Washington State's occupational respiratory disease surveillance system, 2017 – 2022: Surveillance methods and evaluation

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Key Findings

This occupational respiratory disease surveillance system conducts surveillance for work-related asthma, asbestos-related disease (ARD), silicosis, and Valley fever using the Washington State workers' compensation system as our primary data source. Within 2017 to 2022, we captured 604 valid cases for the respiratory diseases of interest. Of these, at least 44 cases resulted in in-patient hospitalizations and 30 resulted in fatalities. The median claim cost paid-to-date for all respiratory diseases was $685.

We identified 549 valid cases of work-related asthma within the reporting period, 83% of which were for work-aggravated asthma. The COVID-19 pandemic resulted in a four-fold increase in asthma case-capture (755 cases in 2017-2019 compared to 3,045 cases in 2020-2022), while the number of valid cases declined by 16% (299 valid cases in 2017-2019 compared to 250 valid cases in 2020-2022). Due to changes in changes in the coding practices of healthcare providers, ICD-10-CM codes for asthma brought in a large percentage of false-positives during the pandemic and case-capture methods had to be adjusted. Another effect of the pandemic was a change in the exposures associated with work-related asthma: in the period 2017-2019 the most common exposures were smoke, mold, and dust, while in the period from 2020-2022, COVID-19 became the most common source.

We identified 51 valid cases of asbestos-related disease within the reporting period, predominantly among construction occupations, and over half were fatal. Approximately 40% of potential cases were exposed to asbestos but did not manifest in clinical disease (N=110). These cases will be monitored for any future progression into disease.

Four valid silicosis cases occurred within the reporting period. All occurred in production occupations; workers were engaged in engineered stone cutting (N=2), open pit mining (N=1), or sandblasting (N=1). There were 46 additional cases that had a confirmed exposure to silica, but are not valid for silicosis disease at time of reporting.

A single valid case of Valley Fever occurred during the reporting period, among a laboratory scientist testing soil samples out of state. Thirteen additional cases of *Coccidioides* fungus exposure were reported but did not result in Valley fever; all were filed by healthcare or research laboratory workers.

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Introduction

Occupational respiratory diseases are preventable. The purpose of Washington's occupational respiratory disease surveillance system is to identify disease trends that when addressed with prevention activities, may lead to a reduction in respiratory disease burden. The overall objective is to describe the incidence of occupational respiratory diseases, identify high-risk industries and exposures, and identify areas that would benefit from prevention resources.

Surveillance for work-related asthma (WRA) began in Washington in 2001. In 2016, surveillance efforts were expanded to include the respiratory conditions of asbestos-related disease (ARD), silicosis, Valley fever, and chronic obstructive pulmonary disease (COPD). An initial evaluation of the expanded surveillance program and results for the years 2016 and 2017 was published in 2019[1]. Since 2019, we have made minor changes to the surveillance program's methods. Our surveillance of COPD cases (2010-2020) is described in a separate report, as the surveillance methods for this condition were expanded in 2023 and require more extensive evaluation. This work was done in collaboration with pulmonologists Dr. Bonnie Ronish and Dr. Coralynn Sack as part of a master's thesis (Ronish 2022).[2]

Valley fever is a fungal disease that affects the lungs as well as other body systems. Occupational exposure to soil dust containing *Coccidioides* fungal spores is risk factor for outdoor workers who may inhale the dust. Industries and jobs known to be at high risk in Washington include construction, agriculture, landscaping, truck drivers, wildland firefighters, and heavy machine operators. Valley fever is included in our respiratory surveillance system when the *Coccidioides* fungus was identified as endemic to eastern Washington, making Valley fever an emerging disease. Early detection of exposure and disease may significantly improve clinical outcomes for exposed work groups.

In this report, we will describe the data sources, updated case capture methods, case definitions, disease classification categories, and results for the years 2017 to 2022. We evaluated the performance of case capture criteria for the respiratory conditions before and during the COVID-19 pandemic, which greatly affected workers compensation claim filing and medical treatment.

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[1] "Washington State's occupational respiratory disease surveillance system, 2016 – 2017: Surveillance methods and a preliminary evaluation". 2019. https://www.lni.wa.gov/safety-health/safety-research/files/2019/64-14-2019_AsthmaTechReport_2016-17v2.pdf

[2] Dr. Bonnie Ronish. "A Proposed Algorithm for the Identification of Occupational COPD in a Cohort of Washington Workers". University of Washington Department of Environmental and Occupational Health Sciences. 2022.

Data Sources

Washington State workers' compensation claims are the primary data source. In Washington State, nonfederal employers are required to obtain workers' compensation insurance through the Department of Labor and Industries (L&I), unless they meet specific requirements to self-insure or are covered under an alternative workers' compensation program. L&I's State Fund (SF) insurance program provides coverage for approximately 1.9 million (about two-thirds) of the workers in the state and 99.7% of all employers. Data from both the SF and self-insurance programs are entered into a centralized data warehouse at L&I which contains both medical diagnoses and administrative codes.

