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Pneumoconiosis incidence and prevalence among US Medicare beneficiaries, 1999–2019

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Abstract

Background: Pneumoconiosis is a group of occupational lung diseases caused by dust and fiber exposure. This study analyzes Medicare claims to estimate the burden of pneumoconiosis among fee-for-service (FFS; Medicare Parts A and B) Medicare beneficiaries during 1999–2019 in the United States.

Methods: Claim and enrollment information from 81 million continuously enrolled FFS Medicare beneficiaries were analyzed. Beneficiaries with any pneumoconiosis and cause-specific pneumoconiosis (e.g., asbestosis, silicosis) were identified using three case definitions (broad, intermediate, and narrow) with varying diagnostic criteria based on claim International Classification of Diseases, Clinical Modification (ICD-CM) diagnosis codes and Healthcare Common Procedure Coding System codes. Results are presented as ranges of values for the three case definitions.

Results: The 21-year prevalence range for any pneumoconiosis was 345,383–677,361 (412–833 per 100,000 beneficiaries) using the three case definitions. The highest prevalence was among those ≥75 years of age, males, Whites, and North American Natives. Most claims (70.0%–72.5%) included an ICD-CM diagnosis code for asbestosis. The broad pneumoconiosis prevalence rate increased significantly ($p < 0.001$) during 2002–2009 by 3%–10% annually and declined significantly by 3%–5% annually starting in 2009. The average annual broad incidence rate declined significantly by 7% annually during 2009–2019.

Conclusions: Despite the decline in rate for any pneumoconiosis among Medicare beneficiaries, which is primarily attributed to a decline in asbestosis, pneumoconiosis is prevalent among FFS Medicare beneficiaries.

KEYWORDS
asbestosis, coal workers' pneumoconiosis, medical claims, Medicare, pneumoconiosis

1 | INTRODUCTION

Pneumoconiosis is an occupational lung disease caused by inhalation of dusts or fibers. The most common types of pneumoconiosis are asbestosis, coal workers' pneumoconiosis (CWP), and silicosis, caused by inhaling asbestos fibers, coal mine dust, and respirable crystalline silica, respectively.[1] Pneumoconiosis develops after respirable particles initiate inflammatory responses in the lungs leading to scarring and irreversible lung tissue damage, which may progress and persist after exposure ceases.[2–4] Pneumoconiosis contributes to the

development of additional respiratory diseases (e.g., chronic obstructive pulmonary disease, pneumonia, lung cancer, tuberculosis) and extra-pulmonary health outcomes (e.g., congestive heart failure, autoimmune diseases).[2,5,6]

The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) compiles available data (i.e., published literature, survey data, surveillance data, inpatient and outpatient records, health insurance claims data, and other types of data) from 195 countries and territories to provide epidemiological surveillance estimates.[7] The GBD reported the annual crude pneumoconiosis incidence increased from 36,200 (1990) to 60,100 (2017) cases and crude prevalence increased during the same time from 291,190 to 527,460.[8] Globally, pneumoconiosis incidence increased with age and was more common in males and in developing countries.[8] The global age-standardized incidence rate for pneumoconiosis overall (and for silicosis, CWP, and other pneumoconioses, specifically) decreased from 0.86 per 100,000 population (1990) to 0.75 (2017), but some countries experienced increasing age-standardized incidence rates (e.g., New Zealand, Singapore, and Australia). Age-standardized incidence increased during 1990–2017 for asbestosis globally, which may be attributed to the long latency of the disease and continued use of the substance in many developing countries.[8] The increase in the crude number of pneumoconiosis cases may be explained by the continued presence of occupational dust exposures in the workplace, overall increase in worldwide coal production, and emergence of new occupational processes and exposures associated with pneumoconiosis.[4,5]

In the United States, there is a need for a coordinated approach to national occupational safety and health surveillance.[9] National pneumoconiosis surveillance data for the United States are limited to specific populations or types of pneumoconiosis. For example, the NIOSH-administered Coal Workers' Health Surveillance Program (CWHSP) identified an increasing prevalence of CWP and progressive massive fibrosis among long-tenured working coal miners, notably in the central Appalachian region.[10] While CWHSP data are valid for monitoring trends, coal miner participation in the program is voluntary.[11] For silicosis, incidence among Medicare beneficiaries ≥65 years of age declined between 3% and 16% annually during 2007–2014, but new outbreaks of silicosis are occurring among workers engaged in mining, sandblasting, drilling, cutting stone, and manufacturing and installing artificial stone.[2,4,12,13] Death certificate data are a component of pneumoconiosis surveillance and indicate a decline in pneumoconiosis deaths during 1999–2018.[14] However, occupational lung diseases, including pneumoconiosis, are often underrecognized and underreported by physicians contributing to underestimates of occurrence on death certificates.[15,16]

Pneumoconiosis is progressive, has no cure, and contributes substantially to morbidity and mortality in US adults. Pneumoconiosis is associated with financial costs assumed by public insurance programs such as Medicare. In the United States, Medicare is the primary federal health insurance for persons aged ≥65 years as well as those <65 years of age receiving disability insurance benefits or of any age with end stage renal disease.[17] Medicare data from 1999 to 2019 were analyzed to estimate the burden of pneumoconiosis among Medicare beneficiaries continuously enrolled in Medicare fee-for-service (FFS; also known as Medicare Parts A and B).

2 | METHODS

All 1999–2019 FFS Medicare claims and beneficiary data files were accessed through the Centers for Medicare & Medicaid Services (CMS) Research Data Center (RDC).[18,19] Final action inpatient hospital and outpatient hospital claims (submitted by institutional providers such as healthcare facilities) and carrier claims (submitted by noninstitutional providers such as physicians or nurse practitioners) for Medicare beneficiaries with continuous FFS Medicare coverage were extracted.[17,20] Claims include International Classification of Diseases, Clinical Modification (ICD-CM) diagnosis codes (up to 25 diagnosis codes for institutional claims and up to 12 for noninstitutional claims). Claims also identify the principal ICD-CM diagnosis code which is chiefly responsible for the services provided on a claim, and claims may also include additional healthcare procedure codes, if available. Medicare claims are populated using Ninth Revision ICD-CM (ICD-9-CM) codes through September 2015 and Tenth Revision ICD-CM (ICD-10-CM) codes starting October 2015.[17,21]

Annual Medicare Master Beneficiary Summary Files (MBSF) include beneficiary enrollment (e.g., type of enrollment [Part A, Part B, or Part C managed care plan]) and demographic data (e.g., age, date of birth, sex, race, state of residence, and original reason for Medicare enrollment). Enrollment and demographic data for 81,311,978 Medicare beneficiaries with continuous FFS enrollment for the full year or for all months preceding death (if a beneficiary died that year) were analyzed. Beneficiaries ever enrolled in a Part C managed care plan during the study period were excluded because these claims are unavailable through the RDC (Figure 1).

