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Epidemiology and temporal trends of carbon monoxide poisoning mortality in the United States, 2018–2024

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Dear Editor,

Carbon monoxide (CO) poisoning remains a significant cause of preventable morbidity and mortality worldwide.¹ As a colorless, odorless, and non-irritating gas typically generated by the incomplete combustion of carbon-containing fuels, CO is especially dangerous because exposure may occur without warning. Common sources include residential heating systems, gas-powered appliances, motor vehicles, and generators, making both accidental and intentional exposures a persistent public health issue.² The clinical manifestations of poisoning range from mild, nonspecific symptoms, up to severe neurological impairment and death, mostly depending on concentration and duration of exposure.²

Despite advances in public awareness and preventive technologies, such as the introduction of residential CO detectors, CO poisoning has continued to account for a substantial burden of worldwide emergency department visits and fatalities over the past decades.¹ Nevertheless, continuous monitoring of mortality trends is essential on a nationwide basis to identify high-risk populations, evaluate temporal changes, and inform targeted prevention strategies. The present study aimed to analyze recent U.S. mortality data to examine temporal trends, demographic patterns, and contextual factors associated with deaths attributable to CO poisoning.

We conducted an electronic search of the Centers for Disease Control and Prevention (CDC) WONDER (Wide-Ranging Online Data for Epidemiologic Research) Provisional Multiple Cause of Death database, an official public-use resource that provides national mortality and population data for the entire US country.³ Data were extracted for the period 2018–2024, the most recent year with complete provisional data available at the time of analysis. The search strategy included the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) code “T58” (“toxic effect of carbon monoxide”) to identify deaths attributable to CO poisoning. The query was combined with the following variables: calendar year (2018–2024), sex, and place of death. For each study year, we extracted the total number of deaths, crude and age-adjusted mortality rates (per 100,000 population), corresponding 95% confidence intervals (95% CIs), and standard errors (SEs). Annualized mortality estimates were used for all analyses. The statistical analysis was performed with Python (Python Software Foundation, Wilmington, US). The study was based on publicly available, de-identified data

and was conducted in accordance with the principles of the Declaration of Helsinki and applicable local regulations.

The results of our analysis are shown in Figure 1 and Table 1. The overall age-adjusted mortality rate per 100,000 population from CO poisoning declined gradually during the first two years of the coronavirus disease 2019 (COVID-19) pandemic (2020 and 2021), followed by a transient increase in 2022 and a subsequent progressive decrease through 2024. This temporal trend was statistically significant, as demonstrated by both one-way analysis of variance (ANOVA; $F=3.96$; $p<0.001$) and Poisson regression analysis (rate ratio per year=0.986; 95% CI, 0.980–0.992; $p<0.001$), indicating an average annual reduction of 1.4% in age-adjusted mortality over the study period.

Post-hoc analysis using Tukey’s Honestly Significant Difference (HSD) test identified statistically significant differences between 2024 and 2018 ($p=0.010$), 2019 ($p=0.013$), and 2022 ($p=0.002$), whereas no other pairwise comparisons across the study period reached statistical significance. With specific regard to 2024, the most recent year with complete mortality data in the WONDER database, the age-adjusted mortality rate for CO poisoning was more than twofold higher in men than in women (mean difference=0.381 per 100,000; 95% CI, 0.336–0.426; $p<0.001$; Table 1).

Crude mortality rates by age group are summarized in Table 1, demonstrating a marked age-related increase in CO poisoning mortality. Poisson regression analysis using the midpoint of each age category yielded a rate ratio of 1.031 (95% CI, 1.030–1.033; $p<0.001$), indicating that each 1-year increase in age was associated with a 3.1% increase in the crude death rate from CO poisoning. Regarding place of death, the majority of fatalities occurred at home (53.9%), followed by other locations (33.2%), outpatient medical facilities (8.2%), and inpatient medical facilities (4.7%), indicating that most CO poisoning deaths occurred outside hospital settings.

