INPLASY PROTOCOL

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Review Stage at time of this submission: Formal screening of search results against eligibility criteria.

Conflicts of interest: None declared.

Exposure to greenspace and bluespace and cognitive functioning in children - a systematic review protocol

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Review question / Objective: Following review questions should be addressed: Is there any association between exposure to greenspace or bluespace and cognitive functioning in children as assessed by observational and interventional research? Does exposure to greenspace or bluespace is more strongly associated with a particular domain of cognitive functioning in children compared to other domains of cognitive functioning? Does the association between exposure to greenspace or bluespace and cognitive functioning in children differ according to age? Does the association between greenspace and bluespace differ depending on type and methods of the exposure assessment?
Information sources: PubMed and PsycINFO via EBSCO will be searched. We will also conduct a 'snowball' search to detect additional studies by searching the reference lists of publications eligible for full-text review. Further, we will manually search reference lists of previously published reviews.

INTRODUCTION

Review question / Objective: Following review questions should be addressed: Is there any association between exposure to greenspace or bluespace and cognitive functioning in children as assessed by observational and interventional research?

Does exposure to greenspace or bluespace is more strongly associated with a particular domain of cognitive functioning in children compared to other domains of cognitive functioning? Does the association between exposure to greenspace or bluespace and cognitive functioning in children differ according to

age? Does the association between greenspace and bluespace differ depending on type and methods of the exposure assessment?

Rationale: The field of green- and bluespace research is rapidly developing, and there are more and more studies in relation to cognitive outcomes. Hence, there is a strong need to systematically review the existing studies and to detect research gaps. Seven systematic reviews have been already published in relation to this topic (de Keijzer et al. 2016; Gascon et al. 2015; Islam et al. 2020; Luque-García et al. 2021; Ohly et al. 2016; Stevenson et al. 2018; Vanaken & Danckaerts 2018) and four systematic reviews are currently registered (Ferguson et al.; Herchet et al.; Vella-Brodrick & Gilowska; Xiao-Ling et al.) but none of them is specific to cognitive outcomes in children of the entire age range. Moreover, only Gascon et al. (2015) looked into the effects of bluespace in addition to greenspace. Also, except for the Gascon et al. (2015), published or planned reviews are focused either only on observational studies (Islam et al. 2020; de Keijzer et al. 2016; Ferguson et al.; Luque-García et al. 2021; Vanaken & Danckaerts 2018) or only on experimental studies (Ohly et al. 2016; Stevenson et al. 2018; Vella-Brodrick & Gilowska; Herchet et al.). The registered review by Xiao-Ling et al. will only summarize studies which investigated diagnosed neurodevelopmental disorders. Finally, nearly none of these reviews, except for Islam et al. 2020; Stevenson et al. (2018) and Herchet et al., conducted search in PsychInfo database, which lists environmental psychological research that is not necessarily indexed by PubMed or Web of Science. Our systematic review will be focused on cognitive outcomes in relation to green- and bluespace in children of all ages. We will conduct search in two major databases – PubMed and PsychInfo, to capture observational and experimental studies from the fields of environmental epidemiology and environmental psychology. We believe that our interdisciplinary team of environmental epidemiologists and psychologists who are specialised in green- and bluespace,

cognition, and systematic reviews, will produce a high-quality systematic review on the topic.

Condition being studied: Not applicable.

METHODS

Search strategy: Searches were conducted on two data bases – PubMed and PsycInfo, both on 17.12.2021. Free-text terms related to outcome (e.g. cognition, cognitive, intelligence), exposure (e.g. greenspace, green space, greenness), and population (e.g. child, boy, girl) as well as Medical Subject Headings (MeSH) terms for outcome (e.g. cognition, intelligence) and population (e.g. child, adolescent) were used. We will also conduct a 'snowball' search to detect additional studies by searching the reference lists of publications eligible for full-text review.

Participant or population: The target population is children up to 18 years of age, boys and girls, regardless of ethnicity. Exclusion: Neurodevelopmental disorders such as ADHD and autism spectrum disorder; any clinical condition involving brain damage; age above 18 years of age; animal studies.Studies containing a mixed population will be included when some of the participants meet the eligibility criteria.

