









Geographic, Temporal, and Sex-Specific Trends in Mesothelioma Burden in the United States, 1990–2023

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ABSTRACT

PURPOSE Mesothelioma is a rare, aggressive cancer, strongly linked to asbestos. Although US regulations limiting asbestos use were introduced beginning in the 1970s, the long latency necessitates ongoing evaluation of population-level burden.

METHODS Age-standardized incidence (ASIR) and mortality rates (ASMR), disability-adjusted life-years (DALYs), and occupational-attributable fractions were obtained from the Global Burden of Disease study for mesothelioma at the national and state levels from 1990 to 2023 for males, females, and both sexes combined. Mortality-to-incidence ratios (MIRs) were calculated. Temporal trends were evaluated using joinpoint regression to estimate annual percent change and average annual percent change.

RESULTS Nationally, ASIR declined 33% (0.64–0.43 per 100,000) and ASMR declined 31% (0.60–0.41) from 1990 to 2023, with markedly steeper reductions among males (ASIR, –42%; ASMR, –41%) than females (ASIR, –7%; ASMR, –8%), while absolute cases and deaths increased. The MIR rose from 0.93 to 0.95 overall and increased among males (0.95–0.98), indicating no meaningful population-level survival improvement. Occupational asbestos exposure accounted for 95.7% of deaths in 2023. Age-standardized DALY rates declined 40% overall, although absolute DALYs increased 14%. At the state level, Maine, Alaska, Washington, and Minnesota had the highest ASIRs and ASMRs. Female incidence increased in 20 states and mortality in 18, with the largest increases in South Dakota, Arkansas, Mississippi, and West Virginia.

CONCLUSION Although mesothelioma rates have declined nationally, progress has been uneven across sexes and states. Persistently high mortality-to-incidence ratios, rising female burden in multiple states, and substantial geographic heterogeneity emphasize the need for targeted surveillance, remediation of legacy asbestos, and investment in more effective therapies.

ACCOMPANYING CONTENT

 [Data Supplement](#)

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INTRODUCTION

Malignant mesothelioma is a rare, aggressive cancer strongly associated with asbestos exposure, carrying poor prognosis with median survival 9–12 months.^{1–3} Most patients present at advanced stages due to nonspecific symptoms and a long latency period, with few interventions offering meaningful survival benefit.²

Asbestos exposure remains the predominant cause of mesothelioma worldwide, with more than 85% of cases attributable to occupational exposure, particularly among workers in shipbuilding, construction, insulation, and asbestos mining.² Historically, males have been disproportionately affected due to occupational roles, but increasing attention has focused on nonoccupational exposure, particularly among females.^{4,5} The

enduring burden of mesothelioma reflects its long latency, typically spanning decades between initial exposure and clinical presentation, meaning new cases continue to emerge long after regulatory controls have been implemented.^{3,6}

In the United States, asbestos has never been fully banned, and legacy asbestos remains widely embedded in older buildings, ships, industrial facilities, and public infrastructure.^{7,8} Exposure risk has therefore shifted from primary occupational settings to secondary and environmental contexts, including renovation, demolition, and disaster-related building damage.^{7–9}

Asbestos-related risk is highly place-based. Historical industrial activity, shipyard presence, military installations, and construction practices have varied substantially across

CONTEXT

Key Objective

What are the contemporary national and state-level trends in mesothelioma incidence, mortality, disability burden, and occupational-attributable risk in the United States, stratified by sex? Unlike prior analyses, this study integrates disability-adjusted life-years (DALYs) and mortality-to-incidence ratios across all 50 states over three decades to capture the full geographic scope of disease burden.

Knowledge Generated

Nationally, age-standardized incidence and mortality declined 33% and 31%, respectively, from 1990 to 2023, with markedly steeper reductions among males than females; female incidence increased in 20 states and mortality in 18. The mortality-to-incidence ratio rose from 0.93 to 0.95, absolute DALYs increased 14%, and occupational asbestos exposure accounted for 95.7% of deaths in 2023.

Relevance

Clinicians should maintain heightened awareness of mesothelioma in women and patients without occupational asbestos histories, particularly in high-burden states, as nonoccupational exposure pathways are increasingly implicated; the absence of population-level survival gains reinforces the need for more effective systemic therapies.

states, producing marked geographic heterogeneity.⁸ National averages may therefore obscure persistent subnational disparities, making state-level analyses essential for identifying regions with sustained or emerging risk and informing targeted policy responses.

Traditional surveillance focused on incidence and mortality incompletely captures mesothelioma's societal impact. Disability-adjusted life-years (DALYs) incorporate both premature mortality and years lived with disability, while the mortality-to-incidence ratio (MIR) serves as a population-level proxy for survival and health system effectiveness. Together, these metrics clarify whether declining incidence translates into meaningful improvements in patient outcomes. Although prior analyses have documented declining incidence and mortality,^{10,11} most lack state-level resolution or comprehensive burden measures such as DALYs or MIRs, and few have systematically examined sex-specific subnational trends over extended periods.

This study examines temporal and geographic variation in mesothelioma burden from 1990 to 2023, stratified by sex, using the Global Burden of Disease estimates. By integrating incidence, mortality, disability burden, and occupational attributable risk at the national and state levels, this analysis provides a comprehensive assessment of the evolving epidemiology of mesothelioma in the United States and informs ongoing prevention, surveillance, and policy efforts.

METHODS

Data Sources and Measures

To assess national and state-level mesothelioma trends in the United States, we analyzed data from 1990 to 2023 using

the Global Burden of Disease (GBD) 2023 database.¹² We extracted total mesothelioma incidence and deaths, annual age-standardized incidence rates (ASIRs), mortality rates (ASMRs), disability-adjusted life-years (DALYs), and the proportion of deaths and ASMRs attributable to occupational asbestos exposure for males, females, and both sexes combined. The MIR was computed to contextualize mortality relative to incidence, providing an indirect approximation of population-level survival that reflects factors such as disease biology and health system-related attributes.¹³ However, MIR should be interpreted with caution as it does not replicate the properties of a population-based survival estimate.¹⁴ All rates are per 100,000 population. Percent change between 1990 and 2023 was obtained from GBD. For state-level ASIR and ASMR trends, joinpoint analysis was conducted. Institutional review board approval and informed consent were not required because data were deidentified and publicly available.

Characteristics of the Data Source

GBD 2023 provides incidence, mortality, and DALY estimates for 35 cancer types across global, national, and subnational levels. Age-standardized rates are calculated using the GBD world standard, derived from the 2012 United Nation's Population Division's World Population Prospects.^{15,16} The GBD methodology has been described previously.^{15,17,18} Briefly, estimates are generated using vital registration systems, cancer registries, and verbal autopsy data, adjusted for underreporting and misclassification. See the Data Supplement for additional methodology on state-level estimates.

Asbestos-Mortality Trends

For risk-factor analysis, only occupational asbestos exposure data were available. Occupational asbestos exposure was

defined as the proportion of individuals age 15 years and older who were exposed to asbestos during their lifetime.¹⁵ Primary inputs came from the GBD 2023 cause-of-death estimates, published literature, and International Labour Organization data sets on workforce distribution and employment by sector. In data-sparse regions, uncertainty estimates were generated using LOESS curve fitting. Spatial-temporal Gaussian process regression modeled asbestos exposure prevalence with random regional effects and sociodemographic covariates. The theoretical minimum risk exposure level was defined as zero exposure; relative risks were derived from systematic reviews and meta-analyses.

Statistical Analysis

Temporal trends were evaluated with joinpoint regression (version 5.4.0, National Cancer Institute). This method fits segmented log-linear regression models to age-standardized rates, identifying statistically significant changes over time. The model began with zero joinpoints (a single linear trend) and tested up to three joinpoints, with model selection guided by a Monte Carlo permutation method (4,499 permutations) to avoid overfitting. For each segment, the annual percent change (APC) was estimated with 95% CIs. The average annual percent change (AAPC) was used to summarize overall trends across the entire study period. A *P* value <.05 was considered statistically significant

RESULTS

National Trends

Incidence

From 1990 to 2023, annual mesothelioma cases increased from 2,094 to 2,675 (28%). Males accounted for the majority in both years (1990: 1,649; 2023: 1,944; +18%), although females experienced a larger relative increase (1990: 446; 2023: 731; +64%). ASIR declined by 33% overall (0.64–0.46), with markedly sex-specific patterns: a 42% reduction among males (1.21–0.70 [95% CI, –54.3 to –31.3]) versus a nonsignificant –6.5% change among females (0.24–0.22 [95% CI, –28.2 to 18.4]; [Table 1](#)).

Joinpoint regression ([Fig 1A](#); Data Supplement, Table S1) demonstrated a significant decline in ASIR for the total population (AAPC, –1.20% [95% CI, –1.28 to –1.12]; *P* < .001) and males (–1.68% [95% CI, –1.77 to –1.58]; *P* < .001), with a borderline change among females (–0.19% [95% CI, –0.34 to 0.0006]; *P* = .050). Among males, three distinct temporal segments were identified: an initial increase from 1990 to 2000 (APC, 1.47%; *P* < .001), followed by a decline from 2000 to 2011 (APC, –1.61%; *P* < .001), and an accelerated decline from 2011 to 2023 (APC, –4.29%; *P* < .001). Female ASIR showed a nonsignificant increase from 1990 to 1998, followed by a modest but sustained decline from 1998 to 2023 (APC, –0.46%; *P* < .001).

