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Healthcare use and health disparities associated with mold exposure diagnosis codes

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Keywords

mold; health insurance; epidemiology; allergy; asthma; United States

INTRODUCTION

Millions of U.S. residents (3.0% of surveyed homes) could be regularly exposed to indoor mold (1). Lower-quality housing may be more likely to support mold growth, resulting in potential disparities in mold exposure according to socioeconomic status (2). Little is known about health care providers' use of mold exposure diagnosis codes and the characteristics of patients assigned these codes. National baseline data on mold exposure's health effects might help inform public health efforts. We aimed to characterize the epidemiologic and clinical features of U.S. patients receiving healthcare for mold exposure-related illness as defined by diagnosis codes.

METHODS

We used the 2016–2022 Merative™ MarketScan® Commercial/Medicare, and Multi-State Medicaid Databases (https://www.merative.com/documents/brief/marketscan-explainer-general). We identified outpatients assigned the ICD-10-CM diagnosis code

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This activity was reviewed by the CDC and was conducted consistent with applicable federal law and CDC policy (e.g., 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.). MarketScan data are fully de-identified, so this analysis was not subject to review by the Centers for Disease Control and Prevention institutional review board.

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Z77.120 “Contact with and (suspected) exposure to mold (toxic)” during April 1, 2016–April 1, 2022. We selected patients with continuous insurance enrollment in the 90 days before and after their first mold exposure diagnosis code within the study period and examined symptoms and other selected concomitant diagnoses using ICD-10-CM codes (Table E1).

We calculated prevalence and used logistic regression to evaluate associations between individual concomitant diagnoses and having a mold exposure diagnosis code. The comparison group was outpatients who did not have a mold exposure diagnosis code and were continuously enrolled 90 days before and after their first outpatient visit in the study period.

RESULTS

Among 31,119,694 outpatients in the commercial insurance dataset, the overall mold exposure diagnosis prevalence was 3.5 per 10,000 enrollees (Table 1). In Medicaid, among 9,334,643 outpatients, the prevalence was 8.5 per 10,000 enrollees. In both cohorts, prevalence was highest among females vs. males (commercial: 4.5 vs. 2.5, Medicaid: 9.4 vs. 7.4) and patients aged 45–64 years (commercial: 4.2, Medicaid: 12.5). Among Medicaid patients, prevalence was highest among non-Hispanic other race (12.3), followed by non-Hispanic Black (10.4).

Nearly half (49.7%) of commercial insurance patients with mold exposure were assigned the code by family practice or internal medicine practitioners, whereas “acute care hospital” was the most common specified provider type among Medicaid patients (22.9%). The most common symptoms were fatigue (28.8%) and cough (27.2%) among commercial insurance patients and cough (32.5%) and dyspnea (15.3%) among Medicaid patients.

Among commercial insurance patients, the most frequent concomitant diagnoses were allergic rhinitis (30.0%), anxiety disorder (21.4%), and asthma (17.6%); 1.3% had diagnosis codes for invasive mold infection (IMI) (aspergillosis, mucormycosis, or unspecified mycosis) (Table 2). Adjusting for age and sex, patients with reported mold exposure were significantly more likely than the comparison group to have each of the concomitant diagnoses we examined except for diabetes and hypertension. The highest adjusted odds ratios (aORs) were for non-invasive/unspecified aspergillosis (aOR: 123.30, 95% confidence interval [CI]: 96.36–157.80), mucormycosis (aOR: 118.01, CI: 43.32–321.51), and hypersensitivity pneumonitis (aOR: 78.83, CI: 54.64–99.76).

