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Supplementary file

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Supplementary Table S1. ICD-10 case definitions used for lung cancer mortality with co-reported chronic lower respiratory diseases among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2024 (primary phenotype n=490,902)

Classification	ICD-10 code	Description	Use in study
Underlying cause	C34	Malignant neoplasm of bronchus and lung	Primary lung cancer mortality definition
Contributing cause	J40	Bronchitis, not specified as acute or chronic	CLRD
Contributing cause	J41	Simple and mucopurulent chronic bronchitis	CLRD
Contributing cause	J42	Unspecified chronic bronchitis	CLRD
Contributing cause	J43	Emphysema	CLRD
Contributing cause	J44	Other chronic obstructive pulmonary disease	CLRD
Contributing cause	J45	Asthma	CLRD
Contributing cause	J46	Status asthmaticus	CLRD
Contributing cause	J47	Bronchiectasis	CLRD

The primary phenotype required C34 as the underlying cause of death and at least one J40-J47 code among contributing causes. CLRD, chronic lower respiratory diseases; ICD-10, International Classification of Diseases, Tenth Revision.

Supplementary Table S2. Joinpoint annual percent change segments for lung cancer mortality with co-reported chronic lower respiratory diseases among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2024 (primary phenotype n=490,902; overall lung cancer comparator n=2,850,632 where applicable)

Domain	Group	Rate metric	Segment years	APC, % (95% CI)	Significant
Overall / sex	Overall	AAMR	1999-2006	-0.09 (-0.65 to 0.80)	No
Overall / sex	Overall	AAMR	2006-2024	-1.82 (-1.99 to -1.68)	Yes
Overall / sex	Male	AAMR	1999-2005	-1.24 (-1.97 to 0.66)	No
Overall / sex	Male	AAMR	2005-2024	-2.45 (-2.73 to -2.32)	Yes
Overall / sex	Female	AAMR	1999-2005	1.45 (0.88 to 2.27)	Yes
Overall / sex	Female	AAMR	2005-2012	-0.66 (-1.25 to 0.60)	No
Overall / sex	Female	AAMR	2012-2018	-2.34 (-3.52 to -0.63)	Yes
Overall / sex	Female	AAMR	2018-2021	0.93 (-2.51 to 1.73)	No
Overall / sex	Female	AAMR	2021-2024	-1.68 (-3.26 to -0.45)	Yes
Age group	65-74 years	CMR	1999-2006	-1.08 (-1.58 to -0.32)	Yes