Mortality

Annual mesothelioma deaths rose from 1,981 to 2,591 between 1990 and 2023, with larger relative increases among females (61%; 432 to 697) than males (22%; 1,549 to 1,894). Despite this, overall ASMR declined 31% (0.60 to 0.41; [Table 2](#)).

Sex-stratified analyses revealed a significant decline among males (1.15 to 0.68; –4.0.8% [95% CI, –50.9 to –29.7]), while the change among females was small and nonsignificant (0.23 to 0.21; –8.2% [95% CI, –27.7 to 15.8]). Joinpoint regression ([Fig 1B](#); Data Supplement, Table S2) confirmed significant declines for the total population (AAPC, –1.13% [95% CI, –1.21 to –1.04]; *P* < .001), males (–1.59% [95% CI, –1.68 to –1.49]; *P* < .001), and females (–0.23% [95% CI, –0.39 to –0.07]; *P* < .005). Similar to incidence patterns, males experienced an initial increase in ASMR from 1990 to 2000 (APC, 1.23; *P* < .001), followed by progressive declines from 2000 to 2011 (APC, –1.40%; *P* < .001), and a faster decline from 2011 to 2023 (–4.04%, *P* < .001). Female ASMR showed a nonsignificant increase from 1990 to 1996 (APC, 0.69%; *P* = .18), followed by a modest but significant decline from 1996 to 2023 (APC, –0.43%; *P* = .009). These findings indicate that reductions in mortality have largely mirrored reductions in incidence, particularly among males.

MIR

The MIR remained high throughout the study period, increasing nationally from 0.93 to 0.95 (2.15%). Although MIR increased among males (0.95–0.98), it decreased among females (0.95–0.93; [Table 3](#)).

Joinpoint regression ([Fig 1C](#); Data Supplement, Table S3) showed an initial decline between 1990 and 2000 (APC, –0.22%; *P* < .001), increases from 2000 to 2018, and a plateau thereafter, with an AAPC 0.06% ([95% CI, 0.045 to 0.063]; *P* < .001). Among males, MIR APC was –0.25% from 1990 to 1999 (*P* < .001) and increased throughout the rest of the study period (AAPC, 0.08% [95% CI, 0.07 to 0.09]; *P* < .001). Among females, there was a significant decline from 1990 to 2000 (APC, –0.23; *P* = .027), followed by nonsignificant trends thereafter. However, the AAPC for female MIR showed a modest but significant decline of –0.06% ([95% CI, –0.08 to –0.05]; *P* < .001). These persistently high and rising MIR values highlight the lack of meaningful population-level survival gains over three decades.

Attributable Risk

In 2023, 95.7% of US mesothelioma deaths (*n* = 2,479) were attributable to occupational asbestos exposure, largely stable since 1990 (96.2%). Attribution remained higher among males (96.8% [95% CI, 95.6 to 97.82]) than females (92.6% [95% CI, 90.15 to 94.47]). The attributable ASMR

