Evaluation of *Coccidioides* Exposures and Coccidioidomycosis Infections among Prison Employees

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Contents

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The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation. Photo by NIOSH.

Highlights of this Evaluation

The Health Hazard Evaluation Program received a request from managers on behalf of a state correctional and rehabilitation agency and a state correctional health care services agency. They were concerned about potential employee exposure to the fungus *Coccidioides* at two state prisons (prison A and prison B) in the Central Valley of California.

What We Did

- We visited the prisons in June 2013.
- We looked at work and occupational health policies and practices.
- We reviewed medical and work information for the cases of coccidioidomycosis among prison employees.
- We privately interviewed prison employees and asked them about their work practices and exposures.
- We met with prison staff to learn about efforts to reduce employee and inmate exposures to *Coccidioides*.
- We looked at the ventilation systems in some buildings. We chose buildings where more employees worked such as clinics and offices. We also looked at the ventilation in some inmate housing units.

> We were asked to determine the incidence of coccidioidomycosis among prison employees and assess ways to reduce potential employee exposures. We found 103 confirmed cases of coccidioidomycosis among employees over a 4½-year period. Employees are likely exposed to *Coccidioides* in the outdoor and indoor work environment, as well as outside of work.

What We Found

- Both prisons were in areas where *Coccidioides* naturally occurs.
- We identified 65 confirmed cases of coccidioidomycosis among prison A employees and 38 confirmed cases of coccidioidomycosis among prison B employees over a 4½-year period.
- We do not know if each confirmed case of coccidioidomycosis among prison employees was due to an exposure at work or outside of work.
- Employees may be potentially exposed to *Coccidioides* in the outdoor and indoor work environment, as well as outside of work.

What the Employer Can Do

- Wet soil before disturbing it, and continuously wet it while digging to keep dust levels down.
- Install door sweeps and seal gaps around doors and windows. Keep doors and windows closed as much as possible.
- Replace air filters in the ventilation systems as needed.

What the Employer Can Do (continued)

- Provide education and training during work hours to all prison employees on coccidioidomycosis and ways to minimize exposure.
- Consider closing the prison yards and advising inmates and employees to stay indoors during dust storms and unusually windy or dusty days.
- Consider offering the coccidioidal spherulin skin test to employees when it becomes commercially available. This test may help employees evaluate their personal risk for coccidioidomycosis.
- Encourage prison employees to report suspected symptoms of possible coccidioidomycosis to a supervisor.
- Review injury and illness records for reports of coccidioidomycosis infections among prison employees to look for trends over time.

What the Employees Can Do

- Keep doors and windows closed as much as practical.
- Avoid driving vehicles off pavement to keep dust levels down.
- Follow agency policies, including those regarding excavation safety and respiratory protection.
- Report suspected symptoms of possible coccidioidomycosis to a supervisor.

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Abbreviations

CDC	Centers for Disease Control and Prevention
CDPH	California Department of Public Health
CSTE	Council of State and Territorial Epidemiologists
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
MERV	Minimum efficiency reporting value
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration

Introduction

The Health Hazard Evaluation Program received a request from managers at a state correctional and rehabilitation agency and a state correctional health-care services agency. It concerned potential employee exposure to the fungus *Coccidioides* at two state prisons (prison A and prison B) in the Central Valley of California. We were asked to determine the incidence of coccidioidomycosis among prison employees and to assess ways to minimize exposures. We evaluated the prisons in June 2013.

Background

At the time of our evaluation, the state correctional and rehabilitation agency operated 33 adult prisons statewide. In May 2013, the in-state inmate population was 124,741 and the parole population was more than 52,730 [California Department of Corrections & Rehabilitation 2013]. The agency had approximately 69,000 employees, including custody and support staff. The state correctional health care services agency, responsible for providing medical care to inmates, was placed under a federal receivership in 2005. At the time of our evaluation, this health care services agency was still under the federal receivership. This agency had approximately 7,000 employees, including health care personnel and administrative staff.

