



Shaping Tomorrow's Nephrology: Insight-Driven Kidney Care

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Long-Term Effects of Ambient Ozone on Mortality and Cardiovascular Outcomes in a Nationwide Cohort of Over One Million Patients with Chronic Kidney Disease

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Objectives : Global ozone concentrations are increasing, and accumulating evidence links these increases to increased mortality and cardiovascular morbidity. However, the long-term impact of greater ozone exposure in patients with chronic kidney disease (CKD) remains unclear.

Methods : This nationwide, population-based cohort study was conducted using Korean National Health Insurance data linked to district-level ozone estimates aggregated from 1 km²-resolution prediction models. We included 1,077,740 adults with CKD without prior hospitalizations for cardiovascular or kidney disease and followed them from 2015 to 2023. Long-term ozone exposure was defined according to a two-year moving average (lag: 0–1 year). Cox models with time-varying covariates were used to estimate adjusted hazard ratios (HRs) per 10 ppb increase in ozone for all-cause mortality, major adverse cardiovascular events (MACE), end-stage kidney disease (ESKD), and kidney-related hospitalizations. Subgroup, sensitivity, and lag-structure analyses were used to assess model robustness.

Results : During a median follow-up of 9 years, higher ozone concentrations were associated with increased risks of mortality (HR: 1.083; 95% CI: 1.060–1.106), MACE (HR: 1.060; 95% CI: 1.033–1.087), and kidney-related hospital admissions (HR: 1.099; 95% CI: 1.071–1.127). The associations were consistent across exposure lags, and the strongest effect estimates were observed in component outcomes for heart failure, AKI, and UTIs. The effects were more pronounced in older, low-income, hypertensive, and diabetic individuals.

Conclusions : Long-term ozone exposure is associated with adverse clinical outcomes (including mortality, cardiovascular events, and kidney-related hospitalizations) in patients with CKD. These findings highlight ozone as an underrecognized environmental risk factor with important implications for protecting vulnerable populations.

fig_ozone1.jpg



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Figure. Exposure-response curves for the association between ozone and major health outcomes