TABLE 1. ASIR for Mesothelioma at the National and State Levels, 1990-2023

State	Male			Female			Both		
	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)
United States	1.21 (1.04 to 1.40)	0.70 (0.60 to 0.80)	-42.4 (-54.3 to -31.3)	0.24 (0.20 to 0.29)	0.22 (0.18 to 0.26)	-6.5 (-28.2 to 18.4)	0.64 (0.56 to 0.72)	0.43 (0.38 to 0.48)	-32.6 (-44.1 to -21.3)
Alabama	1.05 (0.92 to 1.22)	0.57 (0.49 to 0.65)	-45.8 (-56.4 to -35.7)	0.17 (0.14 to 0.20)	0.18 (0.15 to 0.22)	7.6 (-16.8 to 35.5)	0.53 (0.47 to 0.59)	0.35 (0.31 to 0.39)	-33.2 (-43.3 to -22.2)
Alaska	2.06 (1.77 to 2.37)	1.13 (0.96 to 1.33)	-45.2 (-55.8 to -33.1)	0.26 (0.21 to 0.31)	0.24 (0.19 to 0.29)	-8.2 (-30.4 to 15.5)	1.10 (0.96 to 1.25)	0.67 (0.58 to 0.77)	-39.0 (-49.3 to -28.0)
Arizona	1.04 (0.89 to 1.20)	0.64 (0.56 to 0.74)	-37.8 (-50.7 to -25.5)	0.22 (0.19 to 0.27)	0.22 (0.18 to 0.26)	0.1 (-23.1 to 26.7)	0.58 (0.51 to 0.65)	0.42 (0.36 to 0.47)	-27.8 (-38.8 to -15.5)
Arkansas	0.89 (0.77 to 1.03)	0.56 (0.48 to 0.64)	-37.3 (-49.3 to -25.4)	0.13 (0.11 to 0.15)	0.15 (0.12 to 0.18)	16.9 (-9.0 to 47.8)	0.45 (0.40 to 0.51)	0.33 (0.29 to 0.38)	-25.9 (-37.6 to -13.4)
California	1.10 (0.95 to 1.27)	0.60 (0.52 to 0.69)	-45.4 (-56.6 to -33.9)	0.24 (0.20 to 0.29)	0.21 (0.17 to 0.24)	-12.5 (-32.8 to 12.0)	0.60 (0.53 to 0.69)	0.38 (0.33 to 0.42)	-37.3 (-48.2 to -26.6)
Colorado	1.03 (0.89 to 1.19)	0.64 (0.55 to 0.74)	-38.6 (-50.8 to -25.5)	0.21 (0.17 to 0.25)	0.20 (0.15 to 0.23)	-4.6 (-27.3 to 21.2)	0.55 (0.48 to 0.62)	0.39 (0.34 to 0.44)	-28.4 (-40.0 to -15.3)
Connecticut	1.35 (1.16 to 1.58)	0.78 (0.67 to 0.90)	-42.5 (-54.0 to -30.2)	0.25 (0.21 to 0.29)	0.22 (0.18 to 0.26)	-10.1 (-31.8 to 12.8)	0.69 (0.61 to 0.79)	0.46 (0.40 to 0.53)	-33.1 (-44.7 to -21.2)
Delaware	1.88 (1.62 to 2.17)	1.01 (0.86 to 1.18)	-46.1 (-56.7 to -34.5)	0.28 (0.23 to 0.33)	0.26 (0.21 to 0.30)	-5.7 (-27.7 to 18.2)	0.93 (0.81 to 1.06)	0.59 (0.51 to 0.68)	-35.9 (-46.0 to -24.4)
D.C.	0.59 (0.51 to 0.68)	0.26 (0.22 to 0.30)	-56.3 (-64.4 to -46.8)	0.12 (0.10 to 0.15)	0.10 (0.08 to 0.12)	-17.7 (-37.7 to 4.9)	0.30 (0.27 to 0.34)	0.17 (0.15 to 0.19)	-45.5 (-53.2 to -36.8)
Florida	1.07 (0.92 to 1.24)	0.64 (0.55 to 0.73)	-40.5 (-52.6 to -27.8)	0.20 (0.17 to 0.24)	0.19 (0.15 to 0.22)	-5.3 (-27.3 to 19.2)	0.58 (0.51 to 0.66)	0.39 (0.34 to 0.44)	-32.5 (-44.2 to -20.9)
Georgia	0.85 (0.74 to 0.98)	0.48 (0.42 to 0.55)	-43.3 (-54.3 to -32.4)	0.17 (0.14 to 0.20)	0.17 (0.14 to 0.20)	-1.5 (-24.0 to 22.9)	0.44 (0.39 to 0.49)	0.30 (0.27 to 0.34)	-30.7 (-41.2 to -19.9)
Hawaii	0.86 (0.74 to 0.99)	0.44 (0.37 to 0.52)	-48.6 (-58.9 to -38.7)	0.11 (0.09 to 0.13)	0.10 (0.08 to 0.11)	-13.1 (-33.7 to 8.7)	0.47 (0.41 to 0.53)	0.25 (0.22 to 0.29)	-45.6 (-55.2 to -36.4)
Idaho	1.31 (1.12 to 1.52)	0.76 (0.65 to 0.89)	-41.9 (-53.3 to -29.3)	0.25 (0.20 to 0.30)	0.24 (0.19 to 0.28)	-2.7 (-24.8 to 23.5)	0.71 (0.62 to 0.80)	0.48 (0.42 to 0.54)	-32.3 (-43.1 to -20.6)
Illinois	1.35 (1.16 to 1.56)	0.74 (0.64 to 0.84)	-45.4 (-57.2 to -33.9)	0.29 (0.24 to 0.35)	0.26 (0.21 to 0.31)	-11.3 (-32.7 to 13.4)	0.72 (0.63 to 0.82)	0.46 (0.40 to 0.52)	-36.0 (-46.6 to -25.2)
Indiana	1.27 (1.09 to 1.47)	0.79 (0.68 to 0.91)	-38.0 (-50.9 to -26.0)	0.26 (0.21 to 0.31)	0.26 (0.21 to 0.30)	-0.6 (-24.5 to 27.1)	0.67 (0.59 to 0.75)	0.48 (0.42 to 0.54)	-27.9 (-39.7 to -16.1)
Iowa	1.02 (0.88 to 1.18)	0.63 (0.54 to 0.74)	-37.7 (-50.2 to -24.0)	0.23 (0.19 to 0.27)	0.26 (0.21 to 0.31)	12.9 (-13.6 to 42.2)	0.55 (0.49 to 0.62)	0.42 (0.37 to 0.48)	-23.0 (-34.5 to -9.9)
Kansas	1.02 (0.89 to 1.19)	0.60 (0.52 to 0.69)	-41.8 (-53.0 to -30.0)	0.20 (0.16 to 0.24)	0.20 (0.16 to 0.24)	2.7 (-22.4 to 31.6)	0.54 (0.47 to 0.61)	0.38 (0.33 to 0.43)	-29.4 (-40.8 to -18.1)
Kentucky	0.97 (0.85 to 1.12)	0.56 (0.49 to 0.65)	-42.0 (-53.4 to -30.2)	0.20 (0.17 to 0.25)	0.22 (0.18 to 0.26)	8.0 (-17.4 to 37.0)	0.52 (0.46 to 0.58)	0.37 (0.33 to 0.41)	-28.1 (-38.7 to -16.3)
Louisiana	1.41 (1.22 to 1.63)	0.93 (0.81 to 1.07)	-33.9 (-46.8 to -20.8)	0.33 (0.27 to 0.40)	0.33 (0.27 to 0.38)	-1.4 (-26.6 to 26.2)	0.77 (0.68 to 0.87)	0.59 (0.52 to 0.65)	-23.5 (-35.1 to -10.7)
Maine	1.99 (1.70 to 2.31)	1.14 (0.98 to 1.33)	-42.6 (-53.4 to -31.1)	0.43 (0.35 to 0.53)	0.42 (0.33 to 0.49)	-3.4 (-28.2 to 23.1)	1.06 (0.93 to 1.21)	0.74 (0.65 to 0.83)	-30.3 (-40.8 to -18.9)
Maryland	1.28 (1.10 to 1.47)	0.60 (0.52 to 0.70)	-52.9 (-62.6 to -43.4)	0.24 (0.20 to 0.29)	0.19 (0.16 to 0.23)	-21.1 (-39.0 to -0.7)	0.66 (0.58 to 0.75)	0.37 (0.32 to 0.41)	-44.2 (-53.4 to -34.4)
Massachusetts	1.58 (1.35 to 1.84)	0.87 (0.73 to 1.00)	-45.1 (-57.1 to -33.0)	0.29 (0.23 to 0.36)	0.27 (0.21 to 0.32)	-6.8 (-31.2 to 23.3)	0.79 (0.69 to 0.91)	0.52 (0.45 to 0.59)	-34.2 (-46.1 to -21.8)
Michigan	1.20 (1.03 to 1.39)	0.75 (0.65 to 0.86)	-37.6 (-50.5 to -24.6)	0.26 (0.21 to 0.31)	0.24 (0.20 to 0.28)	-6.4 (-28.8 to 17.3)	0.65 (0.57 to 0.74)	0.46 (0.40 to 0.52)	-28.8 (-41.0 to -16.5)
Minnesota	1.66 (1.42 to 1.93)	0.99 (0.85 to 1.16)	-40.5 (-53.3 to -27.8)	0.33 (0.27 to 0.39)	0.35 (0.28 to 0.41)	7.1 (-19.1 to 36.9)	0.88 (0.77 to 1.00)	0.63 (0.54 to 0.71)	-28.6 (-41.0 to -15.9)
Mississippi	1.02 (0.89 to 1.18)	0.56 (0.49 to 0.65)	-45.1 (-55.1 to -34.3)	0.17 (0.14 to 0.21)	0.19 (0.16 to 0.22)	9.5 (-14.8 to 37.0)	0.52 (0.46 to 0.58)	0.35 (0.31 to 0.39)	-32.1 (-42.6 to -21.7)
Missouri	1.05 (0.91 to 1.22)	0.63 (0.55 to 0.73)	-39.9 (-51.6 to -28.1)	0.20 (0.17 to 0.24)	0.22 (0.18 to 0.26)	7.6 (-18.2 to 37.2)	0.55 (0.48 to 0.61)	0.40 (0.35 to 0.45)	-27.0 (-37.9 to -15.0)
Montana	1.36 (1.18 to 1.58)	0.79 (0.68 to 0.92)	-41.9 (-52.8 to -29.7)	0.33 (0.27 to 0.39)	0.34 (0.28 to 0.40)	5.1 (-19.9 to 34.0)	0.78 (0.69 to 0.88)	0.55 (0.48 to 0.62)	-29.1 (-40.1 to -18.1)
Nebraska	1.15 (0.99 to 1.32)	0.70 (0.60 to 0.82)	-38.9 (-51.4 to -26.7)	0.26 (0.21 to 0.30)	0.27 (0.21 to 0.31)	3.5 (-20.9 to 30.7)	0.62 (0.55 to 0.70)	0.46 (0.40 to 0.52)	-26.3 (-38.3 to -15.0)
Nevada	1.10 (0.95 to 1.27)	0.59 (0.51 to 0.68)	-46.7 (-57.9 to -35.8)	0.24 (0.20 to 0.30)	0.22 (0.17 to 0.25)	-10.8 (-33.1 to 13.9)	0.62 (0.55 to 0.70)	0.39 (0.34 to 0.44)	-37.8 (-47.8 to -26.3)
New Hampshire	1.51 (1.29 to 1.73)	0.92 (0.78 to 1.07)	-39.0 (-51.2 to -25.4)	0.22 (0.18 to 0.26)	0.20 (0.16 to 0.24)	-5.7 (-28.4 to 19.2)	0.74 (0.64 to 0.84)	0.53 (0.46 to 0.61)	-28.5 (-40.6 to -15.3)
New Jersey	1.58 (1.36 to 1.83)	0.81 (0.69 to 0.93)	-49.0 (-60.5 to -38.5)	0.31 (0.25 to 0.37)	0.27 (0.21 to 0.32)	-12.7 (-33.7 to 12.7)	0.82 (0.72 to 0.93)	0.50 (0.43 to 0.55)	-39.6 (-50.5 to -29.5)
New Mexico	0.97 (0.84 to 1.11)	0.58 (0.50 to 0.66)	-40.7 (-51.9 to -28.8)	0.22 (0.18 to 0.25)	0.22 (0.18 to 0.26)	2.1 (-21.5 to 26.7)	0.54 (0.48 to 0.61)	0.38 (0.34 to 0.43)	-29.7 (-40.0 to -17.9)
New York	1.02 (0.88 to 1.17)	0.59 (0.50 to 0.68)	-42.3 (-54.9 to -29.9)	0.23 (0.19 to 0.27)	0.18 (0.14 to 0.21)	-20.5 (-39.6 to 0.6)	0.54 (0.48 to 0.61)	0.35 (0.31 to 0.40)	-35.0 (-46.2 to -24.5)
North Carolina	1.00 (0.87 to 1.16)	0.58 (0.51 to 0.67)	-41.9 (-53.6 to -30.8)	0.16 (0.14 to 0.20)	0.16 (0.13 to 0.19)	-0.4 (-24.1 to 24.8)	0.50 (0.44 to 0.56)	0.35 (0.30 to 0.39)	-30.7 (-42.0 to -19.5)

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TABLE 1. ASIR for Mesothelioma at the National and State Levels, 1990-2023 (continued)

