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Ambient Air Pollution, Green-Space Exposure, and Environmental Correlations among LASI Wave-1 Participants in Tripura, India: A Secondary Cross-Sectional Analysis

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Abstract: ***Background: Joint patterns of air pollution and surrounding environmental features are understudied in northeastern India. Objective: To describe multi-window exposure distributions and environmental correlations among LASI Wave-1-linked records attributed to Tripura. Methods: We analyzed 1,195 records selected from the LASI Wave-1 Environmental Exposure Dataset v2 using the previously identified primkey prefix 116. Means, standard deviations, medians and interquartile ranges summarized environmental variables. Pearson correlations were calculated across participant records, with exploratory p-values recomputed on distinct exposure pairs to flag pseudoreplication. Results: Mean (SD) 1-year PM2.5 was 31.44 (5.07), NO2 3.63 (2.21), green-space index 0.609 (0.097), and ozone 58.89 (1.39; n=1,072). Mean PM2.5 values for 5- and 10-year windows were 33.83 (5.65) and 34.09 (5.62). Participant-record Pearson correlations were PM2.5–NO2 r=0.584, PM2.5–green space r=-0.409, NO2–green space r=-0.786, and NO2–ozone r=0.860. Forty-one distinct complete five-indicator exposure profiles were identified. Conclusion: Pollution indicators and green-space exposure show pronounced cross-sectional co-patterning in this subset. Results are descriptive, not survey-weighted population estimates; unit and geographic-code validation and cluster-aware analyses are prerequisites for confirmatory inference.***

Keywords: air pollution; particulate matter; nitrogen dioxide; ozone; green space; LASI; Tripura; spatial epidemiology

1. Introduction

Ambient air pollution is a major environmental health concern worldwide. The World Health Organization (WHO) identifies fine particulate matter, nitrogen dioxide, and ozone among pollutants for which health-based air-quality guidelines are available [1]. The India State-Level Disease Burden Initiative estimated substantial health and economic consequences attributable to air pollution across Indian states [2].

Environmental exposure is multidimensional: ambient pollutants, anthropogenic lighting, and the availability of vegetated or water-covered surroundings may vary together [3]. Correlations between these indicators are important for exposure assessment and for designing subsequent multipollutant studies; however, they should not be interpreted as direct health effects.

The Longitudinal Ageing Study in India (LASI) is a large multistage population survey covering middle-aged and older adults and eligible younger spouses [4]. Its baseline wave was conducted primarily during 2017–2018 [5]. An environmental exposure supplement allows a descriptive assessment of spatially assigned exposures. We focus on the Tripura subset to quantify exposure distributions and characterize relationships between selected indicators.

2. Methods

2.1 Study design and data source

This was a secondary, cross-sectional descriptive analysis of the supplied LASI Wave-1 Environmental Exposure Dataset version 2 [6]. The source file comprised 73,408 records. The prior extraction selected 1,195 records whose primkey string began with '116', provisionally interpreted as Tripura. The official state-code crosswalk was not supplied and this interpretation remains subject to validation. The environmental supplement includes 108 columns in the extracted dataset.

2.2 Population and variables

All extracted records were retained, without an age restriction because participant age was not available in the exposure-only file. Thus, the study population is described as LASI-linked participants rather than exclusively adults aged ≥45 years. Primary variables were dimaq_pm25_1yr, no2_1000m_1yr, grnmean_1000m_1yr, blue_1000m_1yr, and ozone_1yr. Corresponding 5- and 10-year windows were examined where available. Exposure values were analyzed in their original numeric scales; their physical units, spatial resolution, source models, and time alignment require confirmation from the supplement's codebook.