Three case definitions were developed to identify FFS beneficiaries with any type of pneumoconiosis (CWP, asbestosis, silicosis, byssinosis, cannabinosis, flax-dressers' disease, other/unspecified pneumoconiosis) and to calculate prevalence and incidence during 1999–2019 (Figure 1). These definitions were based on patterns of diagnosis codes used by the CMS Chronic Conditions Warehouse and previous studies estimating the prevalence of chronic respiratory diseases among Medicare beneficiaries.[13,22–24] A broad pneumoconiosis definition identified beneficiaries with a FFS claim including any pneumoconiosis ICD-9-CM code (500–505) or ICD-10-CM code (J60, J61, J62.8, J63, J64, J65, or J66) (Table 1) listed in any diagnosis position. ICD-10-CM code J62.0 (pneumoconiosis due to talc dust) was excluded because mortality data research shows this code frequently represented talcosis among intravenous drug users or others.[25] Among beneficiaries meeting the broad pneumoconiosis case definition, a subset fulfilled the intermediate pneumoconiosis case definition criteria of having at least one inpatient claim listing an ICD-CM pneumoconiosis code or having ≥2 outpatient or carrier claims including an ICD-CM pneumoconiosis code. A subset of beneficiaries meeting the intermediate pneumoconiosis case
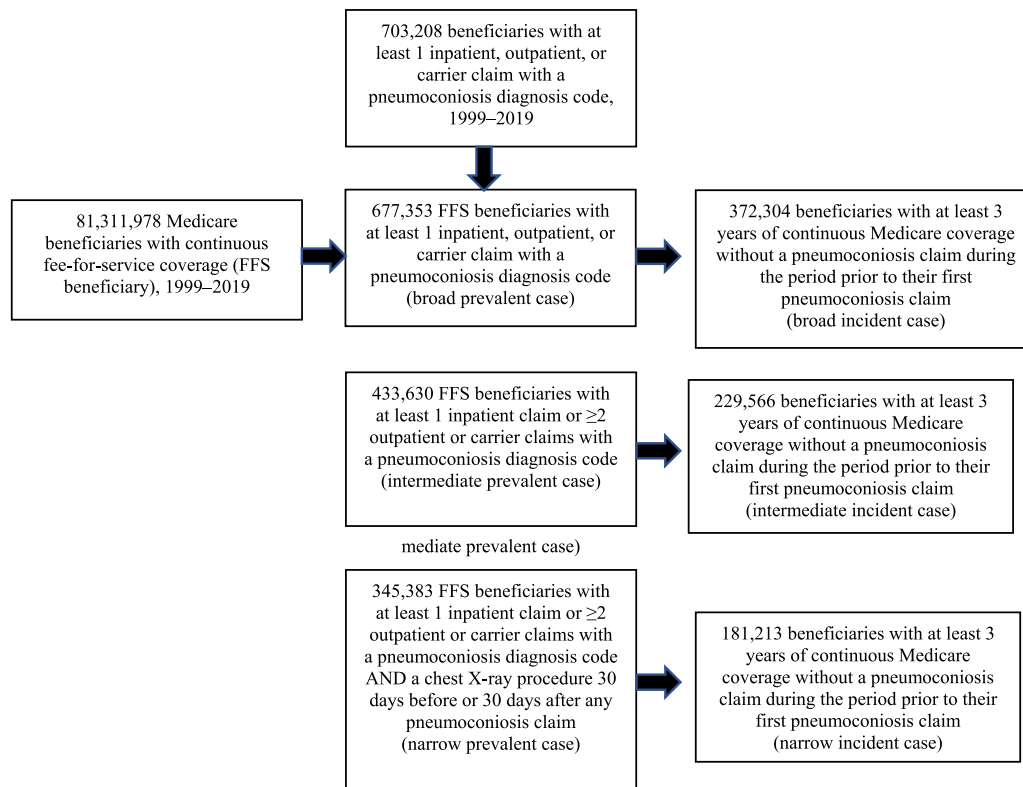
FIGURE 1 Sample selection of fee-for-service Medicare beneficiaries meeting broad, intermediate, and narrow prevalence and incidence pneumoconiosis case definitions, 1999–2019.

TABLE 1 ICD-CM codes for each type of pneumoconiosis.

Type of pneumoconiosis	ICD-9-CM code	ICD-10-CM code
CWP	500 Coal workers' pneumoconiosis	J60 Coal workers' pneumoconiosis
Asbestosis	501 asbestosis	J61 pneumoconiosis due to asbestos and other mineral fibers
Silicosis	502 pneumoconiosis due to other silica or silicates	J62.8 pneumoconiosis due to other dust containing silica
Byssinosis/cannabinosis/flax-dressers' disease (byssinosis+)	504 Pneumonopathy due to inhalation of other dusts	J66 airway disease due to specific organic dust J66.0 byssinosis J66.1 flax-dressers' disease J66.2 cannabinosis J66.8 airway disease due to other specific organic dusts
Other/unspecified pneumoconiosis	503 pneumoconiosis due to other inorganic dusts 505 pneumoconiosis, unspecified	J63 pneumoconiosis due to other inorganic dusts J63.0 aluminosis (of lung) J63.1 bauxite fibrosis (of lung) J63.2 berylliosis J63.3 graphite fibrosis (of lung) J63.4 siderosis J63.5 stannosis J63.6 pneumoconiosis due to other specified inorganic dusts J64 pneumoconiosis, unspecified

Abbreviation: CWP, coal workers' pneumoconiosis.