Domain	Group	Rate metric	Segment years	APC, % (95% CI)	Significant
Age group	65-74 years	CMR	2006-2018	-2.92 (-3.51 to -2.67)	Yes
Age group	65-74 years	CMR	2018-2024	-1.02 (-1.66 to 0.28)	No
Age group	75-84 years	CMR	1999-2007	0.45 (-0.15 to 1.45)	No
Age group	75-84 years	CMR	2007-2024	-1.78 (-2.05 to -1.58)	Yes
Age group	85+ years	CMR	1999-2006	2.08 (0.65 to 7.04)	Yes
Age group	85+ years	CMR	2006-2024	-0.35 (-1.05 to -0.03)	Yes
Census region	Midwest	AAMR	1999-2005	1.36 (0.29 to 3.13)	Yes
Census region	Midwest	AAMR	2005-2024	-1.65 (-1.88 to -1.46)	Yes
Census region	Northeast	AAMR	1999-2010	-0.65 (-1.07 to -0.13)	Yes
Census region	Northeast	AAMR	2010-2024	-3.41 (-3.79 to -3.11)	Yes
Census region	South	AAMR	1999-2006	-0.27 (-0.90 to 1.42)	No
Census region	South	AAMR	2006-2015	-1.56 (-3.32 to -0.70)	Yes
Census region	South	AAMR	2015-2021	0.29 (-1.34 to 1.99)	No
Census region	South	AAMR	2021-2024	-2.16 (-4.43 to -0.60)	Yes
Census region	West	AAMR	1999-2009	-1.02 (-1.68 to -0.23)	Yes
Census region	West	AAMR	2009-2018	-3.86 (-6.26 to -2.46)	Yes
Census region	West	AAMR	2018-2024	-1.82 (-3.03 to 1.24)	No
Comparative analysis	Overall lung cancer mortality	AAMR	1999-2005	-0.33 (-0.79 to 0.48)	No
Comparative analysis	Overall lung cancer mortality	AAMR	2005-2012	-1.89 (-2.49 to -1.43)	Yes
Comparative analysis	Overall lung cancer mortality	AAMR	2012-2020	-4.03 (-5.08 to -3.73)	Yes
Comparative analysis	Overall lung cancer mortality	AAMR	2020-2024	-2.45 (-3.29 to -0.88)	Yes
Comparative analysis	Lung cancer mortality with co-reported CLRD	AAMR	1999-2006	-0.09 (-0.65 to 0.80)	No
Comparative analysis	Lung cancer mortality with co-reported CLRD	AAMR	2006-2024	-1.82 (-1.99 to -1.68)	Yes
Race and ethnicity	Non-Hispanic American Indian or Alaska Native	AAMR	1999-2004	7.11 (0.73 to 30.98)	Yes
Race and ethnicity	Non-Hispanic American Indian or Alaska Native	AAMR	2004-2024	-1.05 (-2.63 to -0.38)	Yes
Race and ethnicity	Non-Hispanic Asian or Pacific Islander	AAMR	1999-2007	-0.69 (-2.72 to 8.87)	No
Race and ethnicity	Non-Hispanic Asian or Pacific Islander	AAMR	2007-2024	-3.79 (-6.33 to -3.20)	Yes
Race and ethnicity	Non-Hispanic Black	AAMR	1999-2024	-1.20 (-1.41 to -0.96)	Yes
Race and ethnicity	Hispanic or Latino	AAMR	1999-2024	-2.30 (-2.54 to -2.05)	Yes
Race and ethnicity	Non-Hispanic White	AAMR	1999-2005	0.62 (-0.07 to 1.70)	No
Race and ethnicity	Non-Hispanic White	AAMR	2005-2024	-1.51 (-1.66 to -1.39)	Yes

Domain	Group	Rate metric	Segment years	APC, % (95% CI)	Significant
Urbanization level	Metropolitan	AAMR	1999-2009	-0.78 (-1.14 to -0.28)	Yes
Urbanization level	Metropolitan	AAMR	2009-2020	-2.45 (-2.85 to -2.15)	Yes
Urbanization level	Non-metropolitan	AAMR	1999-2004	2.08 (1.03 to 3.77)	Yes
Urbanization level	Non-metropolitan	AAMR	2004-2020	-1.00 (-1.20 to -0.81)	Yes

APC, annual percent change; AAMR, age-adjusted mortality rate; CMR, crude mortality rate; CI, confidence interval. Statistical significance was defined by a 95% CI that excluded zero. Program-exported confidence limits were retained as supplied. For non-Hispanic American Indian or Alaska Native adults, the significant increase during 1999-2004 and significant decline during 2004-2024 occurred in opposite directions; the weighted full-period AAPC was therefore close to zero and was not statistically significant.

Supplementary Table S3. Average annual percent changes and endpoint mortality rates for lung cancer mortality with co-reported chronic lower respiratory diseases among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2024 (primary phenotype n=490,902; overall lung cancer comparator n=2,850,632 where applicable)