As of July 2000, work-related asthma is a reportable condition for health care providers and health care facilities in Washington State[3]. Less than 1% of all valid asthma cases are reported into our surveillance system through physician reports. In 2023, silicosis was added to the list of reportable occupational respiratory conditions. The effect on case reporting has yet to be seen. Physicians submit report of work-related asthma or silicosis directly to the SHARP Program using forms posted to the SHARP website[4].

Surveillance Procedures

Case Capture

L&I's workers' compensation data warehouse is queried on a monthly basis to capture potential respiratory disease cases. Potential cases are captured using three types of data: a) a text search for keyword terms on the Report of Industrial Injury or Occupational Disease (ROIID) form; b) International Statistical Classification of Disease (ICD-10-CM) codes with clinical modification; and c) Occupational Injury and Illness Classification System (OIICS) codes (Table 1). The ROIID form initiates the claim and among other things describes the initial treatment reason and the initial work-related diagnosis. It is completed by the injured worker, their physician, and their employer. Diagnosis codes (ICD-10-CM) are assigned by health care providers and are pulled from the claim adjudication process, and from medical and hospital bills. Injury and illness (OIICS) codes classify and standardize the information on the ROIID form and are assigned by insurance staff. For additional detail on the case-capture criteria, see the Appendix.

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[3] WAC 246-101. https://apps.leg.wa.gov/wac/default.aspx?cite=246-101
[4] https://lni.wa.gov/safety-health/safety-research/ongoing-projects/occupational-respiratory-disease#notifiable-condition-reporting

Table 1. Case Capture criteria for five diseases under surveillance

Condition	Keywords[1]	OIICS Codes[2]	ICD-10-CM Codes[3]
Work-related asthma	asthma	Event: 340, 341, 1443	J45*, J46*
Asbestos-related Disease[4]	asbestos mesothelioma pleural plaques	Event: 340, 341, 1452 Source: 551	C38.4, C45*, C78*, D02*, J61, J91-92*
Silicosis	silica silicosis	Event: 340, 341 Nature: 1453 Source: 557	J62*
Valley fever	cocci Valley fever	Event: 340, 341 Nature: 244	B38*

[1] Includes misspellings and other variations on these terms
[2] Occupational Injury and Illness Classification System, v1.01
[3] International Classification of Diseases, Tenth Revision
[4] An asbestos-claim flag from the insurance system is used in addition to keywords, OIICS and ICD-10-CM codes
* Select sub-codes within the umbrella code are excluded. See Appendix for greater detail.

Case Validation

Potential cases are uploaded into SHARP's respiratory disease database where they are reviewed, validated, and classified for disease and exposure. For all disease conditions, potential cases are excluded if the injury is not predominant for an inhalation or respiratory illness. Examples of excluded cases are those where keyword capture criteria inadvertently brought in asbestos-abatement workers with traumatic injuries, and 'asthma' injuries that are predominant for dermatitis or COVID-19. The process of validating cases as valid, not valid, undetermined, or duplicate is referred to as dispositioning. Missing values for occupation and industry for valid cases are manually coded using the claim documentation, whenever possible.

Case Definitions and Classifications

The case definitions for work-related asthma, asbestos-related disease, silicosis, and Valley fever (*Coccidioidomycosis*) are summarized in Table 2. In addition to the case definitions, there are disease classifications for work-related asthma and asbestos-related disease (Table 2). For all potential cases, we use medical and administrative records from the workers' compensation system to determine if the case definition is met and the appropriate disease classification. Case review can take 30 minutes to several hours per case. Those diagnosed with work-related asthma may be interviewed over the telephone. Potential cases of asbestos-related disease and silicosis have their exposure classified (Table 2), so that we can count workers who have verified exposure but who may or may not have clinical manifestation of disease. Counting workers with exposure but no disease helps to understand the risk for disease manifestation. For Valley fever, we determine whether the exposure occurred within Washington State. Workers exposed while out-of-state are still covered by the workers' compensation system.

Table 2. Case definition, disease classification, and exposure classification for occupational respiratory diseases[1]

Case Definition	Disease Classification	Exposure Classification
Work-related asthma		
Surveillance follows the National Institute for Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational Risks (SENSOR) program and NIOSH's work-related asthma case definition and case classification decision logic [2]. Cases are classified at 6 months of claim maturity.		
Healthcare professional's diagnosis consistent with asthma AND Association between symptoms of asthma and work	-Work-aggravated asthma (WAA) - New-onset asthma (NOA)[3] - Occupational asthma (OA) - Reactive airways dysfunction syndrome (RADS)	-No classifications
Asbestos-related disease (ARD)		
Case definition developed by the SHARP program. Cases are classified at 12 months of claim maturity.		
History of occupational exposure to airborne asbestos AND Physician diagnosis of asbestos-related disease with reference to HRCT or chest X-ray OR Physician diagnosis of mesothelioma with reference to diagnostic testing; or death certificate with mesothelioma as primary cause of death.	-Asbestos-related disease (includes asbestosis and pleural plaque) -Mesothelioma	-Exposure positive[4] -Exposure negative[5] -Exposure undetermined
Silicosis		
The case definition follows NIOSH's silicosis surveillance case definition [6]. Cases are classified at 12 months of claim maturity.		
History of occupational exposure to airborne silica dust AND Chest radiograph or other imaging technique interpreted as consistent with silicosis OR Pathologic findings characteristic of silicosis	-No classifications	-Exposure positive[7] -Exposure undetermined