2.3 Statistical methods

For each indicator, we calculated nonmissing n, missing n, arithmetic mean, sample standard deviation, median, first and third quartiles, and number of distinct values. Pairwise-complete Pearson and Spearman coefficients assessed bivariate association among five 1-year indicators. Because multiple participants share the same environmental values, ordinary participant-level p-values were not used for inference. As an exploratory sensitivity check, identical pairs of exposure values were deduplicated and Pearson tests applied to those distinct pairs. These p-values are not valid

substitutes for geographic-cluster-aware, design-weighted inference. We made no multiplicity correction and did not fit adjusted models. Analyses were unweighted because survey weights, geographic cluster identifiers and design strata were not available in this supplement.

2.4 Missing data and reproducibility

Available-case summaries were used; no imputation was performed. Ozone_1yr was missing for 123/1,195 (10.3%) records; the remaining four selected 1-year variables were complete. The accompanying tabular outputs and figures were generated directly from the supplied subset using pandas, SciPy and matplotlib. The results reflect the supplied data snapshot, not independent validation of its provenance.

2.5 Ethics

This study reanalyzed a de-identified secondary dataset. The original LASI study obtained informed consent as described in the cohort profile. The author must confirm applicable data-use permissions and local institutional requirements before submission; no new ethics approval or exemption is asserted here.

3. Results

3.1 Study sample and exposure distributions

A total of 1,195 records were included, with no duplicate primkey values. The extracted dataset contained 108 variables. One-year PM2.5 mean (SD) was 31.44 (5.07), NO2 was 3.63 (2.21), mean green-space index was 0.609 (0.097), and ozone was 58.89 (1.39) among 1,072 nonmissing records. The 5- and 10-year PM2.5 means were 33.83 and 34.09, respectively. These differences between windows are descriptive, not longitudinal within-person changes.

Table 1: Selected exposure distributions. Units are intentionally omitted pending source-codebook confirmation. Statistics are unweighted participant-record summaries.

Indicator	n	Mean (SD)	Median [Q1, Q3]	Distinct values
dimaq_pm25_1yr	1195	31.441 (5.071)	31.066 [28.129, 36.919]	41
dimaq_pm25_5yr	1195	33.832 (5.654)	33.518 [27.674, 39.966]	41
dimaq_pm25_10yr	1195	34.093 (5.623)	33.657 [27.880, 40.158]	41
no2_1000m_1yr	1195	3.633 (2.212)	3.602 [2.000, 5.135]	35
no2_1000m_5yr	1195	3.525 (2.185)	3.526 [1.485, 5.057]	37
no2_1000m_10yr	1195	3.473 (2.166)	3.501 [1.370, 4.960]	37
ozone_1yr	1072	58.892 (1.387)	59.523 [57.744, 59.975]	18
ozone_5yr	1195	58.523 (1.306)	58.696 [57.661, 59.518]	23
ozone_10yr	1195	56.352 (1.275)	56.550 [55.513, 57.342]	23
grnmean_1000m_1yr	1195	0.609 (0.097)	0.615 [0.546, 0.700]	41
grnmean_1000m_5yr	1195	0.599 (0.087)	0.598 [0.545, 0.677]	41
grnmean_1000m_10yr	1195	0.589 (0.085)	0.586 [0.536, 0.665]	41
blue_1000m_1yr	1195	0.007 (0.011)	0.000 [0.000, 0.007]	19
blue_1000m_5yr	1195	0.007 (0.011)	0.000 [0.000, 0.007]	19
blue_1000m_10yr	1195	0.007 (0.011)	0.000 [0.000, 0.007]	19

3.2 Correlations among exposure indicators

Participant-record correlations showed positive PM2.5–NO2 (r=0.584), PM2.5–ozone (r=0.655), and NO2–ozone (r=0.860) associations, and negative PM2.5–green space (r=-0.409) and NO2–green space (r=-0.786) associations. The five-variable exposure vector comprised only 41 distinct complete profiles across 1,195 records, indicating substantial repeated exposure assignment.

Table 2: Correlation matrix in pairwise format. *Exploratory p-values calculated after deduplicating exposure pairs; they do not account for actual geographic clustering or survey design and should not be interpreted as confirmatory hypothesis tests.

