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Forest biodiversity and structure modulate human health benefits and risks

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Abstract

The benefits and risks of forests to human health are widely recognized. Yet, variation across forest types and their ecological characteristics driving health effects remain underexplored. Based on a continental-scale, interdisciplinary empirical database from 164 European forest stands, we constructed a Bayesian Belief Network to quantify seven causal pathways relating distinct forest types to physical and mental health. These forest–health pathways included mental well-being via visual or auditory stimuli, thermal comfort, polyphenol content of medicinal plants, mushrooms and nutrition, air quality, and ticks and Lyme disease. Results show that forests consistently provide net health benefits regardless of their ecological characteristics. Forest canopy density and tree species diversity emerge as key drivers, but their effect size and directionality are strongly pathway-dependent. Changes in forest canopy density can generate trade-offs. For example, forests optimized for heat buffering and air pollution mitigation may compromise medicinal plant yield and enhance Lyme disease prevalence. Tree diversity effects were weaker but more uniformly positive. Therefore, forest management should account for such

trade-offs to tailor forest biodiversity and functioning to local public health priorities.

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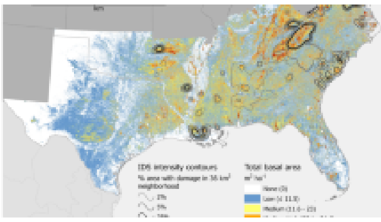

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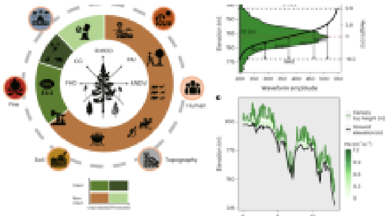

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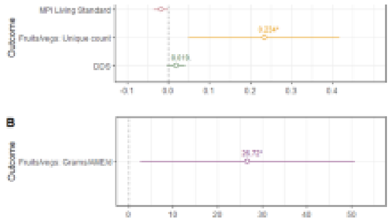

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Data availability

The BBN file that supports the findings of this study is available via Figshare at https://figshare.com/s/63ac8597986bc3d81e2f (ref. [32]). It can be used to replicate the findings or for adding new data (belief updating). The individual datasets used to operationalize the BBN are tied to their respective studies, which are cited in the manuscript and listed in the Supplementary Information. Whether data are readily available via repositories or have to be requested from the owners depends on the study.

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Contributions

L.G., D.L., B.M. and K.V. conceptualized the statistical approach and developed the methodology. L.G., D.L., A. Bourdin, K.R., T.S., M.S., K.S., T.V., A.G.C.R., S.M., R.R.Y.O., A. Bonn, H.B., D.G., D.H., H.J., B.J., M.R.M., Q.P., M.S.L., B.M. and K.V. developed the outlines of the conceptual models (phase I). L.G., D.L., A. Bourdin, K.R., T.S., M.S., K.S., T.V., A.G.C.R., S.M., R.R.Y.O. shared and prepared the empirical data, quantified the submodels and validated the behaviour model (phases II and III). L.G. and D.L. conducted the data analyses. L.G. wrote the original manuscript draft and all authors reviewed the manuscript. D.L., P.D.F., B.M. and K.V. supervised the study. S.M., D.B., A. Bonn, H.B., D.G., D.H., H.J., B.J., M.R.M., Q.P., M.S.L., B.M. and K.V. obtained the funding and administered the project. M.S.L. and D.H. coordinated the project.

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Ethics declarations

Competing interests

The authors declare no competing interests.

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Supplementary information

Supplementary Information

Supplementary Methods and Fig. 1.

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