Among Medicaid patients, the most frequent concomitant diagnoses were allergic rhinitis (33.6%), asthma (23.3%), and acute upper respiratory infection (19.2%); 0.4% had diagnosis codes for IMI. Adjusting for age, sex, and race/ethnicity, patients with reported mold exposure were significantly more likely than the comparison group to have every selected concomitant diagnosis except for diabetes and mucormycosis. The highest aORs were for hypersensitivity pneumonitis (aOR: 89.48, CI: 58.88–135.97), non-invasive/unspecified aspergillosis (aOR: 54.12, CI: 31.60–92.67), and Lyme disease (aOR: 41.06, CI: 30.91-54.53)

In both datasets, patients with reported mold exposure had a higher mean number of return visits within 90 days vs. the comparison group (commercial insurance: 5.6 vs. 2.3, $p<0.001$, Medicaid: 5.6 vs. 3.4, $p<0.001$).

DISCUSSION

This exploratory analysis of large health insurance claims databases provides an epidemiologic and clinical description of U.S. patients receiving healthcare for reported mold exposure. Disparities by insurance type were apparent, with prevalence twice as high among patients with Medicaid compared with those with commercial insurance. This might reflect differences in exposure related to housing quality; lower socioeconomic status has been associated with higher indoor mold levels (3). The disparities by insurance type could also relate to differences in overall health status and access to preventive care. Variation in mold exposure by race/ethnicity and the higher prevalence for middle-aged women could mirror differences in healthcare seeking behaviors (4). Our results suggest that further investigating and addressing underlying social determinants of health contributing to and behaviors mitigating mold exposure and related illness might help understand and reduce disparities.

The strong observed associations between mold exposure diagnosis codes and allergic rhinitis, asthma, hypersensitivity pneumonitis, are unsurprising as these are well-described health effects associated with indoor dampness and mold (5). The association with IMI could reflect coding for mold exposure after the IMI diagnosis, and the number of patients with IMI was small.

Patients with mold exposure codes were also more frequently diagnosed with certain mental health conditions and were more frequent healthcare users vs. the comparison group. A previous study showed an association between dampness/mold and depression, likely mediated by socioeconomic status, housing conditions, and perception of control (6). The possibility of a biological link between mold exposure and cognitive functioning and emotional dysregulation is controversial (7).

Limitations include the lack of race/ethnicity information in the commercial insurance dataset and geographic information in the Medicaid dataset. Medical coding data are subject to misclassification; in particular, the ICD-10-CM code Z77.120 description is somewhat ambiguous and likely reflects patient self-reported exposure, although it is not possible to visually distinguish toxigenic molds. Coding differences by provider type likely also occur, which likely affects our analysis given the variation in provider types visited according to insurance type. Last, the biologically relevant exposure to mold (e.g., location, duration, concentration) is unknown. In general, our findings might vastly underestimate the true prevalence of mold exposure-related illness given the difficulty of attributing upper respiratory symptoms to mold.

Mold exposure remains an important clinical and public health issue. Healthcare providers can share information about how to reduce mold exposure and proper clean-up (https://www.cdc.gov/mold/faqs.htm), help determine whether a home assessment is warranted (8),

and connect patients to support services (9). Controlling indoor moisture and properly remediating mold is essential to reducing mold-related illness.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Clinical Implications box

Medicaid and commercial health insurance claims databases revealed disparities in patients assigned the ICD-10 code “Contact with and (suspected) exposure to mold (toxic)” by insurance type, age, and sex. Allergic rhinitis was the most common concomitant diagnosis.

Table 1.

Characteristics of patients with ICD-10-CM diagnosis code Z77.120: “Contact with and (suspected) exposure to mold (toxic)” — United States, April 1, 2016–April 1, 2022