Exposure pair	Pairwise n	Pearson r	Spearman rho	Distinct pairs	Exploratory p*
dimaq_pm25 / no2_1000m	1195	0.584	0.587	41	2.94e-05
dimaq_pm25 / grnmean_1000m	1195	-0.409	-0.384	41	0.00787
dimaq_pm25 / blue_1000m	1195	0.061	0.074	41	0.619
dimaq_pm25 / ozone	1072	0.655	0.629	36	1.37e-05
no2_1000m / grnmean_1000m	1195	-0.786	-0.734	41	4.2e-09
no2_1000m / blue_1000m	1195	0.328	0.246	36	0.104
no2_1000m / ozone	1072	0.860	0.862	36	1.75e-11
grnmean_1000m / blue_1000m	1195	-0.486	-0.345	41	0.00123
grnmean_1000m / ozone	1072	-0.789	-0.791	36	1.71e-08
blue_1000m / ozone	1072	0.285	0.213	30	0.0244

3.3 Exposure Windows and Visualization

Across the reported windows, mean PM2.5 increased from 31.44 (1-year) to 33.83 (5-year) and 34.09 (10-year), while mean NO2 was 3.63, 3.53, and 3.47. Mean green-space index was 0.609, 0.599, and 0.589, respectively. Because these windows are nested or overlapping, no independent-group comparison or time-trend test was performed.

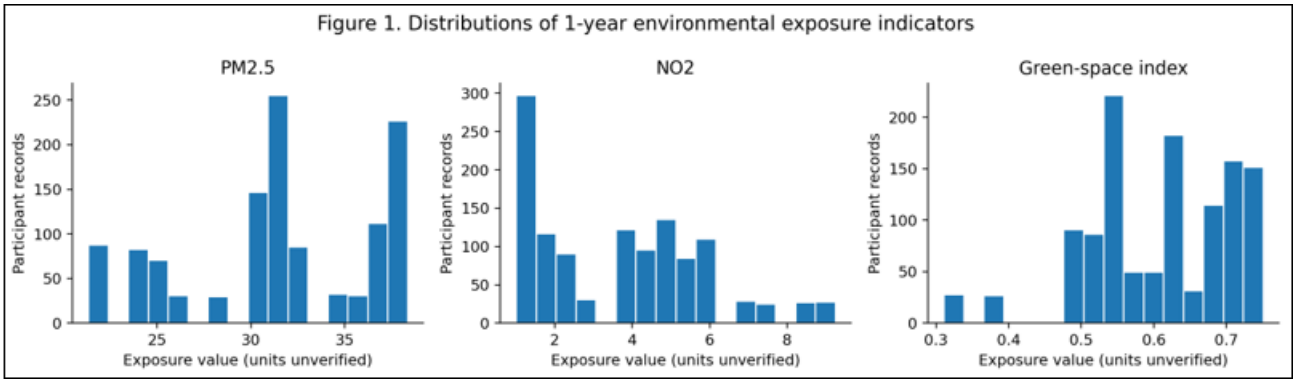


Figure 1: Distributions of selected 1-year exposures (participant records).