definition fulfilled the narrow pneumoconiosis case definition criteria of having a pneumoconiosis diagnostic procedure (i.e., chest X-ray, computerized tomography [CT scan]) within 30 days before or 30 days after any pneumoconiosis claim. Diagnostic procedure codes were available on some inpatient, outpatient, or carrier claims and included Healthcare Common Procedure Coding System (HCPCS) codes for Radiologic Examination, Chest (71010–71035) and Diagnostic Radiology Procedures of the Chest (71045–71555). Procedure codes are incomplete when they are not the basis for payment, so some claims lacked procedure information.[21]

Pneumoconiosis claims were linked to MBSF data using the beneficiary identification number.[19] Demographic information was extracted from the year of a beneficiary's first pneumoconiosis claim meeting the case definition.[17,19] Race categories used by CMS on the MBSF data are those used by the Social Security Administration and included White, Black, Hispanic, North American Native, other/unknown (Asian, other race, and unknown).[19] A beneficiary's original reason for Medicare enrollment included aged ≥65 years; aged <65 years and receiving Social Security Administration disability insurance benefits for 24 consecutive months; or any beneficiary with end stage renal disease or end stage renal disease and disability insurance benefits.[17,19]

A beneficiary meeting a pneumoconiosis case definition was considered prevalent from the first day of their first pneumoconiosis claim during 1999–2019 until they died or were not continuously enrolled in FFS Medicare.[13] Multi-day claims with the first claim day in 1998 that carried into 1999 were counted as occurring in 1999 (broad definition $n = 365$ claims). Cumulative prevalence was calculated as the sum of all unique prevalent cases divided by the total number of FFS Medicare beneficiaries enrolled during 1999–2019. Annual prevalence per 100,000 FFS Medicare beneficiaries was calculated using the number of prevalent pneumoconiosis cases each year divided by the total number of continuously enrolled FFS Medicare beneficiaries for that year. A beneficiary was not counted as prevalent until they had a Medicare claim with a pneumoconiosis diagnosis code leading to incomplete prevalence estimates at the beginning of the study period and more complete estimates toward the end of the study period. Pneumoconiosis prevalence by demographic characteristic was calculated using the number of prevalent pneumoconiosis cases among beneficiaries in that demographic category divided by the total number of continuously enrolled FFS Medicare beneficiaries for that category.

Incident pneumoconiosis cases were identified among prevalent cases continuously enrolled in Medicare for at least 3 years before their first pneumoconiosis claim and without a pneumoconiosis diagnosis code before their first pneumoconiosis claim. Annual incidence per 100,000 FFS Medicare beneficiaries was calculated for 2002–2019 as the total number of FFS Medicare beneficiaries with an incident pneumoconiosis claim for a given year divided by the total number of FFS Medicare beneficiaries continuously enrolled for at least 3 years before the given year. For intermediate and narrow case definitions, the incident year was the year of a beneficiary's first pneumoconiosis claim, not necessarily the year a beneficiary first met the case definition criteria. Total incidence was the sum of all incident cases during 2002–2019 divided by all FFS Medicare beneficiaries with at least 3 years of continuous enrollment during 1999–2019.

Prevalence and incidence for the specific types of pneumoconiosis were determined by identifying beneficiaries with a FFS claim including ICD-CM codes for the specific type of pneumoconiosis (Table 1) as defined by the Centers for Disease Control and Prevention (https://wwwn.cdc.gov/eWorld/Appendix/ICDCodes). Groups were compared using Pearson's χ^2 tests and differences were considered significant at $p < 0.05$. Log-transformed pneumoconiosis rates were evaluated using Joinpoint Regression Program (V 4.9.1.0) to examine time-trends using permutation tests for model selection and a default maximum number of Joinpoints based on the total datapoints.[26] Time-trends were presented by annual percent change (APC) with corresponding 95% confidence intervals (CI) and p values starting in 2002 when more complete case ascertainment for prevalence and incidence was suspected. Analyses were conducted in SAS Enterprise Guide 7.1 (SAS Institute). Results are presented as ranges of values for the three case definitions. NIOSH determined that no additional human subjects review was required for this research study.

3 | RESULTS

Among 81 million Medicare beneficiaries with continuous FFS coverage during 1999–2019, a total of 677,361 (21-year cumulative prevalence 833.0 per 100,000 beneficiaries), 433,630 (513.9), and 345,383 (412.5) beneficiaries met the broad, intermediate, and narrow pneumoconiosis case definition, respectively. Demographic characteristics of all FFS beneficiaries and of FFS beneficiaries with prevalent pneumoconiosis are presented in Table 2. Compared to the entire Medicare FFS population, Medicare FFS beneficiaries with pneumoconiosis were more likely to be ≥75 years of age, male, White, and originally entitled to Medicare due to disability for all three case definitions. At the time of their first prevalent pneumoconiosis claim, most beneficiaries were ≥65 years of age (87.7%–90.8%), male (81.2%–89.2%), White (88.7%–90.7%), and originally entitled to Medicare due to age (71.5%–72.6%).

For the three pneumoconiosis case definitions, cumulative prevalence rates (PRs) were highest among those aged 75+ years of age (1140.0–1895.3 per 100,000 beneficiaries), males (805.6–1420.6), White beneficiaries (455.2–862.8), North American Native beneficiaries (351.0–812.9), and beneficiaries originally entitled to Medicare due to disability (487.2–933.3). The 10 states with the highest broad PRs are presented (Table 2), and West Virginia (2519.0–4152.7), Delaware (1010.4–1991.2), and Kentucky (1015.8–1782.5) had the highest PRs for each case definition.

Pneumoconiosis claims for beneficiaries meeting the three pneumoconiosis case definitions were primarily from a carrier provider (64.9%–67.2%) (Table 2). The most common ICD-CM pneumoconiosis principal diagnosis codes were for asbestosis (20.5%–22.3%) and CWP (3.9%–4.5%) (Table 2). Other common ICD-9-CM principal diagnosis codes on claims among beneficiaries meeting the broad case definition were chronic airway obstruction ($n = 144,962$), obstructive chronic

TABLE 2 Demographic and claim characteristics of fee-for-service Medicare beneficiaries with prevalent pneumoconiosis by case definition, 1999–2019.

