Title: **When Alcohol Hits Harder: Pollen Exposure and Alcohol-Related Harm**

Authors: Joelle Abramowitz, University of Michigan
Olga Aristova, University of Michigan
Shooshan Danagoulian, Wayne State University
Owen Fleming, Wayne State University
Carina Gronlund, University of Michigan
Johanna Catherine Maclean, George Mason University. NBER, and IZA
Allison Steiner, University of Michigan

Alcohol-related harm is typically studied through the lens of consumption and individual characteristics. We show that environmental conditions can alter the functional effects of alcohol use. More specifically, we examine whether seasonal allergies—driven by daily variation in pollen exposure—modify alcohol-related impairment and health consequences.

Alcohol use accounts for more than 178,000 deaths annually in the United States, including roughly 100,000 attributable to alcohol use disorders (AUD). While a large literature has documented the social and economic determinants of alcohol consumption and related harms, there is less causal evidence on how environmental factors shape the alcohol-related outcomes. Our contribution is to show that environmental exposures shift the severity of alcohol-related outcomes. Environmental exposure to pollen could influence alcohol-related outcomes through at least two channels. First, ambient pollen levels can moderate the effects of alcohol use – both in terms of intoxication and underlying health conditions due to sustained alcohol use (e.g., liver disease), holding current consumption patterns constant. For example, medications used to treat seasonal allergies (e.g., antihistamines) can interact with alcohol and increase the intoxicating effects of this substance. Second, in response to pollen levels, consumers may alter their use of alcohol – for example, on high pollen days, people may stay indoors as a pollen avoidance strategy and, in turn, increase their alcohol consumption. We will test for the overall effect of exposure to pollen on alcohol-related outcomes, and we will explore the mechanisms that may drive a relationship between pollen and alcohol outcomes.

We combine multiple high-frequency national datasets: Medicare and Medicaid claims, Multiple Cause of Death records, NielsenIQ Consumer Panel data, and detailed pollen measures from the National Allergy Bureau augmented with measures from the Pollen Emissions for Climate Models (PECM) system. These data are linked at the county-day level, allowing us to study short-run fluctuations in environmental exposures alongside alcohol-related health outcomes and purchasing behavior. The combined dataset captures both alcohol-related health outcomes—emergency department (ED) visits and mortality—and consumption behavior through household purchase data.

Our empirical strategy exploits daily deviations in pollen relative to local seasonal norms within models that include county fixed effects and detailed time controls, including year-by-month, month-by-day-of-week, and day-of-season fixed effects. We also control for weather conditions

that may independently affect both pollen and health outcomes. Conditional on these controls, short-run deviations in pollen are unlikely to be correlated with alcohol consumption decisions.

We estimate effects separately for AUD and, as a comparison, drug use disorders. We find that increases in pollen exposure lead to a rise in ED visits with alcohol use disorders as the primary diagnosis. In our preferred specification, a 100 percent increase in the pollen level leads to approximately a one percent increase in such visits. In contrast, the same increase in pollen is associated with a decline in mortality attributable to AUD. These effects are contemporaneous and significantly larger on weekends, when alcohol consumption is higher, providing evidence of an interaction between environmental exposures and alcohol use. Notably, the increase in non-fatal events coincides with a reduction in fatal outcomes. The combination of increased ED visits and reduced mortality is inconsistent with increased consumption and instead points to a shift in the severity of outcomes.

Importantly, these patterns are not mirrored in drug use disorder outcomes. For drug-related cases, we find no meaningful change in ED visits and a weakly significant increase in mortality, though this finding is sensitive to specification. This pattern of results contrasts with the increase in non-fatal events and reduction in deaths observed for alcohol and is inconsistent with a general increase in substance-related harm. Our findings demonstrate that the observed shifts in severity documented in our main analysis likely emerge through amplification of alcohol's effects (e.g., impairment and underlying health conditions due to chronic use) during high pollen periods rather than changes in alcohol consumption levels in response to elevated pollen levels.

We interpret the joint increase in ED visits and reduction in mortality as evidence of a shift in the margin of alcohol-related harm. Pollen exposure increases the likelihood of acute episodes requiring medical intervention, thereby preventing some cases from progressing to fatal outcomes.

The effects differ across geographic contexts. Increases in ED visits are concentrated in rural areas, while reductions in mortality are more pronounced in metropolitan counties. These patterns suggest that acute alcohol-related episodes progress through observed outcomes differently across settings. In particular, episodes in rural areas appear more likely to result in ED visits, while in metropolitan areas they are less likely to result in mortality. We do not attribute this heterogeneity to a single mechanism.

To investigate mechanisms for the overall changes in alcohol-related outcomes, we examine alcohol purchasing behavior using household scanner data. We find no evidence of an increase in total alcohol purchases in response to higher pollen exposure. If anything, point estimates suggest modest declines in purchased quantities, with no consistent changes in spending. These patterns hold across categories of alcohol, including beer, liquor, and wine. This evidence rules out increased consumption on higher pollen days as the primary driver of the observed health effects.

This interpretation is consistent with clinical evidence that alcohol exacerbates allergic responses, including fatigue, cognitive impairment, and respiratory distress. Our findings indicate that pollen

exposure amplifies the functional impairment associated with alcohol consumption, increasing the likelihood of acute episodes that lead to emergency care.

These results have broader implications for how alcohol-related risk is measured and understood. Standard metrics such as blood alcohol content implicitly assume that impairment is stable conditional on consumption. Our findings suggest that impairment is state-dependent and can vary with environmental conditions. As a result, the risks associated with a given level of alcohol consumption may be systematically higher during periods of elevated pollen exposure.