State	Male			Female			Both		
	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)
North Dakota	1.38 (1.19 to 1.59)	0.80 (0.68 to 0.94)	-41.7 (-52.6 to -29.6)	0.25 (0.21 to 0.30)	0.26 (0.21 to 0.31)	1.7 (-20.1 to 27.1)	0.74 (0.65 to 0.84)	0.51 (0.44 to 0.58)	-31.1 (-42.5 to -19.5)
Ohio	1.30 (1.12 to 1.50)	0.85 (0.74 to 0.98)	-34.3 (-48.0 to -20.3)	0.27 (0.22 to 0.32)	0.26 (0.21 to 0.30)	-3.4 (-26.7 to 23.2)	0.69 (0.60 to 0.77)	0.51 (0.45 to 0.57)	-25.2 (-37.3 to -12.2)
Oklahoma	0.92 (0.79 to 1.06)	0.56 (0.48 to 0.64)	-39.0 (-49.6 to -26.8)	0.20 (0.17 to 0.24)	0.22 (0.18 to 0.25)	7.5 (-17.2 to 34.1)	0.49 (0.44 to 0.55)	0.37 (0.32 to 0.41)	-25.6 (-36.6 to -14.1)
Oregon	1.39 (1.19 to 1.60)	0.84 (0.71 to 0.96)	-39.6 (-51.9 to -28.0)	0.31 (0.26 to 0.38)	0.31 (0.25 to 0.36)	-1.9 (-25.0 to 25.3)	0.77 (0.67 to 0.87)	0.54 (0.47 to 0.61)	-28.9 (-40.4 to -17.0)
Pennsylvania	1.49 (1.28 to 1.72)	0.90 (0.77 to 1.03)	-39.9 (-52.6 to -26.6)	0.28 (0.23 to 0.33)	0.27 (0.22 to 0.32)	-0.9 (-24.3 to 27.9)	0.76 (0.67 to 0.87)	0.54 (0.47 to 0.60)	-29.4 (-41.7 to -16.7)
Rhode Island	1.59 (1.37 to 1.88)	0.85 (0.72 to 1.00)	-46.5 (-58.1 to -35.1)	0.25 (0.20 to 0.30)	0.22 (0.17 to 0.25)	-13.0 (-33.5 to 9.3)	0.77 (0.68 to 0.88)	0.49 (0.42 to 0.56)	-36.6 (-48.5 to -24.1)
South Carolina	1.08 (0.94 to 1.25)	0.69 (0.60 to 0.80)	-36.1 (-48.8 to -23.5)	0.21 (0.17 to 0.25)	0.21 (0.17 to 0.25)	3.1 (-21.6 to 32.0)	0.55 (0.49 to 0.62)	0.42 (0.37 to 0.47)	-23.9 (-35.6 to -11.4)
South Dakota	1.02 (0.88 to 1.18)	0.62 (0.53 to 0.72)	-39.6 (-51.1 to -26.1)	0.16 (0.13 to 0.19)	0.19 (0.15 to 0.22)	18.2 (-10.0 to 47.7)	0.53 (0.46 to 0.60)	0.38 (0.33 to 0.44)	-27.2 (-38.8 to -15.0)
Tennessee	1.00 (0.87 to 1.16)	0.60 (0.52 to 0.69)	-39.9 (-51.6 to -28.5)	0.18 (0.15 to 0.21)	0.21 (0.17 to 0.25)	13.7 (-12.7 to 42.9)	0.51 (0.45 to 0.57)	0.38 (0.33 to 0.42)	-25.6 (-37.2 to -13.5)
Texas	1.05 (0.90 to 1.22)	0.60 (0.52 to 0.68)	-43.2 (-54.7 to -31.4)	0.20 (0.17 to 0.24)	0.19 (0.15 to 0.22)	-7.6 (-29.3 to 15.5)	0.56 (0.49 to 0.63)	0.37 (0.32 to 0.41)	-34.0 (-44.9 to -23.2)
Utah	1.17 (1.01 to 1.36)	0.74 (0.63 to 0.86)	-36.7 (-49.0 to -22.8)	0.20 (0.17 to 0.25)	0.21 (0.17 to 0.25)	3.3 (-21.6 to 29.9)	0.62 (0.54 to 0.70)	0.46 (0.39 to 0.52)	-26.5 (-38.8 to -13.4)
Vermont	1.25 (1.08 to 1.44)	0.62 (0.52 to 0.73)	-50.4 (-60.4 to -40.5)	0.25 (0.21 to 0.30)	0.24 (0.19 to 0.28)	-6.3 (-29.1 to 17.5)	0.65 (0.57 to 0.74)	0.41 (0.36 to 0.46)	-37.4 (-47.7 to -27.6)
Virginia	1.51 (1.30 to 1.74)	0.86 (0.74 to 0.98)	-43.5 (-55.4 to -32.0)	0.25 (0.21 to 0.31)	0.23 (0.19 to 0.27)	-8.3 (-30.5 to 16.0)	0.76 (0.67 to 0.86)	0.51 (0.44 to 0.56)	-33.9 (-45.1 to -22.0)
Washington	1.65 (1.42 to 1.94)	1.00 (0.86 to 1.15)	-39.8 (-52.5 to -27.7)	0.36 (0.29 to 0.43)	0.34 (0.28 to 0.41)	-4.0 (-27.7 to 23.4)	0.91 (0.79 to 1.03)	0.63 (0.55 to 0.71)	-30.3 (-41.9 to -18.1)
West Virginia	1.57 (1.36 to 1.80)	1.01 (0.88 to 1.17)	-35.6 (-47.6 to -22.8)	0.20 (0.16 to 0.24)	0.23 (0.19 to 0.27)	15.5 (-11.6 to 47.7)	0.76 (0.66 to 0.86)	0.58 (0.52 to 0.66)	-22.9 (-35.4 to -9.0)
Wisconsin	1.43 (1.23 to 1.66)	0.81 (0.69 to 0.93)	-43.7 (-55.8 to -32.2)	0.32 (0.27 to 0.38)	0.31 (0.25 to 0.37)	-2.5 (-26.3 to 23.3)	0.79 (0.69 to 0.89)	0.53 (0.46 to 0.60)	-32.6 (-43.9 to -21.0)
Wyoming	1.53 (1.30 to 1.79)	0.95 (0.80 to 1.10)	-37.9 (-51.0 to -25.3)	0.27 (0.22 to 0.33)	0.28 (0.22 to 0.33)	2.4 (-22.0 to 31.9)	0.81 (0.71 to 0.92)	0.59 (0.51 to 0.68)	-26.4 (-39.5 to -13.7)

Abbreviation: ASIR, age-standardized incidence rate.

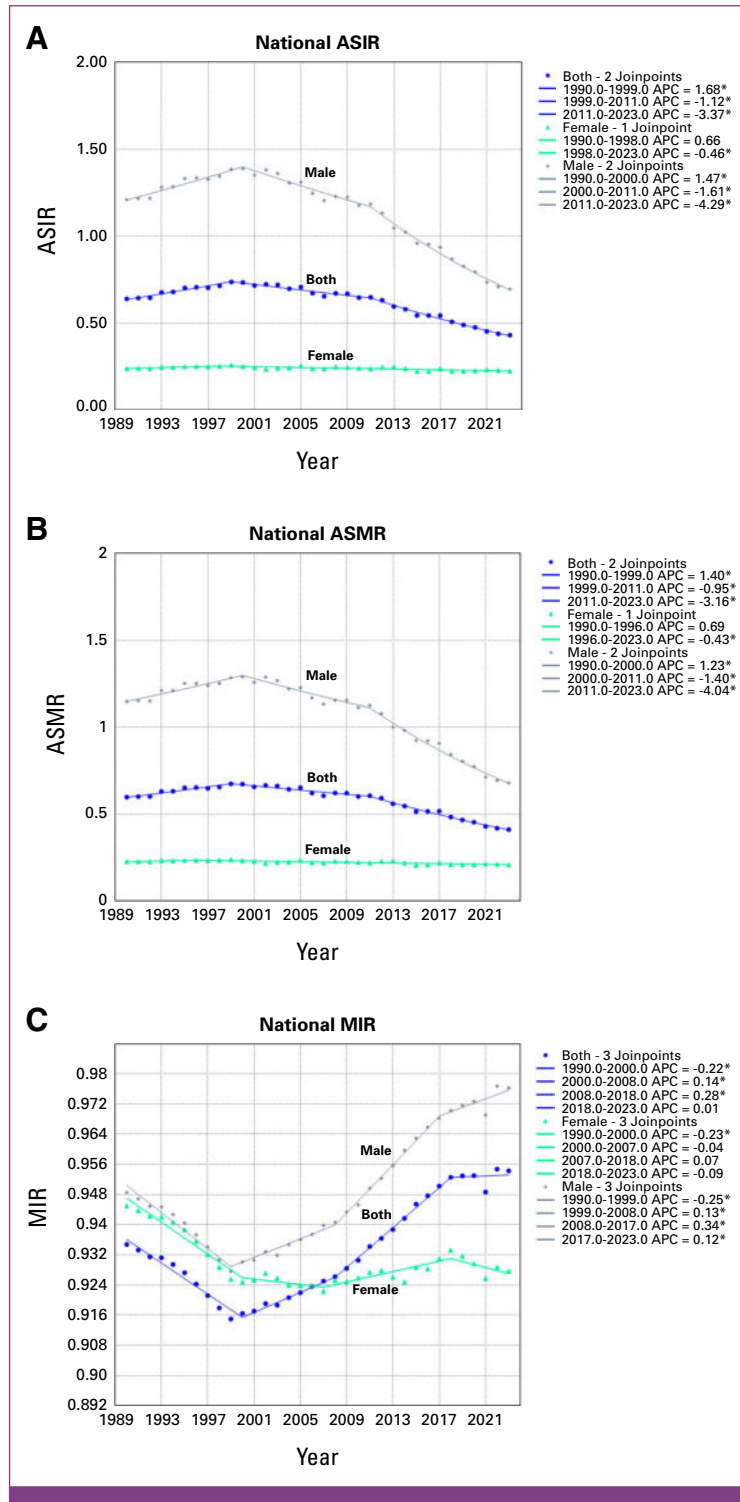


FIG 1. Joinpoint regression analysis depicting trends in mesothelioma. (A) ASIR, (B) ASMR, and (C) MIR (1990-2023). *Statistical significance. APC, annual percent change; ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; MIR, mortality-to-incidence ratio.

declined significantly overall (-33% [95% CI, -42 to -23]; 0.57-0.39) and among males (-42% [95% CI, -52 to -31]; 1.12-0.65), with no significant change observed among females (-10% [95% CI, -29 to 14]; 0.21-0.19).

