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Review Article

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# Occupational coccidioidomycosis surveillance and recent outbreaks in California

**Marie A. de Perio[1,2,*], Barbara L. Materna[3], Gail L. Sondermeyer Cooksey[4], Duc J. Vugia[4], Chia-ping Su[1], Sara E. Luckhaupt[1,2], Jennifer McNary[3] and Jason A. Wilken[2,3,5]**

[1]National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Cincinnati, Ohio, USA, [2]United States Public Health Service Commissioned Corps, Rockville, Maryland, USA, [3]Occupational Health Branch, California Department of Public Health, Richmond, California, USA, [4]Infectious Diseases Branch, California Department of Public Health, Richmond, California, USA and [5]Career Epidemiology Field Officer, Office of Public Health Preparedness and Response, Centers for Disease Control and Prevention, Atlanta, Georgia, USA

*To whom correspondence should be addressed. Marie A. de Perio, MD, Centers for Disease Control and Prevention National Institute for Occupational Safety and Health 1090 Tusculum Avenue, R-10 Cincinnati, OH 45226. Tel: +513-841-4116; E-mail: mdeperio@cdc.gov

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## Abstract

Workers in *Coccidioides*-endemic areas performing soil-disturbing work or exposed to windy and dusty conditions are at increased risk for coccidioidomycosis. Four occupational coccidioidomycosis outbreaks from 2007 to 2014 in California are described, involving construction workers in a number of excavation projects and an outdoor filming event involving cast and crew. These outbreaks highlight the importance of identifying industries and occupations at high risk for coccidioidomycosis, conducting targeted occupational health surveillance to assess the burden of illness, developing and implementing prevention strategies, and setting research priorities.

**Key words:** coccidioidomycosis, valley fever, workers, occupational, outbreak, surveillance.

Coccidioidomycosis, also known as Valley fever, is caused by inhalation of spores of the fungus *Coccidioides*, which grows in soil in semiarid areas. Coccidioidomycosis is endemic in the southwestern United States, particularly parts of Arizona and California, Mexico, and parts of Central and South America.[1] This disease has important occupational risk factors. Workers in endemic areas involved in soil disturbance, including but not limited to agricultural, construction, and archeological workers, military personnel, and workers in mining, quarrying, and oil and gas extraction industries have been shown to be at higher risk for coccidioidomycosis.[2,3] Clusters of infections have also been found among employees and inmates at state prisons located in endemic areas.[4,5] Disruption of soil or strong dust-raising winds can aerosolize spores. It follows that, in *Coccidioides*-endemic areas, persons who work outdoors are at particular risk for coccidioidomycosis when their duties include soil-disruptive work or when working in dusty or windy conditions.

Occupational coccidioidomycosis surveillance is important to assess the burden of illness among workers in endemic areas, identify groups of workers at high risk, identify and set research priorities, and develop and implement prevention strategies. Achieving a high sensitivity for detection of individual occupational coccidioidomycosis cases or occupational clusters requires public health practitioners to recognize relevant occupational information on individual case report forms or patterns in a notifiable disease database. However, describing the occupational burden of coccidioidomycosis has been challenging because existing surveillance systems are not comprehensive in their collection of occupational information.

Detecting occupational patterns is often done by examining rates of illnesses and injuries stratified by industry and

occupation. In general, the term "industry" refers to the type of business for which a person works (e.g., correctional facility or home construction), and the term "occupation" refers to a worker's specific job (e.g., registered nurse or carpenter). Capturing information on both industry and occupation can further inform public health workers on those specific job risk factors needing further assessment.

Coccidioidomycosis and outbreaks of any disease are reportable in California.[6] The California Reportable Disease Information Exchange has drop-down boxes for occupation and occupation setting (i.e., industry) with a predetermined list of specific occupations and industries. It also has a free text box for occupation location (or workplace.) However, these items are not usually filled out. In addition, cases are reported to the county of the patient's residence, which might not be the same county as the worksite where exposure occurred.

## Occupational coccidioidomycosis outbreaks—California, 2007–2014

Despite the above limitations, the current surveillance system in California has been able to detect some occupational coccidioidomycosis outbreaks. Here we describe four such outbreaks, highlighting the importance of occupational health surveillance, of collecting standard information, and of limiting dust exposure to prevent disease among workers. A summary of the outbreaks is presented in Table 1.

