# Environmental Exposure and Comorbidity Burden in Cancer Patients:

## Insights from a Novel Linked Real-World Dataset

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## Purpose

- ❖ Cancer outcomes depend not only on tumor biology but also on baseline health.
- ❖ At The Christie, 60% of patients have at least one comorbidity at diagnosis, and comorbidity severity is associated with socioeconomic deprivation [1].
- ❖ Emerging evidence suggests environmental exposures associate with cancer outcomes [2], but linked oncology–environmental datasets are lacking in the UK.
- ➢ Our aim was to establish a linked oncology–environmental dataset, with its utility demonstrated by investigating the association between environmental exposure and comorbidity burden at cancer diagnosis in patients treated at The Christie..

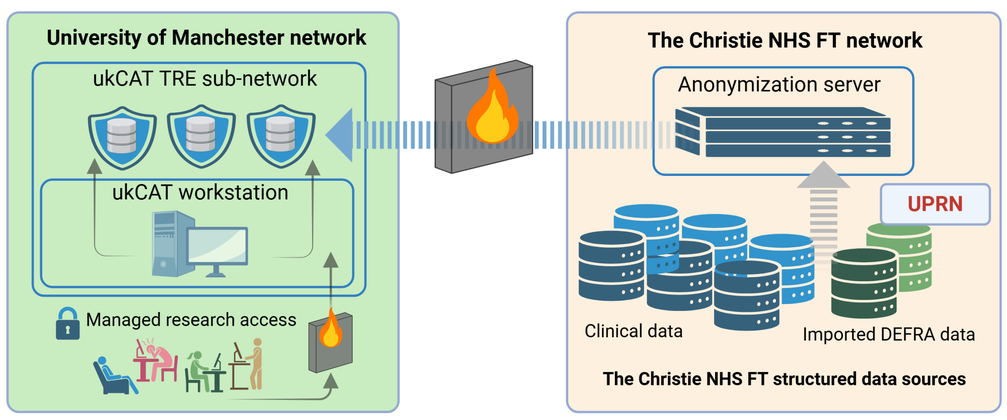


**Figure 1: High-level architecture of UK Computer-Aided Theragnostics Trusted Research Environment**
Christie health records and UK Department for Environment, Food & Rural Affairs (DEFRA) environmental data were linked using Unique Property Reference Number (UPRN) identifiers. Created in BioRender. (2026) https://BioRender.com/srx5cam

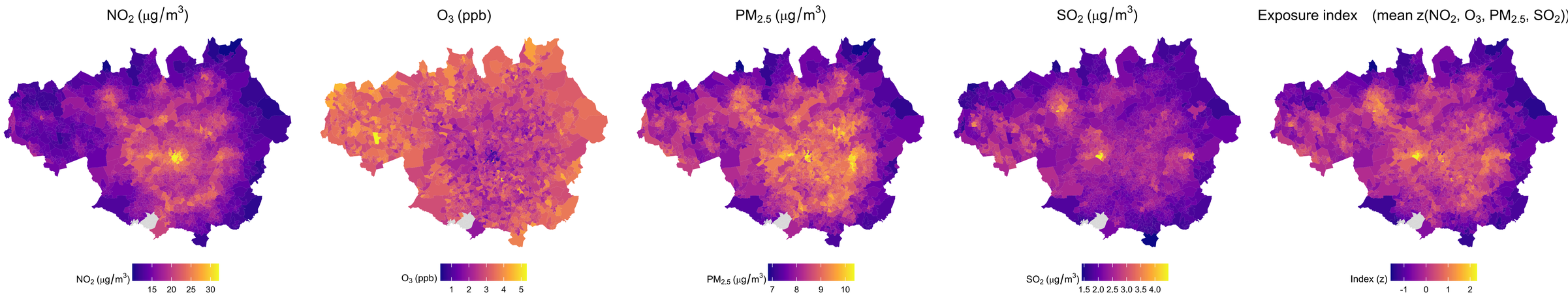


**Figure 2: Spatial distribution of four environmental exposures and the derived exposure index across Greater Manchester.**
Annual residential concentrations of $NO_2$, $O_3$, $PM_{2.5}$, and $SO_2$ were assigned to patients by converting values to 1×1 km grids and applying area-weighted averages at the residential Lower Super Output Areas (LSOAs; small census neighbourhoods of ~1,500 residents). To account for differing measurement scales and correlations between pollutants, each pollutant was standardised using z-scores, and the four standardised variables were averaged with equal weighting to generate a composite environmental exposure index. Mixture exposure used since patients are exposed to multiple correlated pollutants rather than a single pollutant. Higher index values represent a greater exposure burden at the time of cancer diagnosis.