DALYs

Mesothelioma accounted for 48,146 DALYs in 2023, up 14% from 42,347 in 1990, predominantly among males (1990:

TABLE 2. ASMR for Mesothelioma at the National and State Levels, 1990-2023

State	Male			Female			Both		
	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)
United States	1.15 (1.00 to 1.31)	0.68 (0.59 to 0.78)	-40.7 (-50.9 to -29.7)	0.23 (0.19 to 0.27)	0.21 (0.17 to 0.25)	-8.2 (-27.7 to 15.8)	0.60 (0.54 to 0.67)	0.41 (0.37 to 0.46)	-31.2 (-40.0 to -21.1)
Alabama	1.02 (0.89 to 1.17)	0.57 (0.50 to 0.65)	-44.3 (-54.1 to -33.2)	0.16 (0.13 to 0.19)	0.18 (0.15 to 0.21)	7.3 (-15.8 to 34.3)	0.50 (0.45 to 0.56)	0.34 (0.30 to 0.38)	-31.7 (-40.5 to -20.4)
Alaska	1.99 (1.73 to 2.27)	1.08 (0.95 to 1.26)	-45.4 (-54.9 to -32.6)	0.25 (0.20 to 0.29)	0.22 (0.18 to 0.26)	-11.7 (-32.8 to 10.6)	1.05 (0.93 to 1.18)	0.63 (0.56 to 0.73)	-39.5 (-48.6 to -27.9)
Arizona	0.97 (0.85 to 1.12)	0.62 (0.54 to 0.72)	-36.0 (-47.1 to -24.0)	0.21 (0.17 to 0.25)	0.21 (0.17 to 0.25)	-1.1 (-22.2 to 24.7)	0.54 (0.48 to 0.60)	0.40 (0.35 to 0.45)	-26.2 (-35.8 to -15.6)
Arkansas	0.85 (0.75 to 0.98)	0.55 (0.48 to 0.63)	-35.3 (-46.0 to -22.1)	0.12 (0.10 to 0.15)	0.15 (0.12 to 0.17)	16.3 (-9.9 to 45.9)	0.43 (0.38 to 0.48)	0.32 (0.29 to 0.36)	-23.9 (-34.8 to -10.8)
California	1.04 (0.91 to 1.20)	0.58 (0.51 to 0.67)	-44.0 (-54.5 to -34.4)	0.23 (0.19 to 0.27)	0.19 (0.16 to 0.23)	-15.1 (-33.7 to 7.5)	0.57 (0.50 to 0.64)	0.36 (0.32 to 0.40)	-36.5 (-45.2 to -26.9)
Colorado	0.98 (0.86 to 1.13)	0.61 (0.53 to 0.71)	-37.7 (-48.1 to -25.2)	0.19 (0.16 to 0.23)	0.18 (0.14 to 0.22)	-6.5 (-27.3 to 18.6)	0.51 (0.46 to 0.58)	0.37 (0.32 to 0.42)	-27.6 (-37.2 to -16.1)
Connecticut	1.27 (1.10 to 1.46)	0.74 (0.64 to 0.86)	-41.7 (-52.1 to -29.9)	0.23 (0.19 to 0.27)	0.20 (0.16 to 0.24)	-12.4 (-31.6 to 10.0)	0.64 (0.57 to 0.72)	0.43 (0.38 to 0.49)	-32.4 (-41.2 to -22.2)
Delaware	1.81 (1.58 to 2.07)	0.98 (0.83 to 1.14)	-46.2 (-55.3 to -33.9)	0.26 (0.22 to 0.31)	0.24 (0.19 to 0.28)	-8.5 (-28.6 to 15.1)	0.88 (0.78 to 0.98)	0.56 (0.50 to 0.64)	-35.7 (-44.9 to -24.2)
D.C.	0.59 (0.51 to 0.68)	0.25 (0.21 to 0.29)	-57.5 (-64.6 to -48.0)	0.12 (0.10 to 0.14)	0.09 (0.08 to 0.11)	-20.7 (-39.1 to 9.9)	0.30 (0.26 to 0.33)	0.16 (0.14 to 0.18)	-47.0 (-53.8 to -38.4)
Florida	1.00 (0.87 to 1.15)	0.62 (0.54 to 0.71)	-38.2 (-49.6 to -27.1)	0.19 (0.16 to 0.23)	0.18 (0.14 to 0.21)	-7.5 (-27.3 to 15.6)	0.54 (0.48 to 0.61)	0.37 (0.33 to 0.42)	-30.7 (-40.0 to -21.3)
Georgia	0.83 (0.72 to 0.94)	0.48 (0.42 to 0.55)	-42.2 (-52.3 to -30.7)	0.17 (0.14 to 0.19)	0.16 (0.13 to 0.19)	-2.7 (-23.7 to 21.0)	0.42 (0.37 to 0.47)	0.29 (0.26 to 0.33)	-29.6 (-38.1 to -18.6)
Hawaii	0.81 (0.70 to 0.93)	0.42 (0.36 to 0.49)	-48.3 (-57.9 to -37.7)	0.10 (0.09 to 0.12)	0.09 (0.07 to 0.10)	-15.5 (-34.4 to 5.1)	0.44 (0.38 to 0.50)	0.24 (0.20 to 0.27)	-46.0 (-54.0 to -36.6)
Idaho	1.25 (1.08 to 1.43)	0.74 (0.64 to 0.87)	-40.9 (-51.3 to -28.3)	0.23 (0.19 to 0.28)	0.23 (0.18 to 0.27)	-4.1 (-25.4 to 20.7)	0.67 (0.59 to 0.76)	0.46 (0.41 to 0.52)	-31.5 (-40.9 to -20.5)
Illinois	1.28 (1.11 to 1.47)	0.72 (0.63 to 0.83)	-43.6 (-53.8 to -33.3)	0.28 (0.23 to 0.33)	0.24 (0.20 to 0.29)	-13.1 (-31.9 to 11.2)	0.68 (0.60 to 0.77)	0.44 (0.39 to 0.49)	-34.6 (-43.2 to -25.5)
Indiana	1.19 (1.04 to 1.36)	0.79 (0.68 to 0.90)	-34.0 (-45.4 to -21.3)	0.24 (0.20 to 0.29)	0.24 (0.20 to 0.29)	-1.3 (-22.8 to 26.5)	0.62 (0.56 to 0.70)	0.47 (0.42 to 0.52)	-24.4 (-33.7 to -13.3)
Iowa	0.96 (0.84 to 1.10)	0.62 (0.54 to 0.71)	-36.1 (-46.7 to -22.5)	0.22 (0.18 to 0.25)	0.24 (0.19 to 0.29)	11.7 (-12.7 to 39.1)	0.51 (0.46 to 0.58)	0.40 (0.36 to 0.45)	-21.6 (-31.3 to -10.0)
Kansas	0.97 (0.85 to 1.10)	0.58 (0.50 to 0.67)	-40.0 (-50.0 to -27.8)	0.18 (0.15 to 0.22)	0.19 (0.15 to 0.23)	2.0 (-20.6 to 28.9)	0.50 (0.44 to 0.56)	0.36 (0.32 to 0.41)	-27.5 (-36.9 to -16.7)
Kentucky	0.92 (0.81 to 1.06)	0.56 (0.49 to 0.64)	-39.8 (-49.7 to -27.4)	0.19 (0.16 to 0.23)	0.21 (0.17 to 0.25)	8.2 (-15.9 to 37.1)	0.48 (0.43 to 0.54)	0.36 (0.32 to 0.40)	-25.8 (-35.2 to -15.0)
Louisiana	1.35 (1.18 to 1.56)	0.92 (0.81 to 1.06)	-31.7 (-43.2 to -18.6)	0.31 (0.26 to 0.38)	0.31 (0.25 to 0.37)	-2.0 (-24.6 to 25.3)	0.73 (0.65 to 0.82)	0.57 (0.51 to 0.64)	-21.7 (-31.6 to -10.4)
Maine	1.89 (1.65 to 2.17)	1.11 (0.96 to 1.27)	-41.2 (-51.0 to -29.3)	0.40 (0.33 to 0.49)	0.38 (0.31 to 0.46)	-4.7 (-27.4 to 21.4)	0.99 (0.88 to 1.10)	0.70 (0.63 to 0.79)	-28.9 (-37.9 to -18.0)
Maryland	1.24 (1.08 to 1.41)	0.59 (0.51 to 0.68)	-52.5 (-60.6 to -42.8)	0.23 (0.19 to 0.28)	0.18 (0.15 to 0.21)	-23.3 (-39.9 to -4.3)	0.62 (0.56 to 0.69)	0.35 (0.31 to 0.39)	-43.9 (-51.3 to -35.2)
Massachusetts	1.47 (1.28 to 1.68)	0.82 (0.71 to 0.95)	-44.6 (-54.2 to -33.7)	0.27 (0.22 to 0.33)	0.24 (0.19 to 0.29)	-10.6 (-32.1 to 16.1)	0.72 (0.64 to 0.82)	0.48 (0.42 to 0.54)	-34.1 (-43.2 to -24.0)
Michigan	1.14 (0.99 to 1.31)	0.74 (0.65 to 0.85)	-34.9 (-46.2 to -22.4)	0.24 (0.20 to 0.29)	0.23 (0.18 to 0.27)	-7.7 (-27.5 to 16.6)	0.61 (0.54 to 0.68)	0.45 (0.40 to 0.50)	-26.5 (-35.9 to -15.3)
Minnesota	1.52 (1.33 to 1.76)	0.94 (0.82 to 1.09)	-38.1 (-49.1 to -25.8)	0.30 (0.24 to 0.36)	0.31 (0.25 to 0.38)	5.1 (-19.6 to 32.6)	0.80 (0.72 to 0.90)	0.59 (0.52 to 0.67)	-26.4 (-36.6 to -15.3)
Mississippi	1.00 (0.87 to 1.14)	0.56 (0.49 to 0.65)	-43.5 (-52.9 to -31.6)	0.17 (0.14 to 0.20)	0.18 (0.15 to 0.22)	9.6 (-14.0 to 36.3)	0.50 (0.44 to 0.56)	0.34 (0.31 to 0.38)	-30.6 (-39.6 to -19.9)
Missouri	1.00 (0.88 to 1.15)	0.62 (0.55 to 0.71)	-38.0 (-48.9 to -25.6)	0.19 (0.16 to 0.23)	0.20 (0.17 to 0.24)	6.3 (-17.6 to 35.3)	0.51 (0.46 to 0.58)	0.38 (0.34 to 0.43)	-25.2 (-33.9 to -13.4)
Montana	1.30 (1.13 to 1.48)	0.78 (0.68 to 0.91)	-40.1 (-49.9 to -26.7)	0.31 (0.26 to 0.37)	0.32 (0.26 to 0.38)	3.1 (-20.5 to 30.6)	0.73 (0.65 to 0.82)	0.53 (0.47 to 0.60)	-27.7 (-36.9 to -15.5)
Nebraska	1.09 (0.94 to 1.25)	0.68 (0.59 to 0.79)	-37.3 (-48.4 to -22.9)	0.24 (0.20 to 0.29)	0.25 (0.20 to 0.29)	2.2 (-19.6 to 29.0)	0.58 (0.52 to 0.65)	0.44 (0.39 to 0.50)	-24.8 (-34.7 to -11.6)
Nevada	1.06 (0.93 to 1.23)	0.57 (0.50 to 0.66)	-46.5 (-56.1 to -35.4)	0.23 (0.19 to 0.28)	0.20 (0.16 to 0.24)	-12.4 (-32.9 to 12.2)	0.59 (0.53 to 0.67)	0.37 (0.33 to 0.42)	-37.5 (-45.7 to -27.7)
New Hampshire	1.43 (1.24 to 1.63)	0.88 (0.76 to 1.02)	-38.7 (-50.0 to -25.2)	0.20 (0.17 to 0.25)	0.19 (0.15 to 0.22)	-8.0 (-29.5 to 16.1)	0.69 (0.61 to 0.77)	0.49 (0.43 to 0.56)	-28.1 (-38.4 to -14.6)
New Jersey	1.49 (1.30 to 1.71)	0.77 (0.68 to 0.89)	-48.3 (-57.7 to -38.2)	0.29 (0.24 to 0.34)	0.24 (0.20 to 0.29)	-14.9 (-34.2 to 9.9)	0.76 (0.68 to 0.86)	0.46 (0.41 to 0.52)	-39.3 (-47.9 to -30.3)
New Mexico	0.93 (0.81 to 1.07)	0.56 (0.49 to 0.65)	-40.0 (-49.3 to -27.6)	0.20 (0.17 to 0.24)	0.21 (0.17 to 0.24)	0.3 (-21.7 to 23.6)	0.52 (0.46 to 0.58)	0.37 (0.33 to 0.41)	-29.3 (-38.0 to -17.5)
New York	0.98 (0.86 to 1.13)	0.57 (0.49 to 0.66)	-42.1 (-52.9 to -31.4)	0.21 (0.18 to 0.26)	0.16 (0.13 to 0.19)	-23.7 (-40.1 to -3.7)	0.51 (0.46 to 0.58)	0.33 (0.29 to 0.37)	-35.4 (-44.4 to -25.9)
North Carolina	0.97 (0.84 to 1.12)	0.57 (0.50 to 0.66)	-40.9 (-50.9 to -29.2)	0.16 (0.13 to 0.19)	0.15 (0.12 to 0.18)	-2.6 (-23.4 to 22.0)	0.47 (0.42 to 0.53)	0.33 (0.30 to 0.37)	-29.7 (-38.5 to -18.1)
North Dakota	1.30 (1.13 to 1.50)	0.77 (0.67 to 0.91)	-40.7 (-51.0 to -26.5)	0.24 (0.20 to 0.28)	0.24 (0.19 to 0.28)	-0.2 (-22.0 to 23.1)	0.69 (0.61 to 0.77)	0.48 (0.42 to 0.55)	-30.5 (-39.9 to -18.4)