### San Luis Obispo County, 2007

In 2007, the San Luis Obispo Public Health Department (SLOPHD) alerted the California Department of Public Health (CDPH) to a possible outbreak of coccidioidomycosis among a construction crew excavating a leaking underground pipe.[3,7] The joint county/state investigation found that 10 of 12 crew members had symptoms compatible with acute pulmonary coccidioidomycosis, 8 of whom had serological confirmation. Illness onset for all cases was <1 month after beginning work. The crew worked in the same area, excavating a trench, replacing the leaking pipe, and refilling the trench. The sandy nature of the soil limited the effectiveness of soil-wetting, heavy equipment was operated with windows open, and no worker used respiratory protection. Following this outbreak, the CDPH Occupational Health Branch began collecting Doctor's First Reports of Occupational Injury or Illness (DFR) citing coccidioidomycosis diagnoses. DFRs are submitted to the California Department of Industrial Relations by workers' compensation insurance carriers or employers after a California healthcare provider identifies work-relatedness and completes the form.[8] DFRs are provided to CDPH for statewide occupational injury and illness surveillance. A review of these collected DFRs identified two additional outbreaks, described briefly below.

### Kern County, 2008.

In 2008, eight of ten construction workers were confirmed with coccidioidomycosis after widening a box culvert in Kern County. All of the workers were residents of counties far from Kern. Illness onset for all cases was <1 month after beginning work. This outbreak was not detected through routine coccidioidomycosis surveillance because workers resided in several low-incidence counties. Rather, the outbreak was identified by a review of DFRs in 2012 by the CDPH Occupational Health Branch. In the epidemiologic triad of person, place, and time, occupational surveillance provided the crucial "place" (i.e., worksite in Kern County) necessary to identify an outbreak. None of the workers used or was advised to use any type of respiratory protection, heavy equipment was operated with windows open, and water was used for dust suppression on some but not all days.[9] The contractor had not been informed about the risk of coccidioidomycosis associated with working in an endemic area.

### Ventura County, 2012

Review of DFRs in 2013 identified two motion picture industry employees residing in Los Angeles County, who were evaluated for coccidioidomycosis after working at the same Ventura County outdoor filming site in early 2012. One employee had received a letter from his employer stating that a worker at the filming site had been diagnosed with coccidioidomycosis, alerting him to the possible cause of his illness.[10] CDPH collaborated with the Los Angeles County Department of Public Health to identify cases and sources of exposure. Ten workers with clinically compatible illness were identified among 655 workers at the outdoor filming. Of these ten, five had serologically-confirmed disease. Only two of the ill workers reported performing soil-disruptive work, though five reported dusty conditions during filming. Soil-disruptive work at the site before filming included grading and digging, and fugitive dust from vehicles travelling on dirt roads and from a nearby mining operation might have also contributed to dusty conditions during filming. The casting agency did not provide employees with information on the risk of coccidioidomycosis before the filming started, and no controls were implemented to prevent exposure. Illness onset for all cases was <1 month after beginning work.

### San Luis Obispo County 2011–2014

Suspicion of an outbreak among workers constructing two neighboring solar power-generating facilities (solar farms) in San Luis Obispo County arose December 2012–February 2013 when San Luis Obispo Public Health Department (SLOPHD) identified cases among workers by manually comparing employee rosters to the county's reportable disease database and CDPH also identified additional cases among workers by review of DFRs. A subsequent search of the statewide reportable disease database

**Table 1.** Summary of work-associated outbreaks of coccidioidomycosis—California, 2007–2014.

| Outbreak | Persons with clinically compatible illness | Laboratory confirmed cases | Hospitalizations | Disseminated disease |
|---|---|---|---|---|
| San Luis Obispo County, 2007[3,7] | 10 | 8 | 0 | 1 |
| Kern County, 2008 | 9 | 8 | 2 | 2 |
| Ventura County, 2012[10] | 10 | 5 | 2 | 1 |
| San Luis Obispo County, 2011–2014[11,12] | 133 | 44 | 9 | 2 |

for terms matching the solar farms identified additional cases, prompting a joint investigation also including the California Division of Occupational Safety and Health (Cal/OSHA). Among 3572 known workers, the investigation identified 44 laboratory-confirmed cases of coccidioidomycosis,[11] and, based on a mail-in survey, an additional 89 workers with clinically compatible coccidioidomycosis but no laboratory confirmation.[12] Illness onset for all cases was ≥1 week after beginning work and <1 month after last workday. Exposures at the solar farms included performing soil-disruptive work, such as digging trenches, and working in a trench. In addition, workers reported working in a dust cloud or dust storm, and operating heavy equipment without enclosed cabs, closed windows, and air-conditioned with high-efficiency particle (HEPA) filtration. By case-control analysis, frequently being in a dust storm or dust cloud was associated with increased risk of having clinically compatible coccidioidomycosis, while frequent wetting of soil before soil-disruptive activities was protective; frequently performing soil-disruptive work was a risk factor only for employees who did not frequently use respiratory protection.