## Methods

### Data Linkage Infrastructure

The Christie electronic health records linked to modelled air-pollution data from UK Department for Environment, Food & Rural Affairs (DEFRA) using Unique Property Reference Number (UPRN) within a secure Trusted Research Environment *(figure1)*.

### Study Population

55,380 cancer patients treated at The Christie (2014–2022) with available records for comorbidty and environmental exposure.

### Environmental Exposure Mapping

Annual mean concentrations of nitrogen dioxide ($NO_2$), ozone ($O_3$), fine particulate matter ($PM_{2.5}$), and sulphur dioxide ($SO_2$) were mapped to patients' residential areas.

For each patient, $NO_2$, $PM_{2.5}$, $O_3$, $SO_2$ standardised and averaged into a single environmental exposure index *(figure 2)*.

### Comorbidity Assessment

Adult comorbidity Evaluation-27 (ACE-27) at cancer diagnosis, capturing 27 conditions across 12 organ systems; with overall score of none, mild, moderate, or severe. Spatial distribution of age-standardised comorbidities are shown in *figure 3*.

### Statistical Modelling

Associations between exposure index and comorbidity were assessed using:

Logistic regression for i) severe vs non-severe score ii) 12 organ-specific systems.

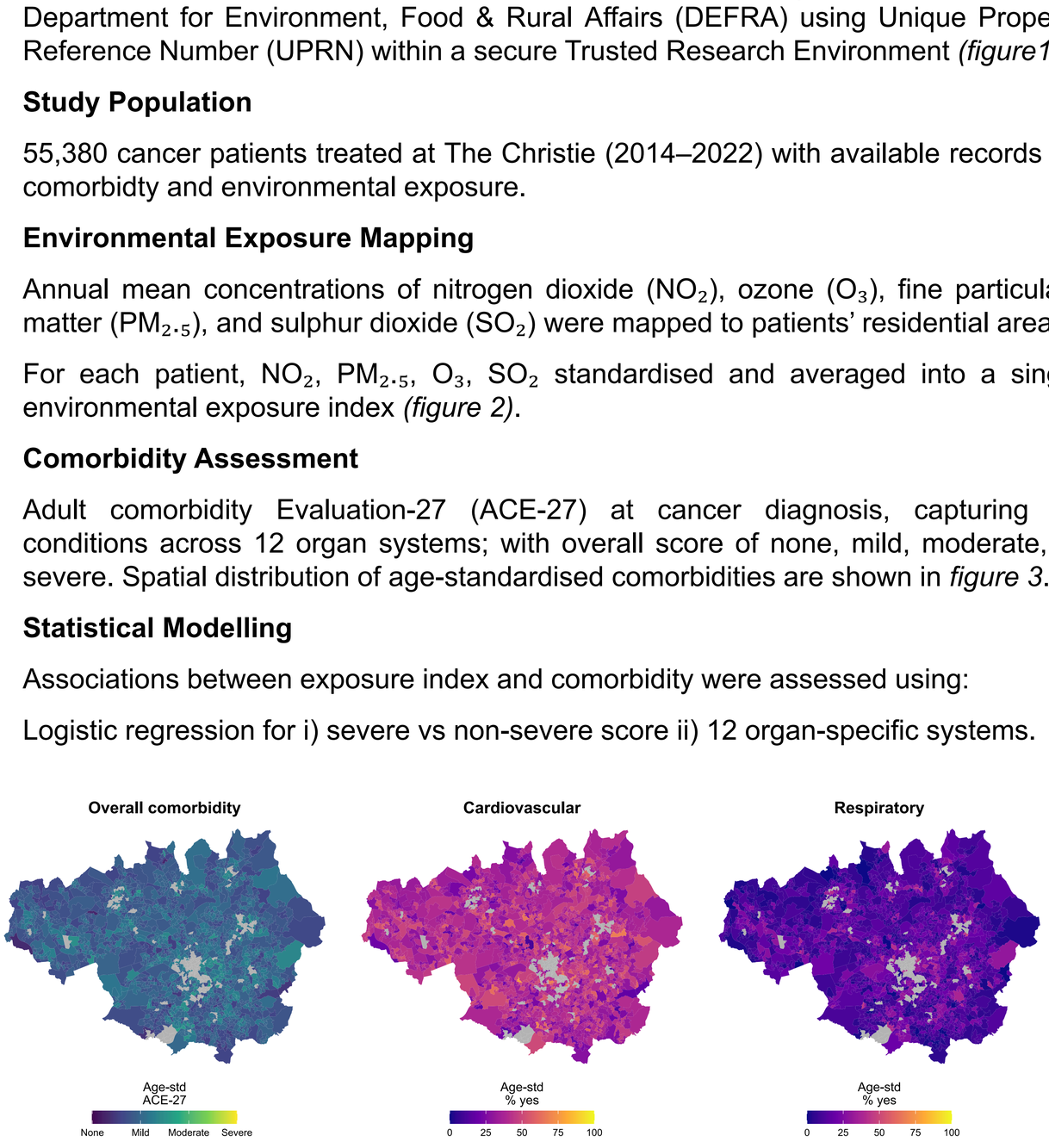


**Figure 3: Baseline comorbidity distribution**
Overall comorbidity scores, along with cardiovascular and respiratory comorbidity patterns, show geographic variation across Greater Manchester. Grey areas indicate suppressed data where the number of patients was fewer than 20.

