



Urban residential greenspace and mental health in youth: Different approaches to testing multiple pathways yield different conclusions



Angel Dzhambov^{a,*}, Terry Hartig^b, Iana Markevych^{c,d}, Boris Tilov^{e,f}, Donka Dimitrova^g

^a Department of Hygiene and Ecomedicine, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria

^b Institute for Housing and Urban Research and Department of Psychology, Uppsala University, Uppsala, Sweden

^c Institute and Clinic for Occupational, Social and Environmental Medicine, University Hospital, LMU Munich, Munich, Germany

^d Institute of Epidemiology I, Helmholtz Zentrum München – German Research Center for Environmental Health, Neuherberg, Germany

^e Medical College, Medical University of Plovdiv, Plovdiv, Bulgaria

^f Department of Management, Faculty of Economics and Management, University of Agribusiness and Rural Development, Plovdiv, Bulgaria

^g Department of Health Management and Healthcare Economics, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria

ARTICLE INFO

Keywords:

Air pollution
Greenness
Green space
Mediation analysis
Noise
Physical activity
Restoration
Social cohesion
Stress

ABSTRACT

Background: Urban greenspace can benefit mental health through multiple mechanisms. They may work together, but previous studies have treated them as independent.

Objectives: We aimed to compare single and parallel mediation models, which estimate the independent contributions of different paths, to several models that posit serial mediation components in the pathway from greenspace to mental health.

Methods: We collected cross-sectional survey data from 399 participants (15–25 years of age) in the city of Plovdiv, Bulgaria. Objective “exposure” to urban residential greenspace was defined by the Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index, tree cover density within the 500-m buffer, and Euclidean distance to the nearest urban greenspace. Self-reported measures of availability, access, quality, and usage of greenspace were also used. Mental health was measured with the General Health Questionnaire. The following potential mediators were considered in single and parallel mediation models: restorative quality of the neighborhood, neighborhood social cohesion, commuting and leisure time physical activity, road traffic noise annoyance, and perceived air pollution. Four models were tested with the following serial mediation components: (1) restorative quality → social cohesion; (2) restorative quality → physical activity; (3) perceived traffic pollution → restorative quality; (4) and noise annoyance → physical activity.

Results: There was no direct association between objectively-measured greenspace and mental health. For the 500-m buffer, the tests of the single mediator models suggested that restorative quality mediated the relationship between NDVI and mental health. Tests of parallel mediation models did not find any significant indirect effects. In line with theory, tests of the serial mediation models showed that higher restorative quality was associated with more physical activity and more social cohesion, and in turn with better mental health. As for self-reported greenspace measures, single mediation through restorative quality was significant only for time in greenspace, and there was no mediation though restorative quality in the parallel mediation models; however, serial mediation through restorative quality and social cohesion/physical activity was indicated for all self-reported measures except for greenspace quality.

Conclusions: Statistical models should adequately address the theoretically indicated interdependencies between mechanisms underlying association between greenspace and mental health. If such causal relationships hold, testing mediators alone or in parallel may lead to incorrect inferences about the relative contribution of specific paths, and thus to inappropriate intervention strategies.

1. Introduction

Improved mental health is a widely studied outcome in relation to

urban greenspace “exposure” (Gascon et al., 2015). Mechanisms thought to generate such beneficial effects include mitigation of harmful exposures (e.g., noise, air pollution), psychological restoration

* Corresponding author.

E-mail address: angelleloti@gmail.com (A. Dzhambov).

