Depressive Symptoms and urban residential greenness: Effects of measurement errors of the mean normalised difference vegetation (NDVI) on its association with depressive symptoms in spatial Regression

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We analyze data from participants in the Heinz Nixdorf Recall study (4814 participants) who were between 45 and 75 years old and were without depressive symptoms at baseline (2000-2003). Depressive symptoms during the previous week were assessed using the 15-item short-form questionnaire of the Center for Epidemiologic Studies Depression Scale (CES-D) which was distributed to participants at the baseline and 5-year follow-up visits at the study center. Possible scores for the 15-item version range from 0 to 45, with higher levels indicating more and/or more frequent depressive symptoms. Previous researches suggest that access to green spaces, contact with nature and outdoor physical activity may benefit mental health ([2]). The level of greenness or green vegetation within a 100-meter buffer of each participant residence was defined using the Normalized Difference Vegetation Index (NDVI), which was calculated from satellite imagery using a geographic information system. We investigate the association between urban residential greenness and depressive symptoms using a negative binomial regression model with depression score as outcome and NDVI as the main exposure, adjusting for some socio-economic covariates. Depression score is proved to be significantly associated with the NDVI, consistent with previous researches.

By considering the source of errors such as error of interpreter, field data collection, geometric and atmospheric correction, etc, which are expected in any remotely-sensed method, we assume that just a proxy of the true NDVI is observed for each of the independent measurements (baseline and follow-up), such that the classical measurement error model can be considered.

We conduct a Bayesian analysis of the measurement error based on a three level hierarchical model using INLA and prove that the failure to account for the measurement error causes the coefficient estimates of the NDVI to be attenuated, consistent with the works of Muff and al. ([3]) on the effect of measurement errors.

There have been some residual spatial variations unexplained in our regression model: We use a generalized additive model with smoothing spline and detect a highly significant smooth Term (function) of the spatial locations (coordinate of the participant's residential locations). The classical measurement error theory is inapplicable in the context of spatial modeling because of the presence of spatial correlation among the observations. We aim to incorporate the spatial dependency in the measurement error analysis in the Hierarchical model and also following the work of Huque et al ([1]).

References

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