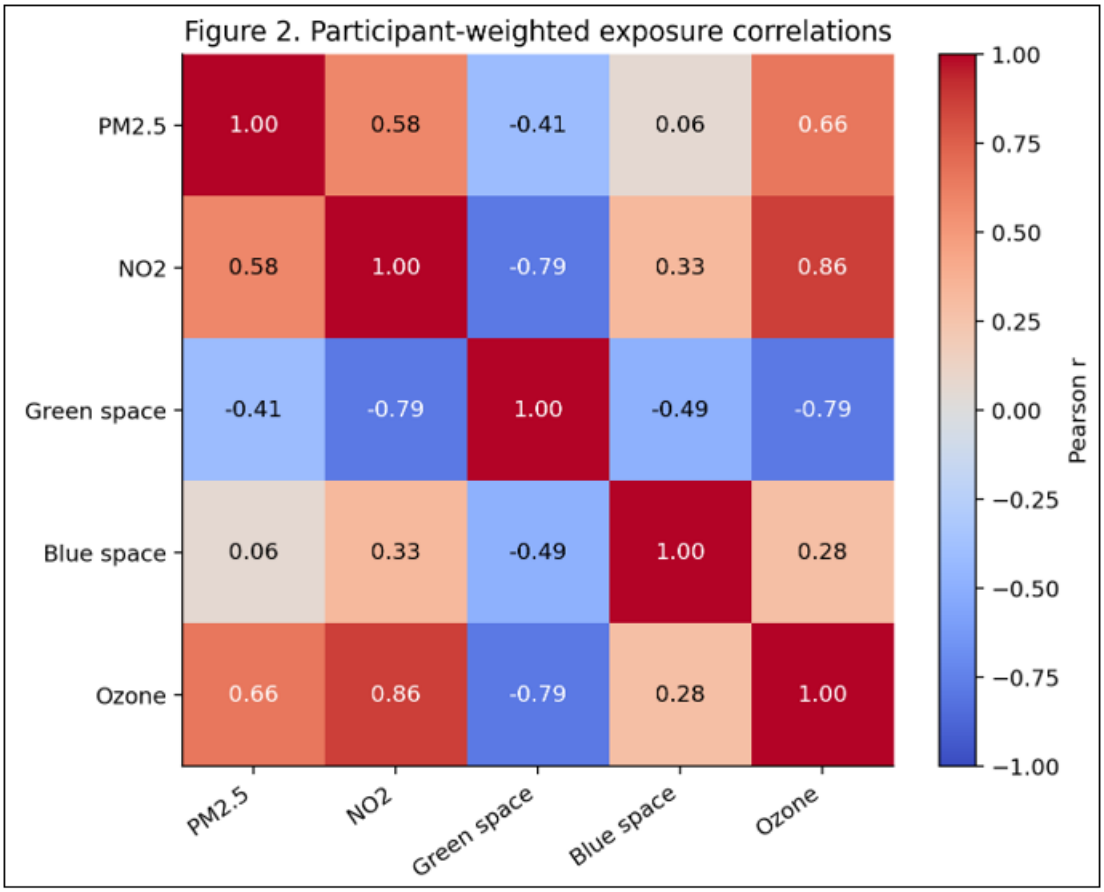


Figure 2: Pearson correlation heatmap of selected 1-year indicators.