Characteristics	Beneficiaries with continuous FFS coverage[a] N (%)	Pneumoconiosis prevalence Broad case definition[b] N (%)[e]	Rate per 100,000	Intermediate case definition[c] N (%)	Rate per 100,000	Narrow case definition[d] N (%)	Rate per 100,000
Total	81,311,978	677,361	833.0	433,630	513.9	345,383	412.5
Age group (years)							
18–44	4,927,947 (6.1)	5726 (0.9)	116.2	2046 (0.5)	41.5	1197 (0.4)	24.3
45–64	11,567,159 (14.2)	73,932 (11.4)	639.2	43,004 (10.3)	371.8	29,507 (8.8)	255.1
65–74	48,297,340 (59.4)	257,880 (39.6)	533.9	153,696 (36.8)	318.2	116,473 (34.7)	241.2
75+	16,507,709 (20.3)	312,867 (48.1)	1895.3	219,079 (52.4)	1327.1	188,195 (56.1)	1140.0
Sex							
Male	37,156,322 (45.7)	527,841 (81.2)	1420.6	370,642 (88.7)	997.5	299,315 (89.2)	805.6
Female	44,155,636 (54.3)	122,606 (18.8)	277.7	47,193 (11.3)	106.9	36,063 (10.8)	81.7
Race[f]							
White	66,837,174 (82.2)	576,692 (88.7)	862.8	377,834 (90.4)	565.3	304,251 (90.7)	455.2
Black	8,585,643 (10.6)	52,566 (8.1)	612.3	29,154 (7.0)	339.6	22,951 (6.8)	267.3
Hispanic	1,959,156 (2.4)	7358 (1.1)	375.6	3455 (0.8)	176.4	2685 (0.8)	137.0
North American Native	382,208 (0.5)	3107 (0.5)	812.9	2078 (0.5)	543.7	1343 (0.4)	351.0
Other/unknown	3,547,797 (4.4)	10,724 (1.6)	302.3	5314 (1.3)	149.8	4148 (1.2)	116.9
Ten states of residence with highest broad prevalence rate							
West Virginia	708,889 (0.9)	29,438 (4.5)	4152.7	22,876 (5.5)	3227.0	17,857 (5.3)	2,519.0
Delaware	297,313 (0.4)	5920 (0.9)	1991.2	3,697 (0.9)	1243.5	3,004 (0.9)	1,010.4
Kentucky	1,381,066 (1.7)	24,617 (3.8)	1782.5	18,322 (4.4)	1326.7	14,029 (4.2)	1,015.8
Alabama	1,505,918 (1.9)	23,316 (3.6)	1528.3	16,455 (3.9)	1092.7	13,310 (4.0)	883.8
New Jersey	2,507,531 (3.1)	33,265 (5.1)	1326.6	22,255 (5.3)	887.5	18,648 (5.6)	743.7
Virginia	2,168,070 (2.7)	28,548 (4.4)	1316.7	20,588 (4.9)	949.6	16,377 (4.9)	755.4
Maryland	1,550,371 (1.9)	20,005 (3.1)	1290.3	12,641 (3.0)	815.4	10,007 (3.0)	645.5
Montana	338,834 (0.4)	4,002 (0.6)	1181.1	3052 (0.7)	900.7	2411 (0.7)	711.6
Mississippi	990,669 (1.2)	11,467 (1.8)	1157.5	7952 (1.9)	802.7	6663 (2.0)	672.6
Pennsylvania	3,610,758 (4.4)	40,647 (6.3)	1125.7	27,664 (6.6)	766.2	22,511 (6.7)	623.4
Original entitlement reason							
Aged ≥65 years	61,946,701 (76.2)	471,987 (72.6)	761.9	298,609 (71.5)	482.0	243,268 (72.5)	392.7
Disability	18,572,055 (22.8)	173,335 (26.6)	933.3	117,095 (28.0)	630.5	90,481 (27.0)	487.2
End stage renal disease	793,222 (1.0)	5125 (0.8)	646.1	2131 (0.5)	268.7	1629 (0.5)	205.4
Type of pneumoconiosis							
CWP		153,916	189.3	81,759	100.5	63,402	78.0
Asbestosis		423,209	520.5	307,141	377.7	247,581	304.5
Silicosis		36,566	45.0	21,824	26.8	16,802	20.7
Byssinosis+[g]		14,736	18.1	5317	6.5	3207	3.9

(Continues)

TABLE 2 (Continued)

Characteristics	Beneficiaries with continuous FFS coverage[a] N (%)	Pneumoconiosis prevalence					
		Broad case definition[b]		Intermediate case definition[c]		Narrow case definition[d]	
		N (%)[e]	Rate per 100,000	N (%)	Rate per 100,000	N (%)	Rate per 100,000
Other/unspecified pneumoconiosis		82,671	101.7	34,248	42.1	23,722	29.2
Total claims		N = 3,031,178 (%)		N = 2,754,682 (%)		N = 541,030 (%)	
Claim type							
Carrier		1,999,182 (66.0)		1,787,848 (64.9)		363,342 (67.2)	
Outpatient		590,793 (19.5)		525,631 (19.1)		75,306 (13.9)	
Inpatient		441,203 (14.6)		441,203 (16.0)		102,382 (18.9)	
ICD-CM diagnosis, any diagnosis position[h]							
CWP		552,207 (17.2)		475,620 (17.3)		91,390 (16.9)	
Asbestosis		2,122,435 (70.0)		1,985,721 (72.1)		392,406 (72.5)	
Silicosis		151,154 (5.0)		137,896 (5.0)		26,044 (4.8)	
Byssinosis+		27,428 (0.9)		18,583 (0.7)		3765 (0.7)	
Other/unspecified pneumoconiosis		192,753 (6.4)		151,127 (5.5)		29,437 (5.4)	
ICD-CM principal diagnosis							
CWP		135,633 (4.5)		111,421 (4.0)		21,065 (3.9)	
Asbestosis		622,080 (20.5)		574,627 (20.9)		120,830 (22.3)	
Silicosis		41,368 (1.4)		37,990 (1.4)		6717 (1.2)	
Byssinosis+		7247 (0.2)		4304 (0.2)		956 (0.2)	
Other/unspecified pneumoconiosis		67,070 (2.2)		48,876 (1.8)		10,111 (1.9)	

Note: Significant differences ($p < 0.05$) for demographic categories (age, sex, race, and original entitlement reason) were found within all three case definitions and between total FFS beneficiaries and all three case definitions.