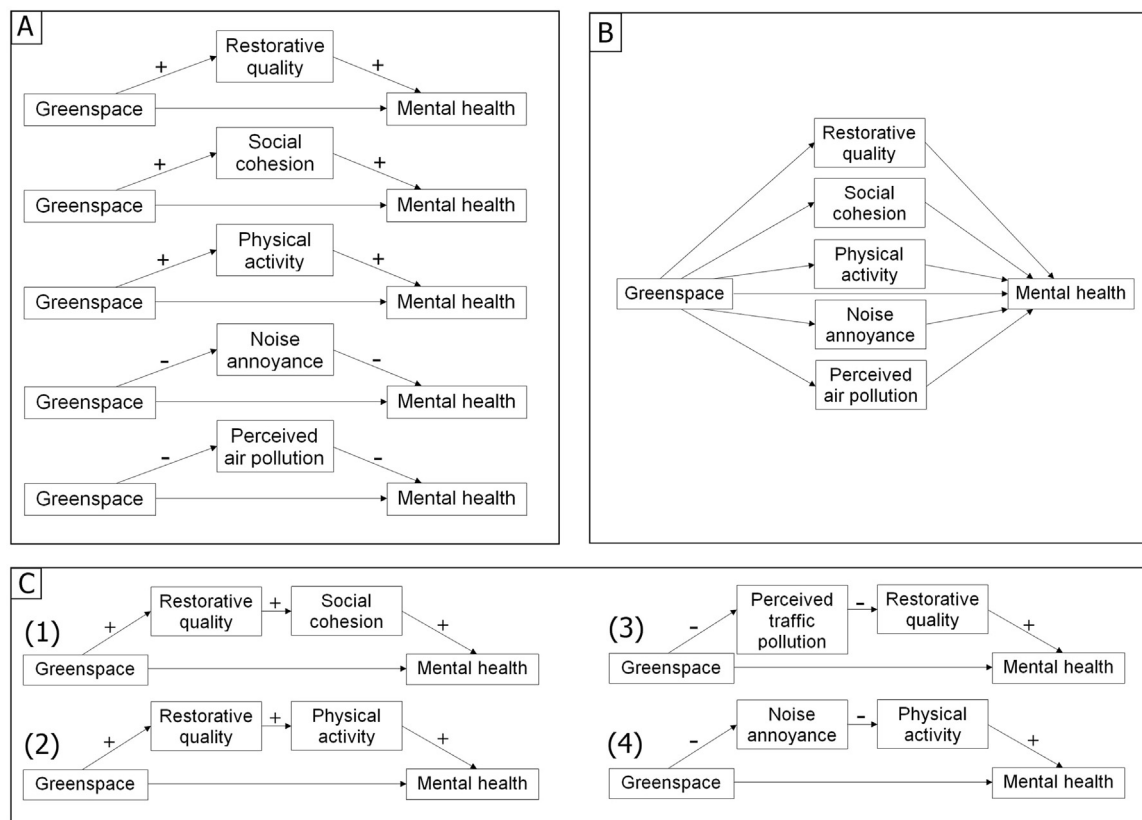


Fig. 1. Conceptual diagrams of alternative approaches to modelling pathways linking greenspace to mental health. A – single mediation models with mediators tested one-at-a-time. B – parallel mediation model with mediators assumed to act independently. C – theoretically-indicated serial mediation models. Panel “C” does not address all possible pathways involving combinations of candidate mediators; given the complexity of such an encompassing conceptual model and the limitations of the present data, we have decomposed it into an illustrative subset of models for which the literature indicates some precedents.

(e.g., stress reduction, renewal of directed attention capacity), and encouragement of health-enhancing behaviors (e.g., physical activity, social interactions) (Markevych et al., 2017b; WHO, 2016). Previous studies have tested the operation of these mediating mechanisms in different ways. Some have tested models with a single mediator (e.g., Dalton et al., 2016). Others have looked at multiple mediators (Dadvand et al., 2016; de Vries et al., 2013; Sugiyama et al., 2008; Zijlema et al., 2017). Both approaches can yield useful information; however, they neglect the possibility of causal relationships between the candidate mediators, and this may hinder progress in the field (Hartig et al., 2014).

Various studies illustrate the potential for further theoretical specification in the form of serial mediation models that join multiple mediators within a causal sequence. von Lindern et al. (2016) found that residential exposures to traffic-related sound and air pollution were associated with poorer mental health, not only as a stressor, working solely through increased disturbance, but also as a constraint on restorative quality by reducing possibilities for gaining psychological distance from taxing demands and diminishing opportunities for pleasant and positive engagement with the environment. Dahlkvist et al. (2016) found that greenery in elderly care facilities did not have a direct association with self-perceived health among residents. They did however uncover indirect paths; garden greenery was associated with two aspects of restorative quality (psychological distance, positive engagement), which in turn were associated with self-perceived health, directly and/or through visitation. This finding concurs with the notion that people pursue physical activity not only to improve fitness in the long-run but also to enjoy restorative benefits more immediately, and that they seek out parks and other green spaces for physical activity because such settings better support the realization of immediate restorative benefits (cf. Barton et al., 2016; Hartig, 2008).

Restorative quality may also attract residents to outdoor green spaces where they can meet their neighbors, thereby enhancing a sense of community and social cohesion in the neighborhood (cf. Kuo et al., 1998). In sum, rather than treating psychological restoration as just one, independent pathway from greenspace to mental health, serial mediation models could consider how restorative quality in the environment is constrained by environmental conditions and/or promotes the performance of salutary behaviors.

Assuming that plausible mediators operate alone or in parallel rather than in serial can lead to heterogeneity in findings and incorrect inferences regarding the relative importance of different indirect paths linking greenspace to health. This can be illustrated with reference to research on relations among greenspace, traffic-related emissions, and mental health. Zijlema et al. (2017) tested the indirect effect of natural environments on cognitive function through noise annoyance and air pollution worries but found no evidence of mediation. Foraster et al. (2016), on the other hand, indicated that noise annoyance may reduce physical activity, possibly due to sleep disturbance and daytime sleepiness. Conceivably, a model in which greenspace reduces noise annoyance could further relate to mental health through enabling physical activity, not only as an attractive setting but also by ensuring that people are not too fatigued from disrupted sleep. This suggestion is congruent in broad outline with the findings of von Lindern et al. (2016) and Dahlkvist et al. (2016) cited above.

The inferential problem can be compounded by the use of the classic causal-steps approach to assessing mediation, which in the present case would require a significant total effect of greenspace on mental health as a logical prerequisite for establishing an indirect effect via any of the mediators (Baron and Kenny, 1986). This approach has been criticized on multiple grounds. For example, it neglects the possibility that multiple, competitive pathways can conceal a direct effect (Hayes, 2009;

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