(continued on following page)

TABLE 2. ASMR for Mesothelioma at the National and State Levels, 1990-2023 (continued)

State	Male			Female			Both		
	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)	1990 (95% CI)	2023 (95% CI)	% Change (95% CI)
Ohio	1.23 (1.07 to 1.41)	0.85 (0.75 to 0.98)	-30.5 (-42.8 to -17.7)	0.25 (0.21 to 0.30)	0.24 (0.20 to 0.29)	-3.8 (-24.7 to 22.5)	0.64 (0.57 to 0.72)	0.50 (0.45 to 0.56)	-21.8 (-31.6 to -10.6)
Oklahoma	0.88 (0.76 to 1.01)	0.56 (0.48 to 0.64)	-36.4 (-46.4 to -22.9)	0.19 (0.16 to 0.23)	0.20 (0.17 to 0.24)	8.1 (-15.6 to 34.0)	0.46 (0.42 to 0.52)	0.36 (0.32 to 0.40)	-22.9 (-32.5 to -10.5)
Oregon	1.31 (1.14 to 1.49)	0.80 (0.69 to 0.92)	-38.6 (-49.3 to -26.5)	0.29 (0.24 to 0.35)	0.28 (0.23 to 0.33)	-3.7 (-24.2 to 21.8)	0.71 (0.64 to 0.80)	0.51 (0.45 to 0.57)	-28.1 (-36.4 to -17.5)
Pennsylvania	1.41 (1.23 to 1.62)	0.88 (0.76 to 1.02)	-37.5 (-49.1 to -26.2)	0.26 (0.21 to 0.31)	0.25 (0.20 to 0.30)	-2.4 (-24.0 to 25.1)	0.71 (0.64 to 0.81)	0.52 (0.46 to 0.58)	-27.4 (-37.4 to -16.7)
Rhode Island	1.52 (1.32 to 1.75)	0.81 (0.70 to 0.94)	-46.7 (-56.2 to -34.9)	0.23 (0.19 to 0.28)	0.20 (0.16 to 0.23)	-16.0 (-35.2 to 5.2)	0.72 (0.64 to 0.81)	0.45 (0.40 to 0.52)	-36.9 (-45.8 to -26.5)
South Carolina	1.06 (0.92 to 1.21)	0.69 (0.60 to 0.79)	-34.8 (-45.9 to -20.7)	0.20 (0.17 to 0.24)	0.20 (0.17 to 0.24)	1.4 (-22.6 to 29.0)	0.53 (0.48 to 0.60)	0.41 (0.37 to 0.46)	-22.4 (-32.1 to -10.0)
South Dakota	0.97 (0.84 to 1.11)	0.60 (0.52 to 0.71)	-37.7 (-47.6 to -24.4)	0.15 (0.12 to 0.17)	0.17 (0.14 to 0.21)	16.4 (-8.6 to 44.3)	0.49 (0.44 to 0.55)	0.37 (0.32 to 0.42)	-25.5 (-35.1 to -13.6)
Tennessee	0.97 (0.84 to 1.11)	0.60 (0.52 to 0.69)	-38.4 (-48.9 to -26.4)	0.17 (0.14 to 0.20)	0.20 (0.16 to 0.23)	13.6 (-11.3 to 42.6)	0.48 (0.43 to 0.54)	0.37 (0.33 to 0.41)	-23.9 (-33.6 to -12.7)
Texas	0.99 (0.87 to 1.14)	0.59 (0.51 to 0.67)	-41.0 (-51.5 to -30.0)	0.19 (0.16 to 0.23)	0.18 (0.14 to 0.21)	-8.3 (-27.6 to 14.2)	0.52 (0.46 to 0.59)	0.35 (0.32 to 0.40)	-31.9 (-40.9 to -22.3)
Utah	1.12 (0.97 to 1.28)	0.73 (0.63 to 0.85)	-35.0 (-45.9 to -21.2)	0.19 (0.16 to 0.23)	0.20 (0.16 to 0.24)	2.8 (-20.7 to 26.9)	0.58 (0.52 to 0.65)	0.44 (0.38 to 0.50)	-24.7 (-34.3 to -11.3)
Vermont	1.21 (1.05 to 1.38)	0.59 (0.50 to 0.69)	-51.2 (-59.5 to -39.9)	0.24 (0.20 to 0.29)	0.22 (0.18 to 0.26)	-10.0 (-31.2 to 11.8)	0.62 (0.55 to 0.69)	0.38 (0.33 to 0.44)	-38.5 (-46.4 to -28.6)
Virginia	1.44 (1.26 to 1.65)	0.83 (0.73 to 0.96)	-42.4 (-52.6 to -31.9)	0.24 (0.20 to 0.29)	0.22 (0.18 to 0.26)	-10.6 (-30.9 to 12.9)	0.72 (0.64 to 0.80)	0.48 (0.43 to 0.54)	-32.8 (-41.8 to -22.4)
Washington	1.56 (1.36 to 1.80)	0.97 (0.85 to 1.11)	-38.1 (-49.0 to -27.3)	0.33 (0.27 to 0.40)	0.31 (0.25 to 0.37)	-6.1 (-26.9 to 20.0)	0.84 (0.76 to 0.95)	0.60 (0.53 to 0.68)	-29.1 (-38.6 to -18.9)
West Virginia	1.51 (1.32 to 1.72)	1.01 (0.88 to 1.15)	-33.4 (-44.2 to -19.7)	0.19 (0.15 to 0.23)	0.21 (0.18 to 0.25)	13.7 (-12.4 to 44.5)	0.72 (0.63 to 0.80)	0.57 (0.51 to 0.64)	-20.6 (-30.9 to -6.7)
Wisconsin	1.33 (1.16 to 1.52)	0.79 (0.69 to 0.91)	-40.7 (-51.4 to -29.6)	0.30 (0.25 to 0.36)	0.29 (0.24 to 0.35)	-3.5 (-25.0 to 21.4)	0.72 (0.65 to 0.81)	0.50 (0.44 to 0.57)	-30.1 (-39.2 to -20.3)
Wyoming	1.47 (1.27 to 1.69)	0.93 (0.79 to 1.08)	-36.8 (-47.1 to -22.8)	0.26 (0.21 to 0.31)	0.26 (0.21 to 0.31)	1.2 (-23.7 to 29.7)	0.76 (0.67 to 0.86)	0.57 (0.49 to 0.65)	-25.2 (-36.2 to -12.7)

Abbreviation: ASMR, age-standardized mortality rate.