Abbreviation: FFS, fee-for-service.

[a]FFS beneficiary characteristics were unavailable for their first year of Medicare enrollment for age group ($n = 11,823$), sex ($n = 20$), and state of residence ($n = 368,969$).

[b]The broad pneumoconiosis case definition identified any FFS beneficiary with a claim including an ICD-9-CM or ICD-10-CM pneumoconiosis code.

[c]The intermediate pneumoconiosis case definition identified any FFS beneficiary with at least one inpatient claim or ≥2 outpatient or carrier claims including an ICD-9-CM or ICD-10-CM pneumoconiosis code.

[d]The narrow pneumoconiosis case definition identified any FFS beneficiary with at least one inpatient claim or ≥2 outpatient or carrier claims including an ICD-9-CM or ICD-10-CM pneumoconiosis code and a code for a radiologic procedure of the chest within 30 days before or 30 days after any pneumoconiosis claim.

[e]Demographic information was determined from the year of a beneficiaries first broad, intermediate, or narrow pneumoconiosis claim and was available for the year of the first pneumoconoisis claim for 650,447 beneficiaries (broad case definition), 417,835 beneficiaries (intermediate case definition), and 335,378 beneficiaries (narrow case definition).

[f]Other/unknown includes Asian, other race, unknown.

[g]Byssinosis+ includes byssinosis, cannabinosis, and flax-dressers' disease.

[h]Claims can include an ICD-CM diagnosis code for more than one type of pneumoconiosis so total may be greater than 100%.

bronchitis with (acute) exacerbation ($n = 80,099$), and pneumonia, organism unspecified ($n = 65,676$) (data not shown).

Claims included a diagnosis code in any position for asbestosis (70.0%–72.5%), CWP (16.9%–17.3%), other/unspecified pneumoconiosis (5.4%–6.4%), silicosis (4.8%–5.0%), and byssinosis/cannabinosis/flax-dressers' disease (0.7%–0.9%). Claims for each type of pneumoconiosis were examined and CWP had the most inpatient hospital claims (18.8%) followed by asbestosis (14.3%),

silicosis (14.0), other/unspecified pneumoconiosis (7.3%), and byssinosis/cannabinosis/flax-dressers' disease (6.5%).

Results describing the demographic characteristics of beneficiaries meeting the broad case definition for each type of pneumoconiosis indicated the highest proportion of those 18–64 years of age were those with CWP (19.0%) and byssinosis/cannabinosis/flax-dressers' disease (19.0%). The highest proportion of females was among beneficiaries with byssinosis/cannabinosis/flax-dressers' disease (52.7%) and other/unspecified pneumoconiosis (35.4%). The highest proportion of White beneficiaries was among those with asbestosis (90.4%) followed by CWP (88.4%), other/unspecified pneumoconiosis (85.2%), byssinosis/cannabinosis/flax-dressers' disease (82.8%), and silicosis (80.6%). The highest proportion of Black beneficiaries was among those with silicosis (13.0%) and byssinosis/cannabinosis/flax-dressers' disease (10.6%). For each type of pneumoconiosis, the top three states of residence were Florida (7.4%), Texas (7.1%), and New Jersey (6.5%) for asbestosis; Kentucky (12.4%), West Virginia (11.6%), and Pennsylvania (9.1%) for CWP; New York (14.6%), Pennsylvania (6.9%), and Ohio (6.1%) for silicosis; California (9.35), Texas (9.2%), and Florida (6.5%) for byssinosis/cannabinosis/flax-dressers' disease; and West Virginia (8.6%), Pennsylvania (6.9%), and Texas (5.8%) for other/unspecified pneumoconiosis. The highest proportion of beneficiaries originally entitled to Medicare due to disability were among those with CWP (38.4%) and silicosis (34.4%) while 2.4% of beneficiaries with other/unspecified pneumoconiosis were originally entitled to Medicare due to end stage renal disease (data not shown).

The broad annual pneumoconiosis PR increased significantly during 2002–2009 with an APC of 10% (95% CI = 8%–12%) during 2002–2004 and 3% (95% CI = 3%–14%) during 2004–2009 (Supporting Information: Table SI; Figure 2A).

From 2009 to 2019, the broad PR decreased significantly with an APC of −3% (95% CI = −3% to −2%) from 2009 to 2015 and −5% (95% CI = −6% to −5%) from 2015 to 2019. The intermediate PRs followed a similar pattern of a significant increase during 2002–2009 with an APC of 8% (95% CI = 6%–9%) during 2002–2005 and 2% (95% CI = 1%–4%) during 2005–2009. From 2009 to 2019, the intermediate PR decreased significantly by −3% (95% CI = −3% to −2%) from 2009 to 2015 and −6% (95% CI = −7% to −5%) from 2015 to 2019. The narrow annual pneumoconiosis PR increased significantly from 2002 to 2006 by 8% (95% CI = 6%–9%) annually and decreased significantly from 2011 to 2019 by −3% (95% CI = −4% to −3%) annually. Annual PRs and IRs for the specific types of pneumoconiosis are presented in Supporting Information figures.

During 2002–2019 the incidence rate (IR) declined during the study period for all three case definitions (Supporting Information: Table SI; Figure 2B). The broad pneumoconiosis IR decreased significantly during 2002–2006 with an APC of −9% (95% CI = −11% to −7%) and −7% (95% CI = −8% to −7%) during 2009–2019. The intermediate IR decreased significantly during 2002–2006 by −10% (95% CI = −14% to −7%), −4% during 2006–2013 (95%CI = −6% to −2%,), and −11% during 2013–2019 (95% CI = −13% to −9%). The narrow IR decreased significantly during 2002–2009 by −8% (95% CI = −10% to −7%) annually and by −12% during 2012–2019 (95% CI = −13% to −10%).

4 | DISCUSSION

Administrative claims data are a promising resource for improving public health surveillance and have been underutilized at the national level for work-related chronic respiratory conditions. We analyzed a healthcare claims database of millions of US adults primarily ≥65 years of age to estimate the burden of pneumoconiosis using tiered case definitions. The three pneumoconiosis case definitions used in this study provided a range of prevalence and incidence estimates for pneumoconiosis overall and for specific types of pneumoconiosis. Findings from this study could help estimate the burden of pneumoconiosis among older adults in the US and identify priority conditions for interventions or enhanced surveillance while demonstrating the utility of these data for public health surveillance.