Case Definition	Disease Classification	Exposure Classification
Valley fever (Coccidioidomycosis) The case definition for work-related Valley fever is an adaptation from the Washington State Department of Health's case definition for Valley fever.[8] Cases are classified at 12 months claim maturity.		
History of occupational exposure to soil or other medium with suspected or confirmed contamination with *Coccidioides* fungus AND Clinical diagnosis of Valley fever with valid clinical symptoms AND Reference in the medical record to positive serologic test for coccidioidal antibodies in serum, cerebrospinal fluid, or other fluid OR Laboratory test for positive serologic test for coccidioidal antibodies in serum, cerebrospinal fluid, or other fluid	-No classifications	-Acquisition in WA State -Acquisition outside WA State[9] -Unknown acquisition location

[1] Work-related asthma adopted 2001, asbestos-related disease, silicosis, Valley fever adopted January 2017.

[2] Asthma surveillance: https://www.cdc.gov/niosh/topics/surveillance/ords/statesurveillance/reportingguidelines-wra.html#guidelines

[3] New onset asthma includes the classifications of occupational asthma with latency, and RADS which is occupational asthma without latency

[4] Confirmed by positive building material test or work in/near an asbestos abatement area

[5] Confirmed by a negative building material test

[6] Silicosis: https://www.cdc.gov/niosh/topics/surveillance/ords/statesurveillance/reportingguidelines-silicosis.html

[7] Confirmed by documentation for exposure to silica or silica-containing products. There is no classification for negative silica exposure because building materials are not typically tested for silica.

[8] Valley fever: https://www.doh.wa.gov/ForPublicHealthandHealthcareProviders/NotifiableConditions/Coccidioidomycosis

[9] Washington residents who acquire Valley fever during work-related travel outside of WA.

Results

During the five-year period 2017 – 2022, a total of 4,127 potential cases were captured for all conditions (Table 3). Overall, 68% of potential cases were excluded because they were predominant for injuries other than inhalation or respiratory illness. Traumatic injuries make up the majority (67%) of excluded cases. See the Appendix for details on the accuracy of the case-capture criteria. Of the remaining cases, 604 met the case definition for one or more condition (Table 3).

Table 3. Surveillance summary of occupational respiratory diseases in WA, 2017-2022

Disease	# Captured	# Excluded[1]	# Dispositioned	# Valid Cases (% Dispositioned)	# Exposure only[2]
Asthma	3,800	2,755	1,045	549 (53%)	N/A
Asbestos-related	255	32	212	51 (24%)	110
Silicosis	80	19	58	4 (7%)	46
Valley fever	17	4	13	1 (8%)	N/A
Total	**4,127[3]**	**2,807**	**1,307**	**604[4] (46%)**	**156**

[1] Excluded because potential case was not predominant for an inhalation or respiratory illness
[2] Confirmed exposure to asbestos or silica without sufficient evidence of disease.
[3] Twenty-five claims were captured as a potential case for more than one condition.
[4] One claim was valid for both asthma and asbestos-related disease.

From 2020 to 2021, we observed a rapid increase in the number of captured potential cases while the number of resulting valid cases declined (Figure 1). By 2022, less than 5% of captured cases were valid for disease. This trend was driven by the asthma case-capture; all other diseases had stable case-capture rates.