Intervention: Not applicable.

Comparator: Children exposed to lower greenspace or bluespace levels.

Study designs to be included: Cohort studies or longitudinal studies or case-control studies or cross-sectional or experimental studies. Excluded are studies focused on behaviour only (ie, without cognition). There are no restrictions on the basis of the date of publication.

Eligibility criteria: Eligibility criteria according to the PECOS (Population, Exposure, Comparator, Outcome, Study) statement:(P) normal human population of children up to 18 years of age; (E) assessed greenspace or bluespace exposure using an objective measure (including NDVI,

proportion of greenspace or blue space, distance to greenspace or blue space), or subjective measures (including self-reported frequency of visits to greenspaces or blue spaces, quality of green space or blue space);(C) exposed to higher greenspace or bluespace compared to those exposed to lower levels; (O) assessed cognitive functioning using an objective measure such as standardized psychometric tasks(S) original human studies including cohort studies or longitudinal studies or case-control studies or cross-sectional, quasi-experimental or experimental studies, published in a peer-reviewed scientific journal. Excluded are studies focused on behavior only (ie, without cognition). There are no restrictions on the basis of the date of publication.

Information sources: PubMed and PsycINFO via EBSCO will be searched. We will also conduct a 'snowball' search to detect additional studies by searching the reference lists of publications eligible for full-text review. Further, we will manually search reference lists of previously published reviews.

Main outcome(s): Main outcome will be cognitive functioning including such domains as attention, memory, executive functioning, and intelligence etc. The outcomes will be extracted if they were measured using standardized psychometric tasks designed to assess cognitive functioning. If multiple outcomes are reported, only those derived from cognitive measures will be extracted. If multiple outcomes assessing different cognitive domains are reported, all of them will be extracted and accordingly assigned to specific cognitive domains.

Additional outcome(s): Not applicable.

Data management: Two independent reviewers will scan titles and abstracts using scanning software Rayyan (https://www.rayyan.ai/) and they will further review the full-text publications to check for their eligibility for inclusion. If there is any difference in the eligibility of a publication

between the two reviewers, it will be resolved by a discussion with/decision of a third reviewer. Two independent reviewers will conduct data extraction. The reviewers will control each other' extractions and confirm their accuracy. An excel spreadsheet will be used for data extraction. The items to be extracted relating to the study characteristics are as follows: the report (author(s), year of publication, country); sample characteristics (age, type of school/type of population, sample size); study design, exposure measures, cognitive outcome measures, and results. Any discrepancies in data extraction between the two reviewers will be resolved by discussion with a third reviewer.

Quality assessment / Risk of bias analysis: We will evaluate the risk of bias (ROB) according to the Office of Health Assessment and Translation (OHAT) tool by the National Institutes of Environmental Health Sciences National Toxicology Program (OHAT, 2015) and Navigation Guide by the University of California (Lam et al., 2016; Woodruff and Sutton, 2014) for each included study. In light of the OHAT tool, we will assess Key criteria (Exposure assessment, Outcome assessment, Confounding bias) and Other Criteria (Selection bias, Attrition/exclusion bias, Selective reporting bias, Conflict of interest, Other source of bias). Each of the above domains should be evaluated as "low", "probably low", "probably high", or "high" risk based on specific criteria. Consequently, the studies for which the key criteria and most of the other criteria are characterized as "high" or "probably high" risk will be removed from our included study pool.

Strategy of data synthesis: Not applicable.

Subgroup analysis: Not applicable.

Sensitivity analysis: Not applicable.

Language: Language restriction will be imposed in the search strategy, publications only in English, German, and Polish will be selected.

Country(ies) involved: Poland and Germany.

Other relevant information: The second affiliation: Institute and Clinic for Occupational, Social and Environmental Medicine, LMU University Hospital Munich, Munich, Germany.

Keywords: cognition; cognitive functioning; greenspace; green space; greenness; greenery; bluespace; blue space; children.

Dissemination plans: The systematic review results will be disseminated by publication in a peer-reviewed journal and presenting at scientific conferences.

Contributions of each author:
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