From 1999 to 2019, the prevalence and incidence for any pneumoconiosis among FFS Medicare beneficiaries declined largely due to the substantial changes in asbestosis prevalence and incidence. Over 70.0% of claims for any prevalent pneumoconiosis included an asbestosis ICD-CM code, and 423,209 beneficiaries met the broad asbestosis case definition (21-year cumulative prevalence 520.5 per 100,000) (Table 2; Supporting Information: Figure S1A). The broad asbestosis PR declined significantly during 2012–2019, and the broad asbestosis IR decreased significantly during 2002–2019 (Supporting Information: Figure S1B). The decline in asbestosis observed in this study was consistent with US declines in production and use of asbestos material since the 1970s.[27] In addition, occupational exposures to asbestos have changed as chronic exposures are less common among textile mill, friction production manufacturing, cement pipe fabrication, and insulation manufacture and installation workers. The current nature of asbestos exposure among general industry workers, miners, and workers performing building maintenance or remediation activities includes short-term, intermittent exposures and proportionally less exposure to long fibers compared to in the past.[28]

The decline in any pneumoconiosis may reflect changes in work practices stemming from regulatory and safety measures helping reduce exposure and ultimately disease.[4,14,29] However, the decline in incidence among a population primarily ≥65 years of age will not adequately reflect the impact of new occupational processes and exposures involving nanoparticles, nanomaterials, and artificial stone associated with pneumoconiosis among workers <65 years of age.[4,12,29]

CWP was reported on 16.9%–17.3% of all prevalent pneumoconiosis claims, but there were wide variations by state. There were 153,916 beneficiaries that met the broad CWP case definition, of whom 17,255 were from West Virginia (data not shown). These CWP cases represent over half (58.6%) of all beneficiaries from West Virginia meeting the broad case definition for any pneumoconiosis

(A)

(B)
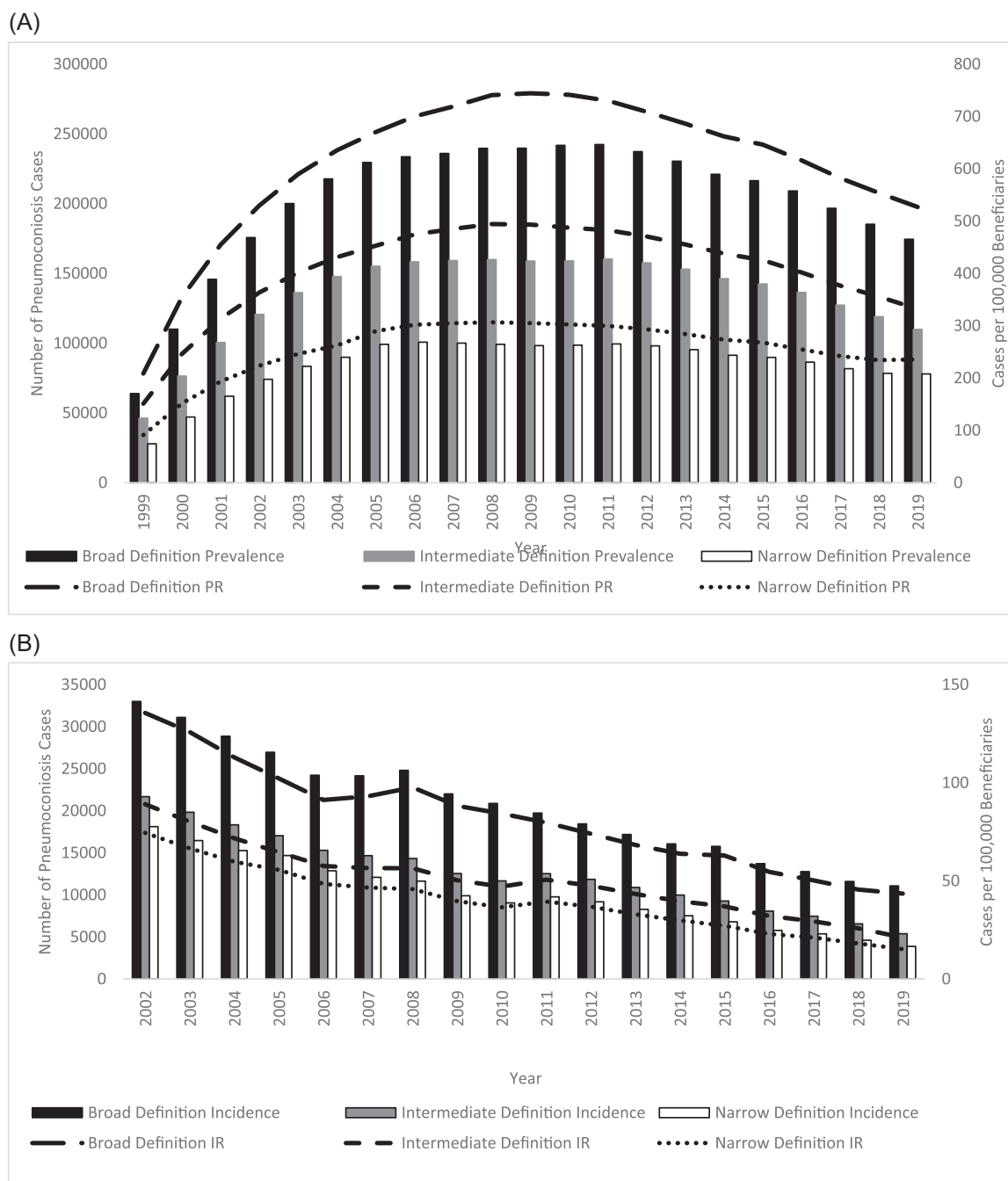
FIGURE 2 (A) Annual number and prevalence rate of prevalent pneumoconiosis cases among fee-for-service Medicare beneficiaries, by case definition, 1999–2019. (B) Annual number and incidence rate of incident pneumoconiosis cases among fee-for-service Medicare beneficiaries, by case definition, 2002–2019. Incident cases had at least 3 years of continuous Medicare enrollment without a pneumoconiosis diagnosis code before the incident year.

and reflect the substantial legacy of coal mining in the state. Potential indicators of severe disease were evident for CWP including the highest proportions of inpatient hospital claims and of beneficiaries originally entitled to Medicare due to disability. The broad CWP prevalence increased significantly during 1999–2009 and decreased significantly during 2009–2019 (Supporting Information: Figure S2A), which differs from the increase in CWP prevalence (2000–2017) among long-tenured coal miners based on chest X-rays from national

surveillance reported by Blackley et al.[10,30] Results from the current Medicare study primarily include those ≥65 years of age, and individuals <65 years of age with CWP are only included if they were originally entitled to Medicare due to disability (38% of beneficiaries meeting the broad, 48% meeting the intermediate, and 46% meeting the narrow CWP case definition) which may underestimate CWP.