Figure 1. Annual counts of captured cases and subsequently valid respiratory disease cases
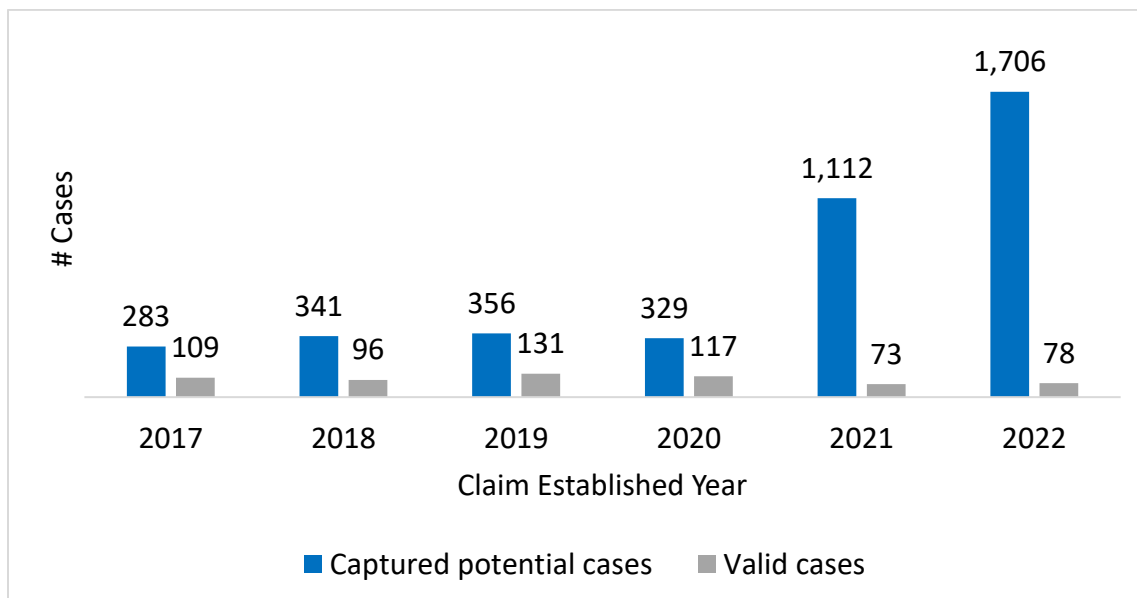
Among all valid cases (N=604), there were 44 known in-patient hospitalizations and 30 fatalities attributable wholly or in comorbidity with the respiratory condition, confirmed through review of the medical and/or pension records (Table 4). We expect hospitalizations and possibly fatalities to be an undercount due to incomplete medical records, especially among self-insured claims. Two additional cases were deceased from work-related causes determined unrelated to the respiratory conditions in our surveillance system. In-patient hospitalization occurred in 29% of valid asbestos-related disease cases, 25% of valid silicosis cases, and 5% of valid asthma cases. Over half of valid asbestos-related cases (56%) were fatal.

Table 4. Hospitalizations and fatalities attributed to respiratory disease among valid cases

Disease	# Valid Cases	In-patient Hospitalizations	Fatalities
Asbestos-related	549	15	29
Asthma	51	28	1[1]
Silicosis	4	1	0
Total	603	44	30

[1] Fatality is attributed to severe COPD/asthma overlap syndrome following 39 years of exposure to metal fumes and dust in a welder.

The demographics of cases valid for any of the respiratory conditions were 47% male with a median age of 48 years at time of injury (Table 5). The median claim cost paid-to-date was $685. Among the 16% of cases that had one or more days of paid time loss, the median number of paid days was 36. Median age at time of injury was highest for asbestos-related disease, though the long latency of this condition may result in inaccurate injury date estimates. Silicosis had the highest median claim cost and the highest median days of paid time loss. Workers can have concurrent work-related injuries and comorbidities (not described here) in addition to their respiratory disease and these comorbidities can contribute to the claim cost and time loss reported here. More than a quarter of valid cases came from workers residing in King County, which contains the city of Seattle (Table 6).

Table 5. Demographics of valid cases for respiratory disease

| Disease	# Valid Cases	% Male	Median Age (Years)	Median Claim Cost	% Claims with Paid Time Loss	Median Days of Paid Time Loss
Asthma	549	42%	45	$682	17%	32
Asbestos-related	51	100%	78	$685	6%	137
Silicosis	4	100%	53	$115,264	50%	778
Valley fever	1	0%	48	$2,020	0%	N/A
Total	604	47%	48	$685	16%	35

Table 6. Geographic distribution of valid cases

County of Residence, by Labor & Industries Administrative Region	# Valid Cases
Region 1 (Island, San Juan, Skagit, Snohomish, Whatcom)	74
Region 2 (King)	153
Region 3 (Clallam, Jefferson, Kitsap, Pierce)	76
Region 4 (Clark, Cowlitz, Grays Harbor, Lewis, Mason, Pacific, Thurston)	66
Region 5 (Adams, Benton, Chelan, Douglas, Franklin, Grant, Kittitas, Okanogan, Walla Walla, Yakima)	97
Region 6 (Ferry, Garfield, Lincoln, Spokane, Stevens, Whitman)	51
Region 998 (Out-Of-State)	14
Region 999 (Unknown Or Not Specified)	73

Work-related asthma

Overall, we observed a decline in the number of valid asthma cases per year from 2017 to 2022. (Figure 2). Within the reporting period, 73% (N = 2,755) of captured cases were found to be for non-respiratory conditions and were dismissed. This false capture rate rose from 31% in the pre-pandemic period (2017-2019) to 83% during the COVID-19 pandemic (2020-2022). The cause of this rapid rise in false-positives were cases being captured as asthma through ICD-10-CM codes; often the code was used once in a single medical visit (Appendix Table 9). In 2020-2022, these cases made up 83% of all captured asthma cases but were found to be valid only 1% of the time. It appears that during the pandemic, providers were increasingly adding asthma ICD-10-CM to medical bills for non-respiratory conditions. The high false-positive rate during this period necessitated changes to the case-capture methods.