## Results

- ❑ Median age 68 years, 51% female; comorbidity: none=20,841 (38%), mild=19,863 (36%), moderate=10,025 (18%), and severe=4,651 (8%).

### i. Severe comorbidity burden

Each 1-SD increase in exposure index → 14% higher odds of severe comorbidity (OR 1.14, 95% CI 1.07–1.21, p<0.001).

Older age and male sex were also associated with higher risk of severe comorbidity.

### ii. Organ-system comorbidity

The exposure index showed a organ-specific association *(figure 4)*.

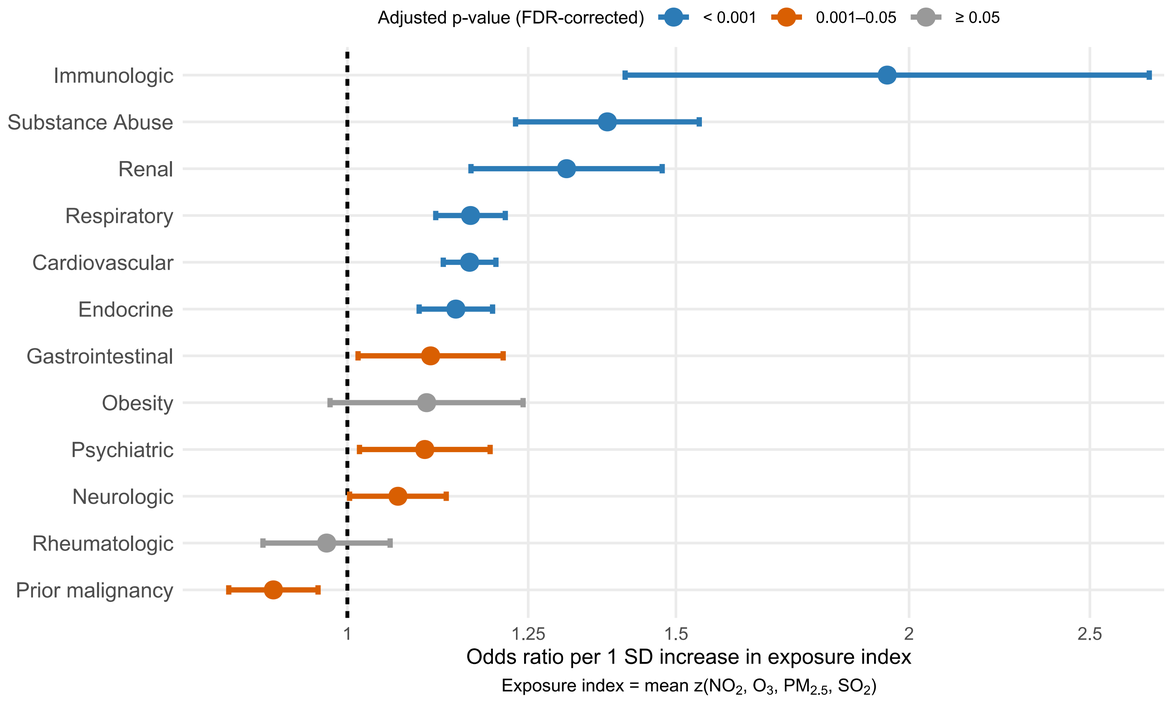


**Figure 4: Association between exposure index and organ-system comorbidity at cancer diagnosis.**
Odds are shown per 1-SD increase in the exposure index, adjusted for age, sex, and cancer site. Increasing exposure index was associated with organ-specific comorbidity. P-values corrected for Benjamini–Hochberg false discovery rate.

## Conclusion

We provide the first UK evidence integrating cancer health records with exposure data, establishing a scalable approach for policy-relevant research and future investigations into environmental determinants of cancer outcomes.

## References

1. Abravan et al (2024) British Journal of Cancer. *Comorbidity in patients with cancer treated at The Christie*

2. Abravan et al (2026) Radiotherapy & Oncology. *Environmental determinants of cancer outcomes: a scoping review*