Ill workers from all four outbreaks were exposed to dust in the course of their job activities in the outdoors. However, not all workers were directly engaged in soil-disruptive work. For example, only two of the ill workers from the Ventura County outbreak reported performing any soil-disruptive work, and 58% of those with laboratory-confirmed disease and 64% with clinically compatible coccidioidomycosis from the 2011–2014 San Luis Obispo County outbreak reported frequently performing soil-disruptive work. The 2007 San Luis Obispo, 2008 Kern, and 2012 Ventura outbreaks occurred during fall, spring, and winter months, respectively, and no variation in incidence by month or by season was observed in the San Luis Obispo 2011–2014 outbreaks. These outbreaks occurred both before and during the 2012–2016 California drought. Taken together, these findings suggest that working outdoors near soil disruption or in dusty conditions in endemic areas is sufficient to expose workers to *Coccidioides* spores regardless of climatic variables.

## Reducing risk of exposure among workers in *Coccidioides*-endemic areas

Reducing the risk of coccidioidomycosis among workers in endemic areas can be accomplished at multiple levels. The occupational health and safety hierarchy of controls approach provides a useful prevention model. Work practices that eliminate or minimize dust generation can reduce exposures among workers. Examples might include reducing grading and reducing the need for trenching by using above-ground work processes versus below-ground when possible (e.g., installing above-ground cabling rather than cabling that must be laid in trenches). Local health jurisdictions should collaborate with local permitting agencies to require that soil disturbance be minimized through safer project design and planning, as well as during construction. Engineering and work practice controls can limit dust generation or can isolate the worker from dust; examples would include frequent and effective soil wetting to minimize dust before and during dust-generating activities and exclusive use of enclosed cabs on earthmoving equipment with HEPA-filtered air conditioning.

Administrative controls that promote safer work practice standards might include (1) ensuring that the worksite injury and illness prevention plan recognizes the risk of coccidioidomycosis and has criteria for temporarily suspending work when there is excessive dust or wind; (2) having onsite monitoring personnel who, when inadequate dust control is identified, have the ability to implement additional control measures or stop work; (3) training workers and supervisors about the risks and symptoms of coccidioidomycosis; and (4) encouraging ill workers to report their symptoms to supervisors (examples of employer and worker educational materials developed by CDPH can be found at https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/HESIS/CDPH%20Document%20Library/CocciFact.pdf and https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/Cocci.aspx).

As an additional line of protection, respiratory protective equipment can reduce the risk of inhaling *Coccidioides* spores. Respiratory protective equipment should be used within a comprehensive, OSHA-compliant respiratory protection program that includes medical clearance for respirator use, fit testing of tight-fitting particulate respirators, training, and clear criteria for when respirators must be worn. Employers should recognize that outdoor work puts workers at risk for coccidioidomycosis, contract with occupational medical providers familiar with coccidioidomycosis, and refer symptomatic workers for evaluation; similarly, clinicians should recognize the likelihood of work-relatedness of coccidioidomycosis

among workers exposed to dust. Finally, employers should know that OSHA programs require them to control workers' exposure to all job hazards including *Coccidioides* (see http://www.dir.ca.gov/dosh/valley-fever-home.html for Cal/OSHA's notice to employers about coccidioidomycosis).

Future research on the effectiveness of interventions to minimize worker exposures to *Coccidioides* spores is needed and might include environmental mitigation efforts (e.g., soil stabilizers), respiratory protection options, and assessing how wind speed and dust levels might be used as triggers for increasing control measures or temporarily stopping work. In addition, developing and validating an air sampling method would be useful for hazard assessment.

Challenges to identifying the occupational burden of coccidioidomycosis can similarly be addressed in a comprehensive manner. Coccidioidomycosis should be considered when workers in industries or occupations at increased risk have symptoms compatible with these diseases. Discovering risk factors for transmission and assessing hazards in the workplace could help employers plan disease prevention measures, such as implementing changes in work practices or an OSHA-compliant respiratory protection program.