Figure 2. Valid work-related asthma cases per claim established year (N = 549)
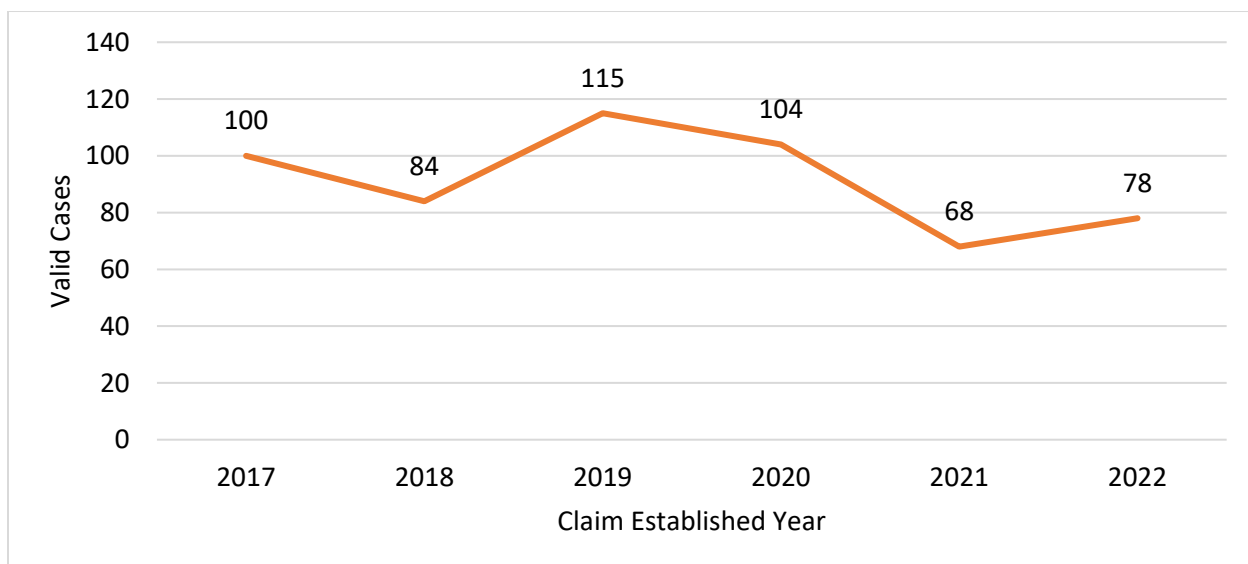
Of the 549 valid work-related asthma cases, most were classified as work-aggravated asthma (83%), followed by occupational asthma (11%) and RADS (3%) and 4% had insufficient information to classify the type of asthma (Table 7, Figure 3). Among occupational asthma cases, 35% had objective medical evidence, such as lung function tests. One asthma case for an industrial welder was fatal with the certificate of death listing COPD as the cause and diagnoses in the medical records consistently stating 'severe COPD/asthma overlap syndrome'; the asthma disease classification for this case is undetermined.

Table 7. Disease classifications for valid asthma cases

Disease Classification	# Valid Cases
Work-aggravated asthma	455
Occupational asthma	60
With objective evidence	*21*
No objective evidence	*39*
Reactive Airways Dysfunction Syndrome (RADS)	14
Insufficient information to classify	20
Total	549

Figure 3. Proportion of valid asthma cases by disease classification
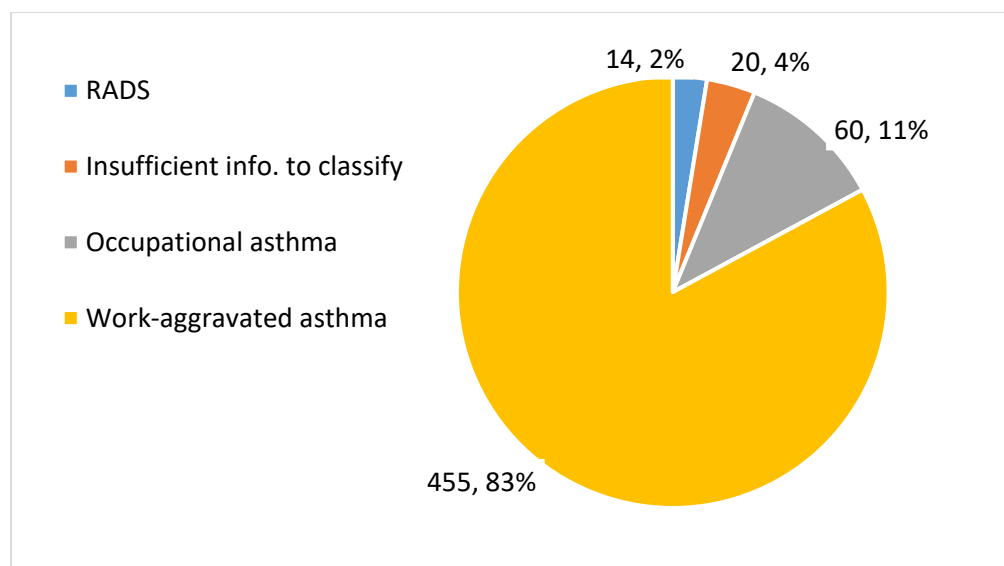
The exposures associated with the development or exacerbation of work-related asthma was coded using the Association of Occupational Environmental Clinics (AOEC) system for all valid asthma cases. Each case can be assigned up to five exposures. Before the COVID-19 pandemic (2017-2019), the most common exposures were smoke (N=31), mold (N=29), dust (N=23), and indoor air pollutants from building renovation (N=15). During the COVID-19 pandemic (2020 to 2022), the most common exposures were COVID-19 (N=64), smoke (N=22), cleaning materials (N=13), and wildfire smoke (N=13). The percentage of asthma cases associated with cleaning chemicals increased during the pandemic.

