Geospatial analysis of cancer incidence and its association to estimated pesticide usage in the U.S. west

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Abstract

This study's objective was to evaluate the potential geospatial relationship between agricultural pesticide use and cancer incidences by using the concept of consolidated environmental burden indices. We conducted two sets of experiments, using pesticide data collected from the U.S. Geological Survey Pesticide National Synthesis Project database and using cancer data collected from the National Cancer Institute State Cancer Profiles and Cancer Data Registry of Idaho. In the first experiment, we analyzed the associations between several potentially carcinogenic pesticides and metals to the pediatric cancer incidence among the counties of Idaho. Principal component analysis was adopted to consolidate the environmental variables. This study identified that the principal components (PCs) were significantly associated with pediatric cancer at P-value < 0.01 and a t-statistic > 3. The PC's improved model performance substantially, from NSE = 0.22 for the control case to NSE = 0.52 for the treatment case. In the second experiment, we evaluated the associations of pesticides to two cancer metrics (pediatric cancer incidence and total cancer incidence) across each of the 11 contiguous states in the Western U.S. at the state and county spatial scales. A multi-level model was developed using fumigant mass, fumigant mass tertiles as well as county and state boundaries, which strongly predicted total cancer incidence (R-squared = 0.95, NSE = 0.91, and SSR = 8.22). Further, this study also identified significant associations between total fumigant mass, total pesticide mass, medium and high fumigant class (tertiles > 0.33), and high pesticide class (tertile > 0.66), relative to total cancer incidence (P-value < 0.01) in the U.S. west. Fumigant application rate was shown to be significantly related to the incidence of total cancers and pediatric cancer. Moreover, this relationship was maintained regardless of the spatial resolution used in the analysis (county or state). Both studies reinforce inferences from previous studies that pesticides are related to an elevated risk for pediatric cancer. Similarly, among the pesticides, fumigants such as metam were shown to be important relative to the cancer incidences for both experiments, highlighting the significance of further analysis.

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