TABLE 3. MIR for Mesothelioma at the National and State Levels, 1990-2023

State	Male			Female			Both		
	1990	2023	% Change	1990	2023	% Change	1990	2023	% Change
United States	0.95	0.98	3.16	0.95	0.93	-2.11	0.93	0.95	2.15
Alabama	0.97	0.99	2.78	0.93	0.89	-4.15	0.95	0.97	2.35
Alaska	0.97	0.96	-0.42	0.95	0.91	-3.98	0.95	0.94	-0.81
Arizona	0.94	0.97	3	0.95	0.92	-3.93	0.93	0.95	2.28
Arkansas	0.96	0.99	3.2	0.95	0.91	-3.78	0.95	0.97	2.65
California	0.95	0.97	2.47	0.98	0.94	-3.62	0.94	0.95	1.25
Colorado	0.95	0.96	1.43	0.94	0.91	-3.47	0.93	0.94	1.11
Connecticut	0.94	0.95	1.4	0.95	0.92	-2.98	0.92	0.93	1.12
Delaware	0.97	0.96	-0.08	0.95	0.92	-2.96	0.95	0.95	0.2
D.C.	1	0.97	-2.78	0.95	0.93	-2.87	0.98	0.95	-2.73
Florida	0.93	0.97	3.94	0.93	0.9	-2.8	0.93	0.95	2.59
Georgia	0.97	0.99	1.88	0.94	0.91	-2.58	0.96	0.97	1.58
Hawaii	0.94	0.94	0.59	0.94	0.92	-2.58	0.93	0.93	-0.75
Idaho	0.96	0.97	1.68	0.95	0.93	-2.52	0.94	0.96	1.17
Illinois	0.95	0.98	3.21	0.94	0.91	-2.48	0.94	0.96	2.11
Indiana	0.94	1	6.38	0.94	0.92	-2.33	0.93	0.97	4.84
Iowa	0.94	0.97	2.63	0.94	0.91	-2.26	0.93	0.95	1.92
Kansas	0.94	0.97	3.13	0.96	0.94	-2.2	0.93	0.95	2.73
Kentucky	0.95	0.99	3.82	0.95	0.93	-2.04	0.93	0.96	3.11
Louisiana	0.96	0.99	3.22	0.94	0.92	-1.99	0.95	0.97	2.4
Maine	0.95	0.97	2.44	0.95	0.93	-1.93	0.93	0.95	2.02
Maryland	0.97	0.98	0.85	0.93	0.91	-1.87	0.95	0.95	0.5
Massachusetts	0.93	0.94	0.97	0.92	0.9	-1.85	0.92	0.92	0.26
Michigan	0.95	0.99	4.41	0.93	0.91	-1.8	0.94	0.97	3.26
Minnesota	0.92	0.95	4.09	0.95	0.93	-1.77	0.9	0.93	2.99
Mississippi	0.98	1	2.9	0.95	0.93	-1.69	0.96	0.98	2.31
Missouri	0.95	0.98	3.22	0.97	0.95	-1.64	0.94	0.96	2.51
Montana	0.95	0.98	3.01	0.96	0.94	-1.6	0.94	0.96	1.95
Nebraska	0.95	0.97	2.67	0.94	0.93	-1.53	0.93	0.95	2.04
Nevada	0.97	0.97	0.39	0.94	0.92	-1.49	0.95	0.96	0.4
New Hampshire	0.95	0.95	0.41	0.95	0.93	-1.45	0.93	0.93	0.58
New Jersey	0.95	0.96	1.38	0.94	0.93	-1.38	0.93	0.94	0.61
New Mexico	0.96	0.97	1.12	0.95	0.94	-1.31	0.95	0.96	0.69
New York	0.97	0.97	0.31	0.94	0.93	-1.25	0.95	0.94	-0.62
North Carolina	0.96	0.98	1.62	0.94	0.92	-1.24	0.95	0.96	1.38
North Dakota	0.95	0.96	1.63	0.95	0.93	-1.23	0.93	0.94	0.88
Ohio	0.95	1	5.73	0.96	0.95	-1.2	0.93	0.98	4.53
Oklahoma	0.95	1	4.27	0.94	0.93	-1.18	0.94	0.97	3.69
Oregon	0.94	0.96	1.69	0.94	0.93	-1.09	0.93	0.94	1.16
Pennsylvania	0.95	0.98	4	0.93	0.92	-1.01	0.93	0.96	2.89
Rhode Island	0.95	0.95	-0.28	0.95	0.94	-0.84	0.93	0.93	-0.5
South Carolina	0.98	1	2.17	0.94	0.94	-0.77	0.96	0.98	1.94
South Dakota	0.95	0.98	3.12	0.94	0.93	-0.73	0.94	0.96	2.32
Tennessee	0.96	0.99	2.53	0.95	0.94	-0.68	0.95	0.97	2.26
Texas	0.95	0.98	3.98	0.95	0.95	-0.58	0.93	0.96	3.29
Utah	0.95	0.98	2.71	0.95	0.94	-0.47	0.94	0.96	2.54
Vermont	0.97	0.95	-1.7	0.95	0.94	-0.43	0.95	0.93	-1.67
Virginia	0.95	0.97	1.92	0.96	0.95	-0.28	0.94	0.95	1.6

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TABLE 3. MIR for Mesothelioma at the National and State Levels, 1990-2023 (continued)

State	Male			Female			Both		
	1990	2023	% Change	1990	2023	% Change	1990	2023	% Change
Washington	0.95	0.97	2.7	0.95	0.95	-0.05	0.93	0.95	1.7
West Virginia	0.96	0.99	3.44	0.96	0.96	0.08	0.95	0.97	3.02
Wisconsin	0.93	0.98	5.22	0.94	0.94	0.2	0.91	0.95	3.78
Wyoming	0.96	0.98	1.79	0.94	0.95	0.58	0.94	0.96	1.69

Abbreviation: MIR, mortality-to-incidence ratio.

32,963; 2023: 34,210; 4%), although with a larger relative increase among females (1990: 9,384; 2023: 13,936; 49%). Age-standardized DALY rates fell 40% overall (13.36 to 8.03), with reductions in males (-49% [95% CI, -58.1 to -40.1]) and a nonsignificant change in females (-13.4% [95% CI, -31.8 to 9.4]; Data Supplement, Table S4).

State-Level Trends

Incidence

Among males, ASIR AAPCs ranged from -1.29%/year in Ohio to -2.40%/year in D.C., with the steepest terminal-segment declines in D.C. (-8.5%/year), Maryland (-7.01%/year), and Wisconsin (-6.96%/year; Data Supplement, Table S5). Female ASIR trends were more heterogeneous: 23 states showed no significant trend, and 10 had significantly positive AAPCs. The largest increases occurred in South Dakota (+0.51%/year) and Arkansas (+0.44%/year). Furthermore, 20 states showed positive final-segment APCs for female incidence, with the steepest recent increases in South Dakota

(+2.8%/year), Iowa (+2.5%/year), and Mississippi (+1.6%/year). The highest overall ASIRs in 2023 were in Maine (0.74), Alaska (0.67), and Minnesota (0.63), with the lowest in D.C. (0.17), Hawaii (0.25), and Georgia (0.30; Figs 2A, 2B and 2C).

Mortality

ASMR patterns were broadly similar to incidence. Male AAPCs ranged from -1.11%/year in Ohio to -2.50%/year in D.C., with the steepest terminal-segment mortality declines in D.C. (-8.5%/year), Maryland (-7.0%/year), and Wisconsin (-6.8%/year; Data Supplement, Table S6). Among females, 13 states showed no significant trend and 10 demonstrated a significantly positive AAPC, with the largest increases in South Dakota (+0.43%/year), Arkansas (+0.42%/year), Mississippi (+0.39%/year), and West Virginia (+0.37%/year). Twenty states showed a positive final-segment female ASMR APC, with the largest recent increases in Iowa (+2.4%/year), Mississippi (+1.5%/year), and South Dakota (+1.5%/year). In 2023, the highest overall ASMRs