Domain	Group	Period	Rate metric	Start rate	End rate	AAPC, % (95% CI)	Significant
Overall	Overall phenotype	1999-2024	Age-adjusted	49.73	35.76	-1.34 (-1.45 to -1.22)	Yes
Sex	Male	1999-2024	Age-adjusted	72.66	42.11	-2.16 (-2.30 to -2.00)	Yes
Sex	Female	1999-2024	Age-adjusted	34.95	30.81	-0.50 (-0.60 to -0.39)	Yes
Race and ethnicity	Hispanic or Latino	1999-2024	Age-adjusted	20.36	11.41	-2.30 (-2.54 to -2.05)	Yes
Race and ethnicity	Non-Hispanic White	1999-2024	Age-adjusted	53.00	41.29	-1.01 (-1.11 to -0.88)	Yes
Race and ethnicity	Non-Hispanic American Indian or Alaska Native	1999-2024	Age-adjusted	33.76	40.75	0.53 (-0.45 to 1.90)	No
Race and ethnicity	Non-Hispanic Black or African American	1999-2024	Age-adjusted	41.17	30.44	-1.20 (-1.41 to -0.96)	Yes
Race and ethnicity	Non-Hispanic Asian or Pacific Islander	1999-2024	Age-adjusted	18.67	8.57	-2.81 (-3.46 to -1.97)	Yes
Census region	Northeast	1999-2024	Age-adjusted	43.61	25.72	-2.21 (-2.36 to -2.05)	Yes
Census region	Midwest	1999-2024	Age-adjusted	53.54	42.82	-0.94 (-1.11 to -0.73)	Yes
Census region	South	1999-2024	Age-adjusted	50.53	41.50	-0.83 (-0.99 to -0.66)	Yes
Census region	West	1999-2024	Age-adjusted	50.36	27.63	-2.24 (-2.46 to -2.02)	Yes