Exposures associated with occupational asthma (OA) or RADS are a good target for prevention efforts. From 2017 to 2022, the most common exposures among valid cases of OA and RADS combined were smoke (N=6), dust (N=5), Western Red Cedar (N=5), cleaning materials (N=4), chemicals (N=4), and cannabis dust (N=3, includes marijuana and hemp).

There were 64 cases for exposure to COVID-19, and of these 64 were work-aggravated asthma and one was occupational or new-onset asthma. As expected, most workers with COVID-19 related asthma (78%) worked in healthcare occupations.

More broadly, the occupations with the greatest number of valid asthma cases were healthcare (N=89, includes practitioners, technicians, and support staff); production (N=67); office and administrative support (N=61); transportation and material moving (N=54); and installation, maintenance, and repair (N=34). By industry sector, the greatest number of asthma cases were in 'Health Care and Social Assistance' (N=136), Manufacturing (N=62), Retail (N=52), and Public Administration (N=39).

Asbestos-related disease

There were 255 captured asbestos-related disease (ARD) cases, 13% of which were dismissed as non-respiratory. Out of the remaining 212 cases, 51 were dispositioned as valid (20% of captured, 24% of dispositioned). Among valid cases, 26 had mesothelioma (24 fatal), 22 had confirmed asbestosis (4 fatal), and 3 had other lung cancers with confirmed asbestos exposure (1 fatal). There were 110 cases that had confirmed exposure to asbestos but no disease (43% of all captured ARD cases).

By occupation, the group with the greatest number of valid cases and exposures without disease was "Construction and Extraction" (SOC 47*, N = 24, Table 8). All workers within this category worked in construction occupations, including one valid case in the subgroup "Hazardous Materials Removal Workers" (SOC 47-4040).

Table 8. Occupations exposed to asbestos, with or without asbestos-related disease

Occupational Group (2-digit SOC)	# Valid for Disease	# Exposed without Disease
Construction and Extraction (47*)	24	49
Production (51*)	7	7
Non-classifiable (99*)	6	30
Installation, Maintenance, and Repair (49*)	5	11
Transportation and Material Moving (53*)	4	0
Management (11*)	2	2
Protective Service (33*)	1	4
Computer and Mathematical (15*)	1	0
Architecture and Engineering (17*)	1	0
Building and Grounds Cleaning and Maintenance (37*)	0	5
Business and Financial Operations (13*)	0	1
Food Preparation and Serving Related (35*)	0	1
Total	51	110

By industry, the NAICS sectors with the greatest number of valid asbestos-related disease cases were Manufacturing (N=18), 'Administrative and Support and Waste Management and Remediation Services' (N=10), and Construction (N=6). The specific industries that include asbestos-removal contractors (562910 – Remediation Services; 562211 - Hazardous Waste Treatment and Disposal) had ten total cases.

Silicosis

There were 80 potential silicosis cases captured, 24% of which were dismissed as non-respiratory. Of the remaining 58 cases, 4 were dispositioned as valid for silicosis. There were 46 cases that had a confirmed exposure to silica, but were not valid for silicosis disease at this time. It is possible that these workers may develop silicosis in the future. However, 33 of these cases have been rejected and there will be no follow-up information unless the worker submits a new claim in the future. Eight cases either had no confirmed exposure to silica or insufficient information to classify the claim.

Two valid silicosis cases were from the same employer in the countertop manufacturing industry. These cases were a production worker (injured in 2018) and a shop lead (injured in 2020) exposed to engineered stone. One is eligible for a lung transplant and the other is no longer able to work. The 2018 case was the first case of severe silicosis from engineered stone observed in Washington State, and was published as part of a an 18-case series across four states[5]. The Washington State Department of Labor and Industries, Division of Occupational Safety and Health (DOSH) has completed a local emphasis inspection program for exposure to silica in this industry and the case employer has participated in several inspections. The cases we have identified are likely an underestimate of the true burden of disease; California has identified 52 cases of silicosis among countertop fabrication workers from 2019 through 2022[6]. We identified four additional cases in countertop manufacturing with symptoms from silica exposure but no disease.

