinitis symptoms in children. In addition, some bacteria which are typically associated with plants, when they occur on the school playground, may be linked to a healthier immune development of school children reflected in less reported allergic symptoms. Policy recommendation: Give the schools access to more funds and coaching to increase the level of biodiversity reflected in the presence of different natural elements at the school playground. Practice recommendation: Health promotion through increase of the level of natural elements at the school playground.

B@SEBALL evidence underlines the importance of tackling health inequality due to unequal access to a green environment. Health-promoting access to nature is very much unequally distributed. Indeed, studies including this one reveal that children are not equal in terms of environmental living conditions. B@SEBALL shows that children with a high SES feel more connected to nature and have a more positive attitude towards outdoor play, possibly leading to more contact with nature and nature induced health benefits compared to children with a lower SES. Furthermore, the results of B@SEBALL show that self-reported well-being of children is higher in greener school playgrounds. Additionally, this positive association is even greater for children with lower socio-economic status (SES). This indicates that some SES inequality outcomes may be offset by greening school playgrounds. Currently, school playground greening is done for schools where teachers/volunteers have time to apply for this funding, while low-SES schools often have no resources to spare on these applications. Our results therefore imply that adapting strategies for school greening to include low-SES schools may be useful to gain more well-being with the same means and additionally decrease SES inequality outcomes. Policy recommendation: target funds toward greening of schools for which socio-economic indicators are low (irrespective of landscape type). Practice recommendation: Raising awareness among local communities and schools. Funding nature-education' actors such as NGOs, Universities, lifelong

education services…will play an important role in empowering local councils, schools, teachers and parents.

Keywords

Biodiversity, microbiome, primary school, green playground, health, health inequality, Belgium