	Commercial insurance[1]			Medicaid[1]		
	n	**%**	**rate per 10,000 enrollees**	**n**	**%**	**rate per 10,000 enrollees**
Total	10,761		3.5	7,944		8.5
Sex						
Male	3,524	32.7%	2.4	3,083	38.8%	7.4
Female	7,237	67.3%	4.5	4,861	61.2%	9.4
Age group in years						
<18	1,570	14.6%	2.3	4,571	57.5%	8.1
18 to 44	4,411	41.0%	3.5	2,142	27.0%	8.0
45 to 64	4,192	39.0%	4.2	1,192	15.0%	12.5
≥65	588	5.5%	3.2	39	0.5%	8.3
U.S. census region of primary beneficiary’s residence						
Northeast	1,701	15.8%	3.2	n/a	n/a	n/a
Midwest	2,094	19.5%	3.2	n/a	n/a	n/a
South	4,841	45.0%	3.5	n/a	n/a	n/a
West	2,096	19.5%	3.9	n/a	n/a	n/a
Unknown	29	0.3%	2.7	n/a	n/a	n/a
Urban/rural classification						
Non-rural	9,682	90.0%	3.5	n/a	n/a	n/a
Rural	1,055	9.8%	3.0	n/a	n/a	n/a
Unknown	24	0.2%	3.2	n/a	n/a	n/a
Race/ethnicity						
Black, non-Hispanic	n/a	n/a	n/a	2,923	36.8%	10.4
Hispanic or Latino	n/a	n/a	n/a	322	4.1%	4.6
Other race, non-Hispanic	n/a	n/a	n/a	743	9.4%	12.3
White, non-Hispanic	n/a	n/a	n/a	3,218	40.5%	7.6
Unknown	n/a	n/a	n/a	738	9.3%	7.7
Season of diagnosis						
Winter	2,397	22.3%		1,793	22.6%	
Spring	2,467	22.9%		1,735	21.8%	
Summer	2,859	26.6%		2,147	27.0%	
Fall	3,038	28.2%		2,269	28.6%	
Provider type(s) on day of diagnosis[2]						
Family practice or internal medicine	5,346	49.7%		839	10.6%	
Laboratory	1,275	11.8%		661	8.3%	
Acute care hospital	1,173	10.9%		1,823	22.9%	

	Commercial insurance[1]			Medicaid[1]		
	n	**%**	**rate per 10,000 enrollees**	**n**	**%**	**rate per 10,000 enrollees**
Pediatrician	811	7.5%		1,450	18.3%	
Radiology	648	6.0%		129	1.6%	
Nurse practitioner	638	5.9%		1,146	14.4%	
Allergy/immunology	544	5.1%		125	1.6%	
Pulmonary disease	490	4.6%		30	0.4%	
Otolaryngology	394	3.7%		51	0.6%	
Other	3,099	28.8%		4,001	50.4%	
Unknown	282	2.6%		964	12.1%	
Symptoms[2,3]						
Fatigue or malaise	3,094	28.8%		947	11.9%	
Cough	2,932	27.2%		2,584	32.5%	
Dyspnea	1,815	16.9%		1,218	15.3%	
Headache	1,323	12.3%		1,047	13.2%	
Chest pain	1,315	12.2%		920	11.6%	
Fever	649	6.0%		903	11.4%	
Nasal congestion	622	5.8%		860	10.8%	
Rash	502	4.7%		561	7.1%	

[1]The Commercial/Medicare database includes health insurance claims data from outpatient visits, outpatient prescriptions, and hospitalizations from >54 million employees, dependents, and retirees throughout the United States. The Medicaid database includes similar information from >16 million patients across several states. We limited the analysis to outpatients (>99% of all patients assigned code Z77.120) and excluded patients for whom this code was listed on a laboratory or radiology claim alone (11% in the commercial database and 4% in Medicaid).

[2]Non-mutually exclusive categories

[3]In the 90 days before through 90 days after the Z77.120 diagnosis code was first used during the study period

Table 2.