The remaining two out of the four valid cases of silicosis occurred in a plant operator at an open pit mine (2018) and in a sand blaster employed at a corrugated and solid fiber box manufacturing plant (2020).

No valid silicosis case was fatal. The median claim cost for valid silicosis cases among compensable claims is $348,484 (N=2) and non-compensable claims is $60,281 (N=2). Among claims for exposure without disease, the median claim cost of non-compensable claims is $1245.59 (N=14); all other claims in this group were rejected.

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[5] 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; doi: http://dx.doi.org/10.15585/mmwr.mm6838a1.
[6] Fazio J, Gandhi S, Flattery J et al. Silicosis among immigrant engineered stone (quartz) countertop fabrication workers in California. JAMA intern Med 2023, doi:10.1001/jamainternmed.2023.3295.

Valley fever

There were 17 captured cases of Valley fever (Coccidioidomycosis). Three cases were dismissed as non-respiratory. The thirteen remaining cases were all filed by medical or laboratory staff who report being exposed to the *Coccidioides* fungus while plating cultures. Only one case resulted in diagnosed Valley fever, an animal scientist working for a large teaching hospital who was exposed while testing soil samples out of state in 2017.

Discussion and Conclusion

The expanded case-capture methods introduced in 2016 and improved in 2019 have been successful in identifying cases of respiratory disease and cases of exposure to high-risk substances such as silica and asbestos that may result in disease in the future. Our manual case review process successfully caught and removed an influx of non-respiratory clams with asthma diagnosis codes during the COVID-19 pandemic. Asthma surveillance systems that are entirely reliant upon ICD-10 codes without a review process may observe an inaccurate increase in case counts over the pandemic years. The reason for the rapid rise of asthma diagnosis codes for non-respiratory injuries remains unclear. The prevalence of pre-existing asthma among adults did not significantly change between 2017 and 2021, according to the Behavioral Risk Factor Surveillance System (BRFSS) survey conducted by the Washington State Department of Health[7].

COVID-19 infection was associated with valid cases of work-related asthma (64 work-aggravated and 1 new-onset), predominately among healthcare workers. Early evidence supports a causal association. A 2023 matched-cohort study in a South Korean hospital observed increased odds of new-onset asthma among patients with a recent history of COVID-19 infection (odds ratio 4.55; 95% CI 1.29–17.89)[8].

Between 2017 and 2022, the Washington State Department of Health reported 474 Valley fever cases among Washington residents of all ages (work-relatedness is not reported)[9]. In eight of the cited cases, the individual was exposed in Washington State. The 2017 case identified through workers' compensation is likely an underestimate of the true burden of occupational disease. Though Valley fever is endemic, limited knowledge of its symptoms and occupational causes among workers and providers may result in underreporting.

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[7] National BRFSS Statistics by Year, https://www.cdc.gov/asthma/brfss/default.htm

[8] Lee H, Kim BG, Chung SJ, Park DW, Park TS, Moon JY, Kim TH, Sohn JW, Yoon HJ, Kim SH. New-onset asthma following COVID-19 in adults. J Allergy Clin Immunol Pract. 2023

[9] Washington State Department of Health. 2022 Communicable Disease Report. https://doh.wa.gov/sites/default/files/2024-01/420-004-CDAnnualReport2022.pdf

The primary data source for this surveillance system, workers' compensation claims, is a stable, consistent, and rapid source of information on cases of occupational disease. Many claims are filed as part of the worker's first medical visit after injury, providing close to real-time reporting. Though imperfect, standardized medical billing procedures and injury coding provided by the Department are of great value to this surveillance system. However, there are several limitations to workers' compensation that contribute to under-estimating the true disease burden, such as injured workers being unaware of the workers' compensation system, failure by both workers and/or healthcare providers to recognize the work-relatedness of a condition, and other barriers to claim filing such as a perceived fear of retribution.

With these limitations and strengths in mind, we will continuously improve our disease surveillance system, and report on workers and industries with high or emerging disease and exposure risk.

Acknowledgments

Appendix

Cases are captured on a combination of keywords (coded as regular expressions), ICD-9-CM/ICD-10-CM codes, and OIICS codes. Figure 3 shows a Venn diagram of how case capture criteria can be combined. As some case-capture criteria are general to many respiratory conditions or exposures, we use combinations of criteria to reduce the false-positive rate and overall time burden of manual case review. All of the ICD and OIICS codes listed in this section can be assumed to include all sub-codes that follow the given prefix.