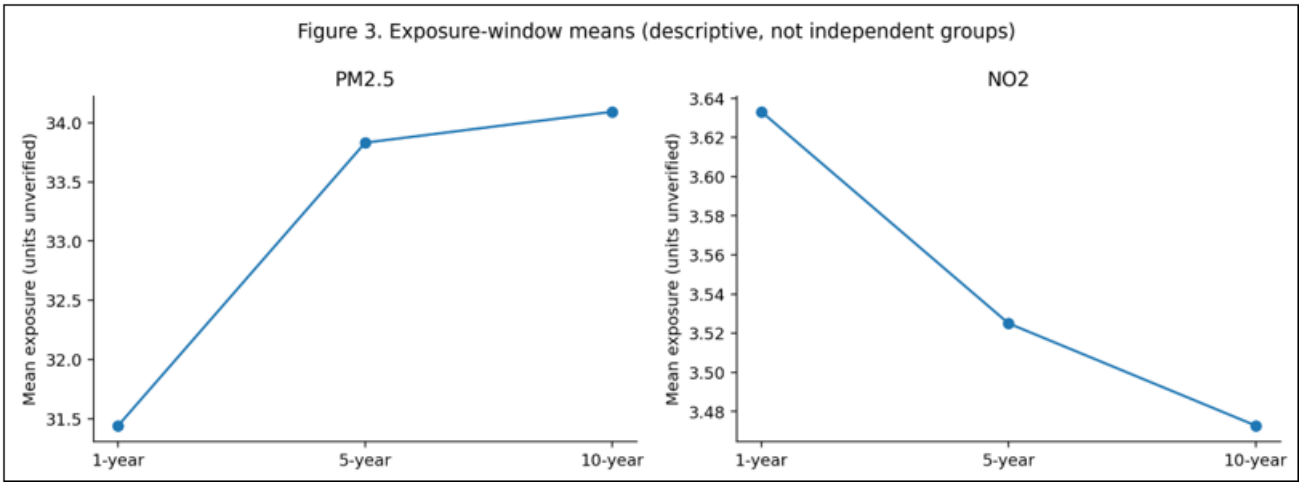


Figure 3: Mean PM2.5 and NO2 across 1-, 5-, and 10-year exposure windows.

4. Discussion

This descriptive study documents variation in assigned environmental exposures within a LASI-linked subset provisionally identified as Tripura. The central findings are positive correlations among selected air-pollution measures and inverse correlations between pollution measures and the green-space index. These patterns may reflect shared spatial drivers such as urbanization, road activity, combustion sources, and land cover, but the exposure-only dataset does not allow these mechanisms to be tested.

The strong correlation between NO2 and ozone (r=0.860) is notable and may reflect spatial or model-specific characteristics of the assigned exposure surfaces [7]. It should not be interpreted as proof of a direct atmospheric causal pathway. Similarly, the negative correlation between NO2 and green space is compatible with co-location of pollution and less vegetated environments, without demonstrating a protective physiological effect of green space [8].

The WHO guidelines and Indian burden-of-disease analyses establish the public-health importance of ambient air pollution [9], but their exposure definitions cannot be mapped to the numeric values here until the supplement's units and averaging conventions are verified. It would therefore be inappropriate to calculate exceedance of WHO concentration thresholds from the present undocumented scales.

The study is particularly limited by repeated assigned exposure values: 1,195 participant records yielded only 41 distinct complete exposure profiles across five selected indicators. Conventional participant-level p-values would produce misleadingly small standard errors. Deduplicating exposure pairs provides a sensitivity description but is not a principled substitute for a multilevel or cluster-robust analysis based on actual geographic units.

4.1 Strengths and limitations

Strengths include use of observed numeric data rather than aggregate state-level factsheet estimates, reporting of multiple exposure windows, explicit missing-data summaries, and transparent distinction between record-level correlations and inferential evidence. Limitations include unverified state coding, unknown units and exposure modeling, lack of participant demographics and clinical outcomes, absent survey weights and cluster identifiers, inability to assess confounding, possible exposure misclassification, and inability to establish temporality or causal effects. LASI's original complex survey design further limits unweighted population-level interpretation.

4.2 Implications for future research

A validated merge with the LASI individual health and biomarker files could support analyses of measured blood pressure, respiratory function, diabetes-related biomarkers, or grip strength. Such work should incorporate survey design, true spatial clusters, confounders, missingness, exposure uncertainty, and appropriate multilevel models. This descriptive study alone does not support claims about physiological outcomes.

5. Conclusion

The LASI Wave-1 environmental exposure supplement contains heterogeneous pollution and land-cover indicators in 1,195 records provisionally assigned to Tripura. Air-pollution indicators were positively correlated with each other and inversely associated with the green-space index. These findings are exploratory and descriptive. Geographic coding, measurement units, exposure provenance, and survey design must be validated before confirmatory epidemiologic interpretation or journal submission.

Declarations

Ethics approval and consent to participate: Original LASI informed consent is documented in the cohort profile; secondary-use permissions and local ethics determination must be confirmed by the author.

Consent for publication: Not applicable to this de-identified secondary analysis, subject to the data-use agreement.

Availability of data and materials: LASI data are available through the International Institute for Population Sciences subject to access conditions. Analysis derived from the user-supplied environmental supplement.

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Competing interests: To be confirmed by the author.

Author contributions: Md Mazharul Hoque — manuscript preparation and oversight; precise analysis and contribution statements should be reviewed and approved by the author.

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