Other diagnoses associated with ICD-10-CM diagnosis code Z77.120: “Contact with and (suspected) exposure to mold (toxic)” — United States, April 1, 2016–April 1, 2022

	Commercial (n=10,761)				Medicaid (n=7,944)			
Condition[1,2]	**n**	**%**	**aOR**[3]	**(95% CI)**	**n**	**%**	**aOR**[4]	**(95% CI)**
Acute upper respiratory infection	1,128	10.5%	2.09	(1.96–2.22)	1,526	19.2%	2.94	(2.77–3.12)
Acute sinusitis	1,264	11.7%	2.29	(2.16–2.43)	766	9.6%	2.74	(2.54–2.97)
Allergic contact dermatitis	119	1.1%	1.82	(1.52–2.19)	86	1.1%	1.95	(1.56–2.44)
Allergic rhinitis	3,224	30.0%	6.82	(6.55–7.11)	2,668	33.6%	6.82	(6.49–7.17)
Anxiety disorder	2,304	21.4%	3.66	(3.50–3.84)	1,467	18.5%	3.20	(3.00–3.41)
Atopic dermatitis	204	1.9%	2.54	(2.21–2.92)	365	4.6%	3.00	(2.68–3.35)
Asthma	1,891	17.6%	5.26	(5.00–5.52)	1,852	23.3%	3.87	(3.67–4.09)
Chronic obstructive pulmonary disease (COPD) or other chronic lower respiratory disease	737	6.8%	3.08	(2.85–3.32)	591	7.4%	2.77	(2.52–3.05)
Chronic sinusitis	1,156	10.7%	6.96	(6.55–7.40)	481	6.1%	5.24	(4.75–5.77)
Conjunctivitis	479	4.5%	2.01	(1.83–2.20)	508	6.4%	2.19	(2.00–2.41)
Depression	1,336	12.4%	2.75	(2.59–2.91)	993	12.5%	2.08	(1.93–2.23)
Diabetes	621	5.8%	0.80	(0.74–0.87)	345	4.3%	1.06	(0.94–1.20)
Fibromyalgia	366	3.4%	6.74	(6.07–7.49)	247	3.1%	6.20	(5.41–7.11)
Food allergy	273	2.5%	7.20	(6.38–8.13)	224	2.8%	4.97	(4.31–5.73)
Fungal infection								
Aspergillosis, invasive	2	0.0%	16.20	(4.07–64.41)	3	0.0%	35.06	(11.10–110.72)
Aspergillosis, non-invasive or unspecified	69	0.6%	123.30	(96.36–157.80)	16	0.2%	54.12	(31.60–92.67)
Dermatophytosis	294	2.7%	1.32	(1.17–1.48)	215	2.7%	1.59	(1.38–1.84)
Mucormycosis	4	0.0%	118.01	(43.32–321.51)	0	0.0%	0.01	(<0.01–999.99)
Unspecified mycosis	70	0.7%	37.03	(28.96–47.35)	12	0.2%	8.33	(4.47–15.53)
Vulvovaginal candidiasis	145	1.3%	2.35	(2.00–2.77)	112	1.4%	1.54	(1.26–1.88)
Hypersensitivity pneumonitis	44	0.4%	73.83	(54.64–99.76)	25	0.3%	89.48	(58.88–135.97)
Hypertension	1,755	16.3%	0.90	(0.85–0.96)	898	11.3%	1.43	(1.31–1.56)
Hypothyroidism	1,431	13.3%	2.54	(2.39–2.69)	365	4.6%	2.69	(2.40–3.02)
Lyme disease	574	5.3%	55.42	(50.91–60.34)	52	0.7%	41.06	(30.91–54.53)
Smoking (current or past)	695	6.5%	1.99	(1.84–2.15)	1,133	14.3%	1.73	(1.61–1.86)
Pneumonia	342	3.2%	3.34	(3.00–3.72)	267	3.4%	2.74	(2.39–3.08)
Vitamin D deficiency	1,423	13.2%	2.77	(2.62–2.94)	468	5.9%	2.92	(2.64–3.24)

[1] Non-mutually exclusive categories

[2] In the 90 days before through 90 days after the Z77.120 diagnosis code was first used during the study period

[3] Adjusting for age and sex

[4] Adjusting for age, sex, and race/ethnicity