Figure 4. Venn diagram showing relationship of case capture criteria.
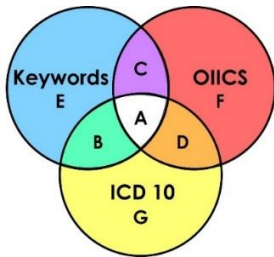
Work-related asthma case capture

Case capture criteria:

- **Keywords**: terms *asthma* and *asthmatic* are captured using regular expression "\bAST*H*MAT?I?C?\b"
- **ICD-9 codes**: 493 (493.0, 493.00, 493.01, 493.02, 493.1, 493.10, 493.11, 493.12, 493.2, 493.20, 493.21, 493.22, 493.8, 493.81, 493.82, 493.9, 493.90, 493.91, 493.92).
- **ICD-10 codes:** J45 (J45.2, J45.20, J45.21, J45.22, J45.3, J45.30, J45.31, J45.32, J45.4, J45.40, J45.41, J45.42, J45.5, J45.50, J45.51, J45.52, J45.9, J45.90, J45.901, J45.902, J45.909, J45.99, J45.990, J45.991, J45.998) and J46
- **OIICS:** accident type codes 340, 341, 1443

Table 9. Accuracy of case-capture criteria combinations for potential work-related asthma cases

Venn Groups	Captured	% Dismissed as non-respiratory	Valid	True-positive rate
(A) Key, ICD, and OIICS	237	3%	209	88%
(B) Key and ICD	95	26%	55	58%
(C) Key and OIICS	57	4%	28	49%
(D) ICD and OIICS	419	9%	139	33%
(E) Key Only	83	23%	41	49%
(F) OIICS Only	21	29%	10	48%
(G) ICD Only*	2,782	95%	55	2%
Allergy & bronchospasm	106	12%	12	11%

* Very low true-positive rate was caused by an influx of claims for other conditions coded with pre-existing asthma during the COVID-19 pandemic. This group was dropped from the case-capture code for all claims established after 2020.

Asbestos-related disease case capture

Case-capture criteria:

- **Keywords**: terms *asbestos*, *asbestosis, mesothelioma,* and *pleural plaques* are captured using regular expression "ASBEST|M[EI]SOTHE|PLEURAL PLAQUES"
- **ICD-9 codes**: 163 (163.1, 163.8, 163.9), 197 (197.1, 197.2, 197.3), 231 (231.2, 231.8, 231.9), 501, 511.81, 989.81
- **ICD-10 codes:** C38.4, C45 (C45.0, C45.1, C45.2, C45.7, C45.9), C78 (C78.00, C78.1, C78.2, C78.39), D02 (D02.20, D02.3, D02.4), J61, J91.0, J92 (J92.0), Z77.090
- **OIICS:** source code 551, nature code 1452
- **Other variables:** claim was flagged as having asbestos exposure by claim managers

Table 10. Accuracy of case-capture criteria combinations for potential asbestos-related disease cases

Venn Groups	Captured	% Dismissed as non-respiratory	Valid	True-positive rate
(A) Key, ICD, and OIICS	110	1%	28	25%
(B) Key and ICD	11	9%	4	36%
(C) Key and OIICS	30	3%	6	20%
(D) ICD and OIICS	13	0%	3	23%
(E) Key Only	66	30%	7	11%
(F) OIICS Only	12	33%	1	8%
(G) ICD Only	13	38%	2	15%

Silicosis case capture

Case-capture criteria:

- **Keywords**: terms *silica* and *silicosis* are captured using regular expression "/SIL*IC[OA][^NE][NTS]?/"
- **ICD-9 codes**: 502
- **ICD-10 codes:** J62 (J62.0, J62.8)
- **OIICS:** source code 557, nature code 1453
- **Other variables:** claim was flagged as having asbestos exposure by claim managers

Table 11. Accuracy of case-capture criteria combinations for potential silicosis cases

Venn Groups	Captured	% Dismissed as non-respiratory	Valid	True-positive rate
(A) Key, ICD, and OIICS	7	0%	2	29%
(B) Key and ICD	3	0%	1	33%
(C) Key and OIICS	37	3%	0	0%
(D) ICD and OIICS	2	0%	1	50%
(E) Key Only	30	60%	0	0%
(G) ICD Only	1	0%	0	0%

Valley fever case capture

Case-capture criteria:

- **Keywords**: terms *Coccidioides* and *Valley Fever* are captured using regular expression "/COCCI|VALLEY FEVER/"
- **ICD-9 codes**: B38 (B38.0, B38.3, B38.4, B38.89, B38.1, B38.2, B38.9)
- **ICD-10 codes:** 114 (114.1, 114.2, 114.3, 114.4, 114.5, 114.9)
- **OIICS:** nature code 244, accident type codes 340 and 341
- **Other variables:** claim was flagged as having asbestos exposure by claim managers

Table 12. Accuracy of case-capture criteria combinations for potential valley fever cases

Venn Groups	Captured	% Dismissed as non-respiratory	Valid	True-positive rate
(A) Key, ICD, and OIICS	3	0%	0	0%
(B) Key and ICD	1	0%	1	100%
(C) Key and OIICS	1	0%	0	0%
(E) Key Only	11	27%	0	0%
(G) ICD Only	1	100%	0	0%