Age group	65-74 years	1999-2024	Crude	42.91	26.11	-1.95 (-2.07 to -1.82)	Yes
Age group	75-84 years	1999-2024	Crude	62.63	46.94	-1.07 (-1.22 to -0.90)	Yes
Age group	85 years or older	1999-2024	Crude	41.57	44.72	0.33 (-0.01 to 0.78)	No
Urban-rural residence	Metropolitan	1999-2020	Age-adjusted	48.39	34.80	-1.66 (-1.80 to -1.50)	Yes
Urban-rural residence	Non-metropolitan	1999-2020	Age-adjusted	55.58	54.35	-0.27 (-0.43 to -0.07)	Yes
Comparator	Overall lung cancer mortality	1999-2024	Age-adjusted	311.80	174.85	-2.30 (-2.40 to -2.19)	Yes

Rates are per 100,000 population. Age-group rates are crude; all other rates are age adjusted. The primary phenotype included 490,902 deaths. The five prespecified harmonized race/ethnicity strata accounted for 489,962 phenotype deaths; 940 deaths (0.19%) fell outside these five reported strata and were retained in overall analyses. Urban-rural analyses were restricted to 1999-2020. AAPC, average annual percent change; CI, confidence interval.

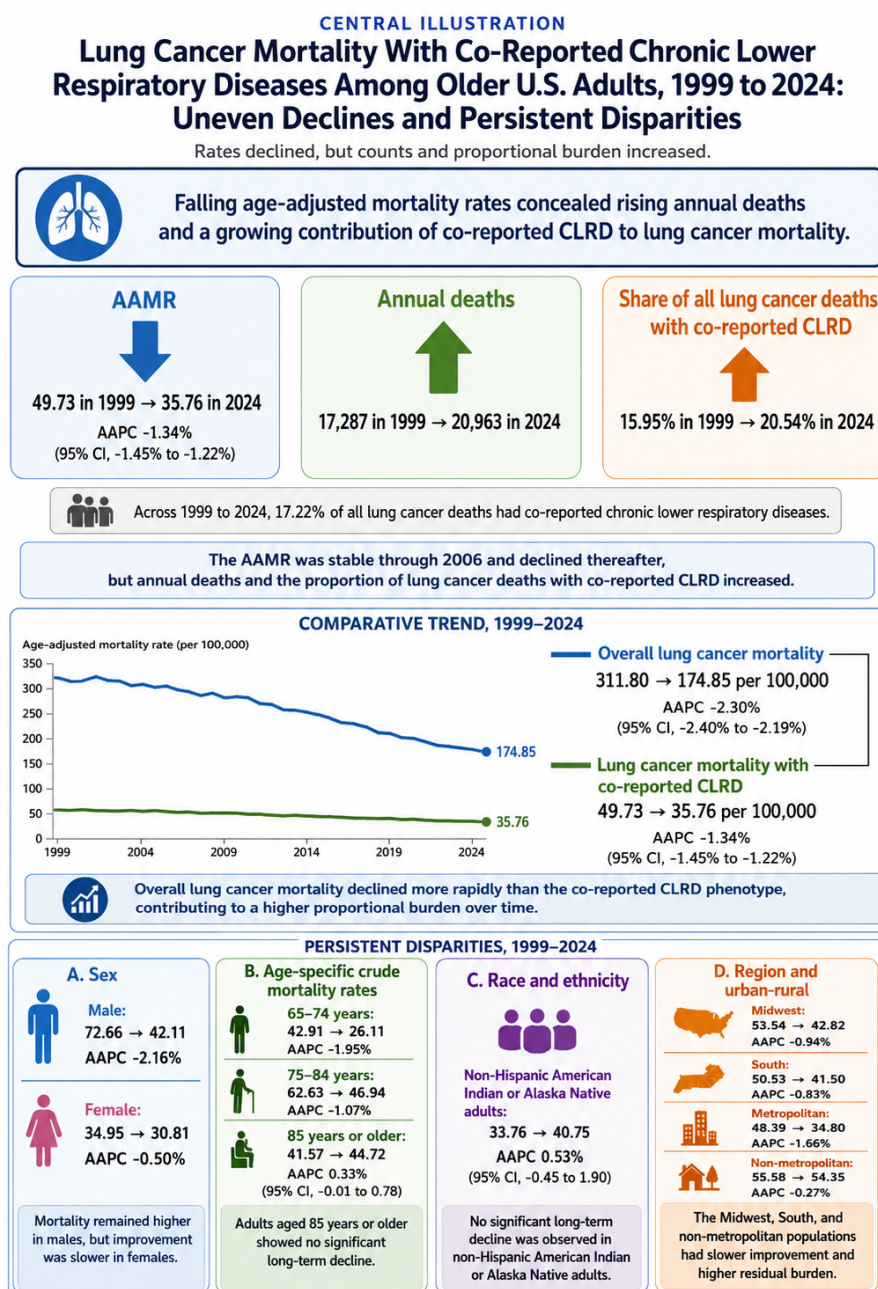
Supplementary Table S4. Annual contribution of co-reported chronic lower respiratory diseases to all lung cancer deaths among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2024 (490,902 phenotype deaths; 2,850,632 total lung cancer deaths)