In 2016, the prevalence and incidence of byssinosis/cannabinosis/flax-dressers' disease increased (Supporting Information: Figures S4A,B)

likely reflecting changes in coding practices, that is, switching from ICD-9-CM to ICD-10-CM codes with greater levels of detail at the end of 2015. For example, of the 27,428 broad byssinosis/cannabinosis/flax-dressers' disease claims (Table 2), 54% included the ICD-9-CM code 504 (pneumonopathy due to inhalation of other dusts) and 31.1% included the ICD-10-CM code J66.8 (airway disease due to other specific organic dusts) that was only applied since October 2015.

This study has limitations. Annual pneumoconiosis case identification is likely incomplete in the earlier study years and may underestimate prevalence and incidence. Prevalent cases before 1999 were not counted until they sought medical care for pneumoconiosis starting in 1999. Therefore, the increase in annual prevalence at the beginning of the study may be due, in part, to the study methodology supporting more complete case ascertainment in later study years. Incident cases were calculated after a 3-year continuous enrollment period, a requirement that may underestimate incidence if a true incident claim did in fact occur during this first 3 years of continuous enrollment. Beneficiaries with disease onset before 2002 might have erroneously been counted as incident cases early in the study which might artificially inflate incidence at the start of the study period.

Another study limitation is related to the use of claims-based pneumoconiosis case definitions, which are not validated by medical records and could be misdiagnosed as, for example, idiopathic pulmonary fibrosis. Furthermore, the purpose of this study was to capture pneumoconiosis outcomes, and we did not study other diseases caused by inhalation of dusts or asbestos fibers (e.g., pleural disease, mesothelioma). With rare exceptions, pneumoconiosis is attributable to workplace exposures, but structured patient work history information which could aide in pneumoconiosis diagnosis is not routinely collected and recorded in the healthcare setting. Without patient work information, clinicians may be less likely to diagnose pneumoconiosis in favor of more common conditions that present similarly. Since Medicare claims are for billing purposes, diagnosis and procedure codes used to define pneumoconiosis may be incomplete. Specifically, the number of beneficiaries meeting the narrow case definition is likely underestimated because HCPCS codes are not required on Medicare claims.[31] Diagnostic HCPCS codes included in the narrow case definition were based on common diagnostic procedures for pneumoconiosis and may not be inclusive of all pneumoconiosis diagnostic procedures, do not include results of procedures (i.e., chest X-rays, CT scan), and may have been conducted as part of management or diagnosis of other respiratory diseases. Medicare rules limit payment of chest X-rays to situations when they are "reasonable and necessary for the diagnosis or treatment of illness or injury or to improve the functioning of a malformed body member."[32]

Results may not be representative of the entire Medicare population since beneficiaries ever enrolled in a managed care plan (Medicare Part C) during 1999–2019 were excluded due to the proprietary nature of Part C claims. Of the eligible Medicare population, Part C enrollment was 19% in 2007 and Part C enrollment steadily increased to 39% in 2019.[33] Part C enrollment

was associated with higher use of preventive care visits, fewer hospital admissions, fewer emergency department visits, shorter hospital and skilled nursing facility lengths-of-stay, and lower healthcare spending compared to FFS Medicare beneficiaries.[34] This analysis included only Medicare beneficiaries with continuous FFS Medicare coverage and may not represent the entire Medicare FFS population, including those with intermittent FFS Medicare coverage. Results are not representative of the entire United States population as Medicare data primarily include claims for persons aged ≥65 years and do not include data on those <65 years unless they are receiving disability insurance benefits or have end stage renal disease.

5 | CONCLUSIONS

The prevalence of pneumoconiosis, a preventable occupational lung disease, declined among Medicare beneficiaries from 2010 to 2019 while the incidence rate of pneumoconiosis declined from 2002 to 2019. Much of this decline in overall pneumoconiosis is attributed to decreases in asbestosis prevalence and incidence. Medicare claims data represent a useful population-level resource for pneumoconiosis morbidity surveillance. Medicare data analyses help describe the burden and periodic changes in pneumoconiosis (specifically among those aged 65 years and older), a need recognized by the National Academy of Sciences in 2018, while also identifying variations in health outcomes that may warrant further study of emerging risks related to exposure and airway disease.[9]

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST STATEMENT
The authors declare that there are no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD
John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

DATA AVAILABILITY STATEMENT

CMS data are available on approved request through the Research Data Assistance Center https://resdac.org/research-identifiable-files-rif-requests.

ETHICS APPROVAL AND INFORMED CONSENT

The NIOSH Human Subjects Review Board determined no additional human subjects review was required for this research study. Centers for Medicare and Medicare data are available: https://www.resdac.org/.

DISCLAIMER

The findings and conclusions of this report are those of the authors and do not necessarily represent the view of the National Institute for Occupational Safety and Health. Mention of a specific product or company does not constitute an endorsement by the Centers for Disease Control and Prevention.