The present findings demonstrate a significant overall decline in age-adjusted mortality from CO poisoning between 2018 and 2024, despite a transient increase in 2022. Mortality remains disproportionately higher among men and increases markedly with advancing age, highlighting vulnerable subgroups. Importantly, the majority of deaths occurred at home, underscoring the persistent risk within residential environments. These data suggest that prevention strategies should prioritize household-level interventions,

Table 1. Mortality for carbon monoxide (CO) poisoning in the US in 2024.

Mortality	Number of deaths (%)	Death rate (95% CI)
Cumulative ¹	1604	0.444 (0.422-0.467)
Sex ¹		
Females	459	0.257 (0.232-0.282)
Males	1145	0.638 (0.600-0.676)
10-year classes ²		
1-4 years	14	0.104 (0.051-0.157)
5-14 years	29	0.071 (0.047-0.101)
15-24 years	114	0.254 (0.208-0.301)
25-34 years	188	0.405 (0.347-0.463)
35-44 years	242	0.531 (0.464-0.598)
45-54 years	255	0.625 (0.549-0.702)
55-64 years	294	0.699 (0.619-0.779)
65-74 years	233	0.657 (0.573-0.742)
75-84 years	167	0.865 (0.734-0.997)
≥85 years	68	1.057 (0.821-1.340)
Place of death ³		
Medical facility (inpatient)	76	4.7%
Medical facility (outpatient)	131	8.2%
Home	864	53.9%
Other places	533	33.2%

95% CI, 95% confidence interval. ¹age-adjusted death rate per 100,000; ²crude death rate per 100,000; ³percentages

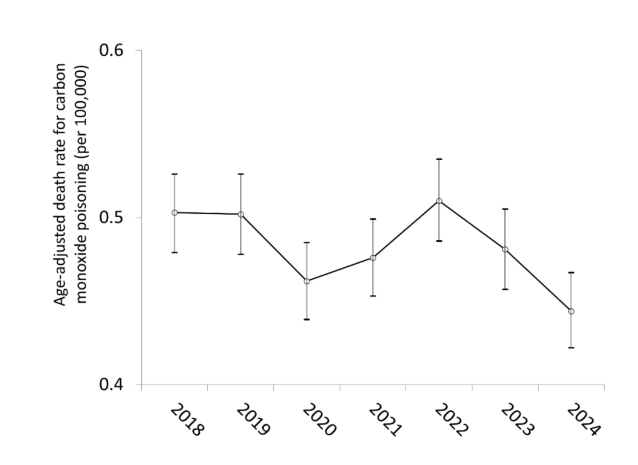


Figure 1. Mortality for carbon monoxide (CO) poisoning in the US during the period 2018-2024. Data are expressed as age-adjusted death rate per 100,000.

including broader installation and maintenance of CO detectors, stricter enforcement of building safety regulations, and targeted public education campaigns focusing on high-risk groups, particularly older male adults.^{4,5} Additionally, seasonal awareness initiatives, safe heating practices, and improved access to preventive services for elderly individuals living alone may help reduce mor-

tality. Continuous surveillance through national databases would also be essential to monitor trends and evaluate the effectiveness of these public health measures.

Age-adjusted mortality from CO poisoning in the US has modestly declined from 2018 to 2024, with men and older adults remaining at higher risk. The predominance of deaths occurring at home highlights the need for targeted household-level prevention measures and reinforced public education to reduce fatalities.

References

1. Mattiuzzi C, Lippi G. Worldwide epidemiology of carbon monoxide poisoning. *Hum Exp Toxicol* 2020;39:387-92.
2. Bleecker ML. Carbon monoxide intoxication. *Handb Clin Neurol* 2015;131:191-203.
3. Centers for Disease Control and Prevention. Wide-Ranging Online Data for Epidemiologic Research (WONDER). Last accessed, February 11, 2026. Available from: <https://wonder.cdc.gov/mcd-icd10-provisional.html>
4. Rupert DJ, Poehlman JA, Damon SA, Williams PN. Risk and protective behaviours for residential carbon monoxide poisoning. *Inj Prev* 2013;19:119-23.
5. Mukhopadhyay S, Hirsch A, Etienne S, et al. Surveillance of carbon monoxide-related incidents - Implications for prevention of related illnesses and injuries, 2005-2014. *Am J Emerg Med* 2018;36:1837-44.

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