Year	All lung cancer deaths	Phenotype deaths	Phenotype share, %
1999	108,383	17,287	15.95
2000	110,837	17,482	15.77
2001	111,201	17,365	15.62
2002	111,942	17,812	15.91
2003	112,034	17,737	15.83
2004	111,891	17,994	16.08
2005	112,785	18,415	16.33
2006	112,486	18,305	16.27
2007	113,003	18,287	16.18
2008	113,502	18,258	16.09
2009	112,952	18,352	16.25
2010	113,482	18,614	16.40
2011	112,295	18,686	16.64
2012	113,499	18,788	16.55
2013	113,032	19,056	16.86
2014	113,104	18,648	16.49
2015	112,318	18,961	16.88

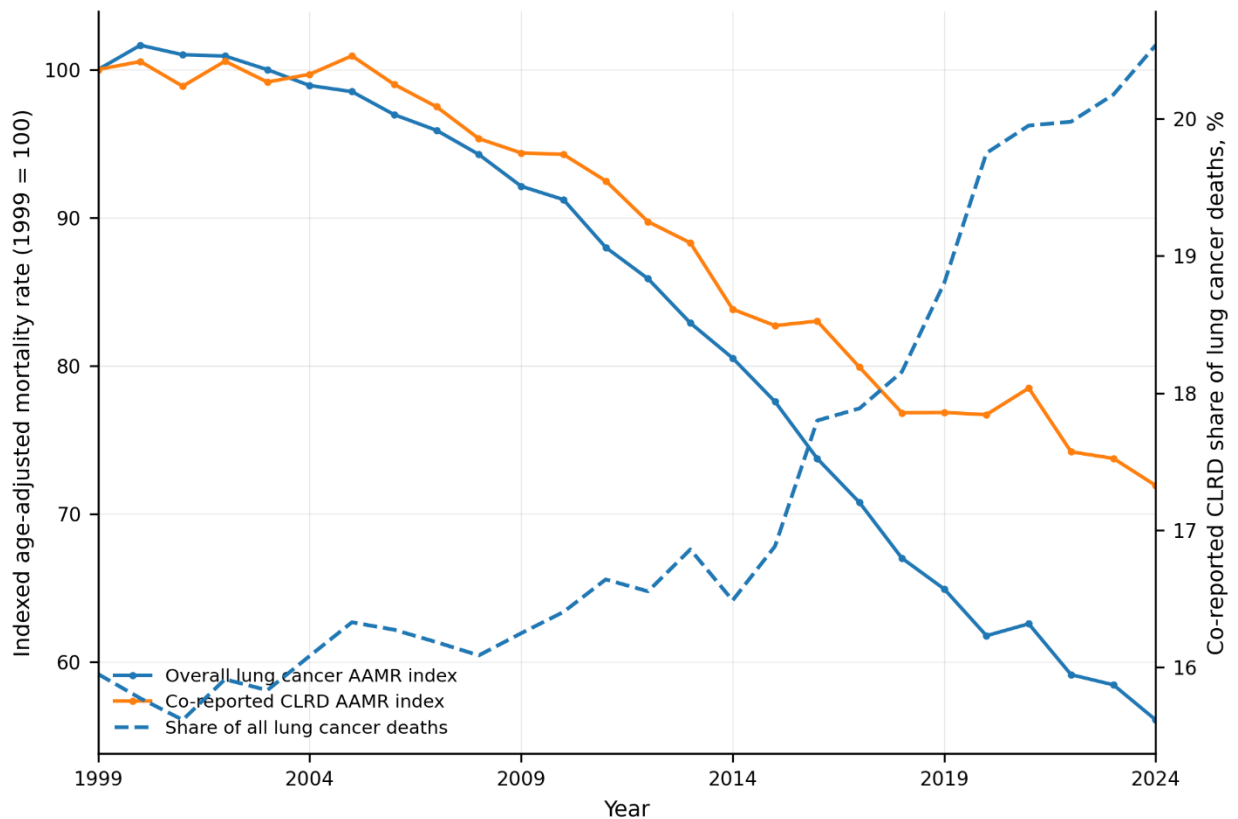
Year	All lung cancer deaths	Phenotype deaths	Phenotype share, %
2016	109,550	19,499	17.80
2017	108,398	19,390	17.89
2018	105,942	19,233	18.15
2019	105,633	19,860	18.80
2020	103,490	20,440	19.75
2021	102,415	20,433	19.95
2022	101,690	20,317	19.98
2023	102,694	20,720	20.18
2024	102,074	20,963	20.54

The phenotype required C34 as the underlying cause of death and at least one J40-J47 code among contributing causes. Across 1999-2024, the analysis included 490,902 phenotype deaths and 2,850,632 total lung cancer deaths. CLRD, chronic lower respiratory diseases.

Supplementary Figure S1: Central Illustration. National trends and persistent disparities in lung cancer mortality with co-reported chronic lower respiratory diseases among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999–2024 (490,902 phenotype deaths; 2,850,632 total lung cancer deaths). Although the age-adjusted mortality rate declined from 49.73 to 35.76 per 100,000, annual deaths increased from 17,287 to 20,963, and the proportion of all lung cancer deaths with co-reported chronic lower respiratory diseases increased from 15.95% to 20.54%. Overall lung cancer mortality declined more rapidly than the co-reported CLRD phenotype. Improvement was slower among females, adults aged 85 years or older, non-Hispanic American Indian or Alaska Native adults, residents of the Midwest and South, and non-metropolitan populations. Urban-rural estimates were available through 2020. AAMR, age-adjusted mortality rate; AAPC, average annual percent change; CI, confidence interval; CLRD, chronic lower respiratory diseases.



Supplementary Figure S2. Comparative national trends in overall lung cancer mortality and lung cancer mortality with co-reported chronic lower respiratory diseases among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2024 (2,850,632 total lung cancer deaths; 490,902 phenotype deaths). Mortality rates are indexed to 1999 to permit visual comparison of relative change. The dashed line shows the annual percentage of all lung cancer deaths that met the co-reported CLRD phenotype definition. The comparator includes phenotype deaths; no formal between-trend test was performed.



Supplementary Figure S3. Annual age-adjusted mortality rates for lung cancer deaths with co-reported chronic lower respiratory diseases by urban-rural residence among U.S. adults aged 65 years or older: serial cross-sectional secondary analysis of the CDC WONDER Multiple Cause of Death database, United States, 1999-2020 (408,469 phenotype deaths with classified urban-rural residence).