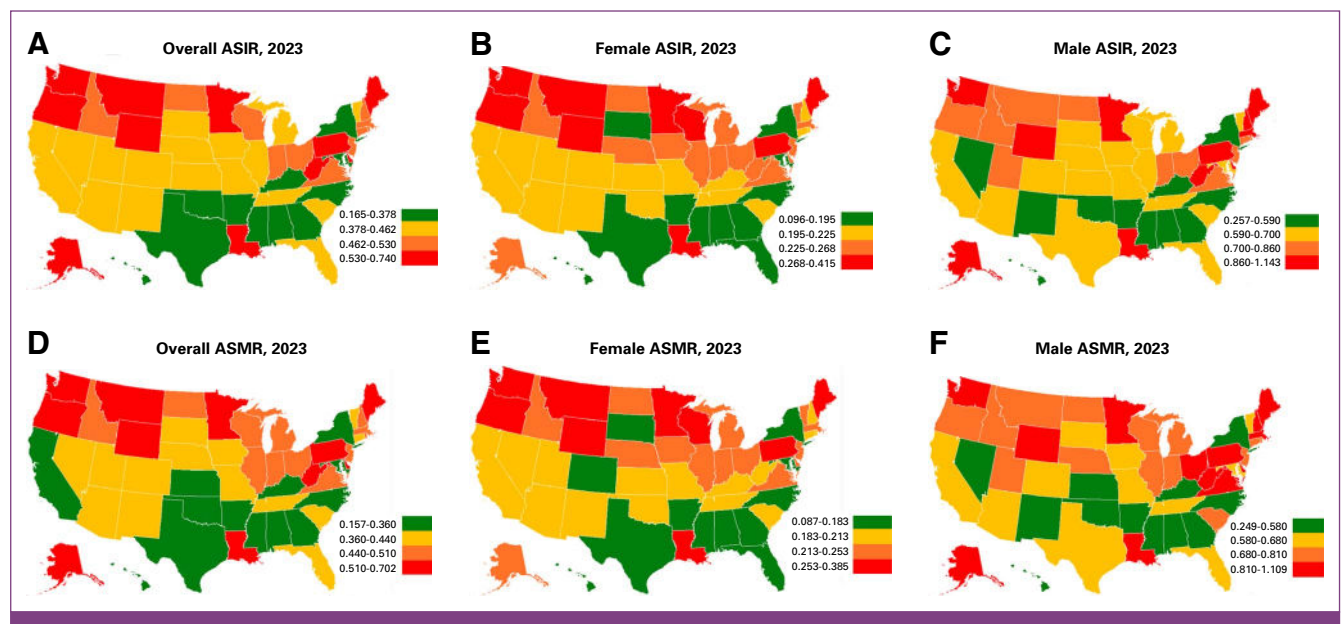


FIG 2. State-level ASIR and ASMR, stratified by sex, 2023: (A) overall ASIR, (B) female ASIR, (C) male ASIR, (D) overall ASMR, (E) female ASMR, and (F) male ASMR. ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; MIR, mortality-to-incidence ratio.

were observed in Maine (0.70), Alaska (0.63), and Washington (0.60), while the lowest were in D.C. (0.16), Hawaii (0.24), and Georgia (0.29; [Figs 2D, 2E and 2F](#)).

MIR

Only six states saw an overall MIR decline ([Table 3](#)). Male MIR increased in all except Alaska (−0.42%), D.C. (−2.78%), and Delaware (−0.08%). Female MIR decreased in all states except West Virginia (0.08%), Wisconsin (0.2%), and Wyoming (0.58%).

Attributable Risk

Occupational-attributable fractions declined modestly across states, with the largest and only significant female decline in Alaska (−5.8% [95% CI, −9.1 to −2.9]; [Data Supplement, Table S7](#)). In 2023, occupational asbestos exposure accounted for ≥96% of mesothelioma deaths in Maine and ≤90% in D.C. Female-attributable fractions were lower overall, with some jurisdictions (ie, Hawaii, D.C.) reporting ≤85%. These findings highlight pronounced state-level and sex-specific variation in attributable risk.

DALYs

State-level DALY patterns largely mirrored the ASIR and ASMR trends, with Maine, Alaska, West Virginia, and Washington consistently among the highest-burden states for both sexes. Several states recorded nonsignificant increases in female DALYs, including West Virginia (+17.9%), South Dakota (+14.5%), Arkansas (+13.5%), and Tennessee (+6.8%). West Virginia was notable for both the smallest male decline (−38.8%) and a female increase. Louisiana recorded the highest female DALY rate in 2023 (7.26), nearly 55% above the national average of 4.69.

DISCUSSION

This study provides a comprehensive contemporary assessment of mesothelioma burden across all US states from 1990 to 2023, integrating incidence, mortality, disability, and occupational-attributable risk. Mesothelioma incidence and mortality have declined nationally, particularly among males, consistent with long-term effects of asbestos regulation. However, these declines have not translated into meaningful survival gains, and substantial geographic and sex-specific heterogeneity persists.

Temporal patterns align closely with the known natural history of mesothelioma and the chronology of asbestos regulation. US asbestos consumption fell from a peak of 803,000 metric tons in 1973 to <520 tons since 2017 after the Clean Air Act, OSHA standards, and subsequent restrictions.^{19–22} Yet mesothelioma incidence continued rising for decades thereafter due to the disease's long latency, often exceeding 40 years.²³ Inflection points around 2000 and again after 2011, particularly the accelerated

declines in male incidence and mortality, likely reflect cohort-level depletion of heavily exposed workers in shipbuilding, construction, and insulation industries. These observations align with reports using other databases, including The SEER and the CDC's Wide-Ranging Online Data for Epidemiologic Research, which found mesothelioma incidence and mortality decreasing in the early 2000s.^{11,24}

Despite declining standardized rates, absolute mesothelioma deaths and disability have increased due to population growth and aging. The 14% rise in DALYs since 1990 reinforces that mesothelioma continues to exert a substantial public health burden even as incidence and mortality fall. The persistently high MIR indicates that case fatality remains largely unchanged over three decades, suggesting that therapeutic advances, including immune checkpoint inhibitors approved since 2020, have not yet produced detectable population-level survival benefits.^{25–27} Mesothelioma remains among the most lethal solid tumors, with only 23% of patients surviving 5 years even with localized disease.^{28,29} The lack of MIR improvement emphasizes the need for more effective therapies.^{30–33}

The near-universal attribution of mesothelioma deaths to occupational asbestos exposure, nearly 96%, confirms this remains a largely preventable cancer. The persistence of high attributable fractions reflects both the durability of historical exposures and ongoing risk from legacy asbestos in older buildings, industrial materials, and infrastructure.^{7,34,35} Despite decades of regulation, disease burden from past exposure will continue for many years.²² Continued enforcement of remediation, demolition safety standards, and exposure surveillance remains essential.

State-level heterogeneity further emphasizes the importance of place-based risk. Although overall ASIRs and ASMRs declined across all states ([Data Supplement, Tables S5 and S6](#)), the states with the highest ASIRs and ASMRs in 2023 were Maine (0.74 and 0.70, respectively), Alaska (0.67, 0.63), Washington (0.63, 0.60), and Minnesota (0.63, 0.59), which had some of the highest DALY rates. Maine and Washington have strong histories of shipbuilding, which has long been associated with asbestos-related cancer.^{36–39} Minnesota's rates are, at least partially, explained by asbestiform exposure among taconite iron ore miners, which is associated with a 2.9-fold higher risk of mesothelioma.^{40,41} Alaska has widespread naturally occurring asbestos, which can be disturbed during construction activities and affect nearby communities.⁴² Notably, Alaska exhibited the largest and only statistically significant decline in female occupational-attributable fraction, suggesting that environmental pathways may play a strong role in driving mesothelioma burden among Alaskan females.

The divergence between male and female trends warrants particular attention. Female incidence and mortality increased in several states, even as male rates declined, likely reflecting

multiple nonoccupational pathways. A 1980 EPA assessment estimated that approximately 250,000 teachers and school staff, a predominantly female workforce, were regularly exposed to asbestos-containing materials across the United States.⁴³ Additionally, unlike occupational exposure, which produces a four- to eight-fold male predominance, mesothelioma arising from environmental asbestos exposure affects males and females in roughly equal proportions, and has a relative risk of mesothelioma of 5.33.^{9,44} Moreover, some cosmetic talc products, such as baby and facial powders, have been shown to contain asbestos fibers because talc and asbestos occur together geologically.⁴⁵⁻⁴⁷ This represents an additional pathway by which females are exposed to asbestos; however, there is conflicting evidence regarding the validity of the association.⁴⁸⁻⁵⁰ Para-occupational exposure further compounds risk, with females whose spouse or parent worked in asbestos industries facing up to a tenfold higher risk of mesothelioma.⁵ The lower occupational-attributable fraction observed among females supports these alternative pathways.

These findings have direct implications for prevention, surveillance, and health equity. High-burden states with elevated occupational attribution should remain priorities for worker-centered interventions and exposure registries, while jurisdictions with rising female incidence require heightened clinical awareness of nontraditional exposure histories and improved environmental monitoring. The absence of systematic screening strategies for mesothelioma further compounds these inequities, as most patients continue to present with advanced disease.

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This study has some limitations, which may include reporting biases, reliance on modeled data, and differences varying by tumor grading, histologic subtype, and different treatment protocols between specific periods of time.^{51,52} Changes in coding systems over time, particularly the ICD-9 to ICD-10 transition, may have introduced inconsistencies, although GBD maps mortalities to standardized cause-of-death lists to ensure comparability. Data heterogeneity across states, variation in death certification reliability, and regional differences in socioeconomic and regulatory environments contribute to variability.⁵² The GBD uses redistribution algorithms for ill-defined diagnoses, although residual misclassification likely persists.^{17,18} Finally, this study is observational and based on modeled estimates; causal inferences beyond risk factor associations cannot be established, and findings should be interpreted as complementary to reported data.

In conclusion, mesothelioma in the United States is declining but far from eliminated. The disease remains overwhelmingly attributable to asbestos, geographically heterogeneous, and highly lethal, with limited improvement in population-level survival despite decades of regulation. Continued regulatory vigilance, remediation of legacy asbestos in built environments, and sustained enforcement of occupational and environmental protections are essential. In parallel, investment in more effective therapies, enhanced surveillance systems, and targeted prevention strategies, particularly in high-burden states and among populations with nontraditional exposure pathways, is critical to reducing the enduring and ineluctable burden of this preventable cancer.

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Manuscript writing: All authors

Final approval of manuscript: All authors

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