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REFERENCES

1. Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health (NIOSH). Workplace Safety and Health Topics: Pneumoconioses. 2023. Accessed April, 2023. https://www.cdc.gov/niosh/topics/pneumoconioses/
2. Castranova V, Vallyathan V, Castranova V, Vallyathan V. Silicosis and coal workers' pneumoconiosis. *Environ Health Perspect*. 2000;108(4):675-684.
3. Hall NB, Blackley DJ, Halldin CN, Laney AS. Current review of pneumoconiosis among US coal miners. *Curr Environ Health Rep*. 2019;6(3):137-147.
4. León-Jiménez A, Hidalgo-Molina A, Conde-Sánchez MÁ. et al. Artificial stone silicosis. *Chest*. 2020;158(3):1060-1068.
5. Rayens NT, Rayens EA, Tighe RM. Co-occurrence of pneumoconiosis with COPD, pneumonia and lung cancer. *Occup Med*. 2022;72(8):527-533.
6. Yen CM, Lin CL, Lin MC, Chen HY, Lu NH, Kao CH. Pneumoconiosis increases the risk of congestive heart failure: a nationwide population-based cohort study. *Medicine*. 2016;95(25):e3972.
7. GBD. Disease and injury incidence and prevalence collaborators. Burden of global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2017;2018(392):1789-1858.
8. Xie M, Liu X, Cao X, Guo M, Li X. Trends in prevalence and incidence of chronic respiratory diseases from 1990 to 2017. *Respir Res*. 2020;21(1):49.
9. National Academies of Sciences, Engineering, and Medicine. *A Smarter National Surveillance System for Occupational Safety And Health in the 21st Century*. The National Academies Press; 2018.
10. Blackley DJ, Halldin CN, Laney AS. Continued increase in prevalence of coal workers' pneumoconiosis in the United States, 1970-2017. *Am J Public Health*. 2018;108(9):1220-1222.
11. Laney AS, Attfield MD. Examination of potential sources of bias in the US Coal Workers' Health Surveillance Program. *Am J Public Health*. 2014;104(1):165-170.
12. Rose C, Heinzerling A, Patel K, et al. Severe silicosis in engineered stone fabrication workers-California, Colorado, Texas, and Washington, 2017-2019. *MMWR Morb Mortal Wkly Rep*. 2019;68(38):813-818.

13. Casey ML, Mazurek JM. Silicosis prevalence and incidence among Medicare beneficiaries. *Am J Ind Med*. 2019;62(3):183-191.
14. Bell JL, Mazurek JM. Trends in pneumoconiosis deaths—United States, 1999-2018. *MMWR Morb Mortal Wkly Rep*. 2020;69(23):693-698. doi:10.15585/mmwr.mm6923a1
15. Goodwin SS, Stanbury M, Wang ML, Silbergeld E, Parker JE. Previously undetected silicosis in New Jersey decedents. *Am J Ind Med*. 2003;44:304-311.
16. Reilly MJ, Timmer SJ, Rosenman KD. The burden of silicosis in Michigan: 1988-2016. *Ann Am Thorac Soc*. 2018;15(12):1404-1410.
17. Chronic Conditions Data Warehouse. CCW technical guidance: getting started with CMS Medicare administrative research files Version 2.8. 2022. Accessed April 2023. https://www.ccwdata.org/web/guest/technical-guidance-documentation
18. Research Data Assistance Center. Find, request, and use CMS data. 2022. Accessed April 2023. https://www.resdac.org/
19. Research Data Assistance Center. Master beneficiary summary file (MBSF) base, 2022. Accessed April 2023. https://www.resdac.org/cms-data/files/mbsf-base
20. Research Data Assistance Center. Medicare fee-for-service data file search. 2022. Accessed April 2023. https://www.resdac.org/cms-data?tid%5B%5D=4931&tid_1%5B%5D=1&=Find+Data+Files
21. Siedelman L. Diagnosis and procedure coding resources. 2017. Accessed March 2023. https://www.resdac.org/articles/diagnosis-and-procedure-coding-resources
22. Chronic Conditions Data Warehouse. Condition categories. 2023. Accessed April 2023. https://www2.ccwdata.org/web/guest/condition-categories
23. Kurth L, Mazurek JM, Blackley DJ. Malignant mesothelioma among US Medicare beneficiaries: incidence, prevalence and therapy, 2016–2019. *Occup Environ Med*. 2023;80:86-92.
24. Raghu G, Chen SY, Hou Q, Yeh WS, Collard HR. Incidence and prevalence of idiopathic pulmonary fibrosis in US adults 18-64 years old. *Eur Respir J*. 2016;48(1):179-186.
25. Mazurek JM, Wood JM, Schleiff PL, Weissman DN. Surveillance for silicosis deaths among persons aged 15-44 years—United States, 1999-2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(28):747-752.
26. US Department of Health and Human Services, National Institutes of Health. National Cancer Institute. Division of Cancer Control and Population Sciences. Statistical Methodology and Applications Branch, Joinpoint Regression Program, Version 4.9.1.0.
27. Sun H. North-South gradient of mesothelioma and asbestos consumption-production in the United States-progresses since the 1st asbestos partial ban in 1973. *Am J Ind Med*. 2019;62:337-346.
28. The National Institute for Occupational Safety and Health. Current intelligence bulletin 62: asbestos fibers and other elongate mineral particles: state of the science and roadmap for research. 2010. Accessed June 2023. https://www.cdc.gov/niosh/docket/archive/docket099C.html
29. Qi XM, Luo Y, Song MY, et al. Pneumoconiosis: current status and future prospects. *Chin Med J*. 2021;134(8):898-907.
30. Kurth L, Casey M. Pneumoconiosis ICD-CM diagnosis codes on Medicare claims for Federal Black Lung Program beneficiaries. *Ann Am Thorac Soc*. 2020;17(7):904-906.
31. Mues K, Liede A, Liu J, et al. Use of the Medicare database in epidemiologic and health services research: a valuable source of real-world evidence on the older and disabled populations in the US. *Clin Epidemiol*. 2017;9:267-277.
32. U.S. Centers for Medicare & Medicaid Services. Chest X-ray policy. 2023. Accessed April 2023. https://www.cms.gov/medicare-coverage-database/view/lcd.aspx?LCDId=37547&ContrId=364
33. Freed M, Fuglesten Biniek J, Damico A, Neuman T. Medicare advantage in 2022: enrollment update and key trends. Accessed March 2023. https://www.kff.org/medicare/issue-brief/medicare-advantage-in-2022-enrollment-update-and-key-trends/

34. Agarwal R, Connolly J, Gupta S, Navathe AS. Comparing Medicare advantage and traditional Medicare: a systematic review. *Health Aff.* 2021;40(6):937-944.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.