Including the systematic collection of occupational information as part of coccidioidomycosis surveillance might facilitate identifying future workplace-associated outbreaks. Indeed, review of DFRs helped identify the 2011–2014 San Luis Obispo while it was ongoing. Capturing information on both industry and occupation can further inform public health workers on those specific job risk factors needing further assessment. Unfortunately, industry and occupation information is not collected in all states where coccidioidomycosis is considered endemic, and states have disparate ways of collecting responses. Examples include "checkboxes" for industries or occupations of interest, "free-text fields" for occupation, and "pick-lists" of job categories based on standard classifications systems or customized lists such as in California. Although checkboxes and pick-lists may be efficient, they may be incomplete and miss capturing at-risk workers. To improve data collection in surveillance systems, the National Institute for Occupational Safety and Health (NIOSH) at the Centers for Disease Control and Prevention (CDC) recommends that occupational questions should be standardized, information on both industry and occupation should be collected, and data should be analyzed with standard coding schemes to monitor disease trends in specific industries or occupations and protect workers' health.[13] Other helpful information for coccidioidomycosis surveillance includes employer name, work location involving dust exposure, job duties, and questions about specific types of exposures and protective measures taken.

In addition, employers should provide employee rosters to public health agencies to assist in identifying coccidioidomycosis cases when necessary. Project owners and employers should also report cases of coccidioidomycosis among their workers to public health agencies.

Employers are currently required to report illnesses resulting in hospitalizations among workers to OSHA programs, and public health agencies should establish agreements with occupational safety and health agencies to share data for surveillance purposes. Outreach in endemic areas can prompt healthcare providers to recognize work-associated coccidioidomycosis (see CDPH's free continuing medical education unit "Coccidioidomycosis Occupational Health Issues" at https://cmecalifornia.com/Activity/5210283/Detail.aspx#lnk5210283). Healthcare providers in California and other endemic states are required to report identified cases and suspected outbreaks of diseases to local health jurisdictions.[6]

In conclusion, recent occupational coccidioidomycosis outbreaks in California have led to targeting education and prevention strategies to help reduce disease among at-risk occupational groups. Improving the systematic collection of occupational information in coccidioidomycosis surveillance systems could provide a better understanding of the extent of occupationally acquired coccidioidomycosis to protect workers' health.

## Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

## Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

## References

1. Galgiani JN, Ampel NM, Blair JE et al. 2016 Infectious Diseases Society of America (IDSA) Clinical Practice Guideline for the Treatment of Coccidioidomycosis. *Clin Infect Dis*. 2016; 63: e112–146.
2. Laniado-Laborin R. Expanding understanding of epidemiology of coccidioidomycosis in the Western Hemisphere. *Ann N Y Acad Sci*. 2007; 1111: 19–34.
3. Das R, McNary J, Fitzsimmons K et al. Occupational coccidioidomycosis in California: outbreak investigation, respirator recommendations, and surveillance findings. *J Occup Environ Med*. 2012; 54: 564–571.
4. Pappagianis D, Coccidioidomycosis Serology Laboratory. Coccidioidomycosis in California state correctional institutions. *Ann N Y Acad Sci*. 2007; 1111: 103–111.
5. de Perio MA, Niemeier RT, Burr GA. Coccidioides exposure and coccidioidomycosis among prison employees, California, United States. *Emerg Infect Dis*. 2015; 21: 1031–1033.
6. California Code of Regulations. Reportable diseases and conditions. Title 17, §2500, 2593, 2641.5–2643.20 and 2800–2812. https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/ReportableDiseases.pdf.
7. Cummings KC, McDowell A, Wheeler C et al. Point-source outbreak of coccidioidomycosis in construction workers. *Epidemiol Infect*. 2010; 138: 507–511.

8. California Code of Regulations. Doctor's first report of occupational injury or illness. Title 8, §14006 Form 5021, Rev 4, 2014 http://www.dir.ca.gov/OPRL/dlsrform5021.pdf.
9. Nicas M. A point-source outbreak of Coccidioidomycosis among a highway construction crew. *J Occup Environ Hyg*. 2018; 15: 57–62.
10. Wilken JA, Marquez P, Terashita D et al. Coccidioidomycosis among cast and crew members at an outdoor television filming event—California, 2012. *MMWR Morb Mortal Wkly Rep*. 2014; 63: 321–324.
11. Wilken JA, Sondermeyer G, Shusterman D et al. Coccidioidomycosis among workers constructing solar power farms, California, USA, 2011–2014. *Emerg Infect Dis*. 2015; 21: 1997–2005.
12. Sondermeyer Cooksey GL, Wilken JA, McNary J et al. Dust exposure and coccidioidomycosis prevention among solar power farm construction workers in California. *Am J Public Health* 2017; 107: 1296–1303.
13. Su CP, de Perio MA, Fagan K et al. Occupational distribution of campylobacteriosis and salmonellosis cases: Maryland, Ohio, and Virginia, 2014. *MMWR Morb Mortal Wkly Rep*. 2017; 66: 850–853.