Prison A opened in 1994 and provided long-term housing and services for minimum, medium, and maximum custody inmates. Located in Fresno County in the Central Valley of California, it covered 640 acres. The prison A inmate population in May 2013 was 3,558 [California Department of Corrections & Rehabilitation 2013]. In 2013, staff, including custody and support staff, numbered over 1,300.

Prison B opened in 1987 and provided long-term housing and services for minimum and medium custody inmates. Located in Kings County in the Central Valley of California, it covered 640 acres. The prison B inmate population in May 2013 was 4,538 [California Department of Corrections & Rehabilitation 2013]. In 2013, staff, including custody and support staff, numbered over 1,500. The prisons are located within 11 miles of each other.

Coccidioidomycosis

Coccidioidomycosis, also known as valley fever, is a disease caused by a fungus of the *Coccidioides* species, which grows in the soil in semiarid areas. Coccidioidomycosis is endemic (native and common) in the southwestern United States, the Central Valley of California, Mexico, and parts of Central and South America [CDC 2013a]. The disease is considered hyperendemic in six California counties (Kern, Kings, Fresno, San Luis Obispo, Tulare, and Madera) that historically have consistently had the highest incidence of coccidioidomycosis. It is a reportable disease in states where it is endemic, including California, New Mexico, Arizona, Nevada, Texas, and Utah. About 150,000 new infections occur annually in the United States [Galgiani et al. 2005] though only over 22,000 cases were reported in 2011 in the United States, suggesting that the disease is greatly underreported

[CDC 2013b]. The incidence of reported coccidioidomycosis increased substantially from 1998 to 2011, from 5.3 per 100,000 population in the endemic area (Arizona, California, Nevada, New Mexico, and Utah) in 1998 to 42.6 per 100,000 in 2011 [CDC 2013b].

Coccidioidomycosis is acquired by inhaling *Coccidioides* arthrospores, or spores, that get into the air when construction, natural disasters, or wind disturb soil contaminated with the fungus [CDC 2013a]. It has been suggested that human illness could be caused by a single spore [Pappagianis 1988; Galgiani 1993]. Additional information on the *Coccidioides* fungus can be found in Appendix A. The infection cannot be spread from to person to person, or from animals to people. Most people who get the disease live in or visit places where the fungus is in the soil and engage in activities that expose them to soil dust. Such activities include construction, agricultural work, military field training, and archeological exploration [CDC 2013a].

About 60% of coccidioidomycosis infections are asymptomatic [Chiller et al. 2003]. People who develop symptoms may experience a flu-like illness with fever, cough, headache, rash, and muscle aches that are self-limited. Symptoms usually resolve on their own without treatment, but antifungal medications can be used. A small percentage of infected persons (< 1%) may develop widespread disseminated infection [Chiller et al. 2003]. People at increased risk for severe pulmonary disease are the elderly, those with diabetes or recent smoking history, and people of low socioeconomic status [CDC 2014]. People at greater risk for developing disseminated infection include people of African American and Asian (particularly Filipino) descent, pregnant women during their third trimester, and immunocompromised persons [CDC 2013a]. Coccidioidomycosis has been shown to be costly and debilitating, with nearly 75% of patients in whom the disease has been recognized missing work or school because of their illness and more than 40% requiring hospitalization [Tsang et al. 2010].

Diagnosis of coccidioidomycosis can be made by looking for *Coccidioides* antibodies or antigens in blood or other body fluids. Diagnosis can also be made through a tissue biopsy, in which a small sample of affected tissue is taken from the body and examined under a microscope or by culture where the fungus can be grown from the sample on special nutrient plates. Beginning in the 1940s, skin testing was used to determine if a person has been exposed to *Coccidioides*. The skin test indicated exposure to the fungus but not when exposure occurred. However, *Coccidioides* skin test reagents have not been commercially available in the United States for more than a decade [Ampel 2003]. No vaccine against coccidioidomycosis is currently available.

Methods

The purpose of our evaluation was to (1) determine the incidence of coccidioidomycosis among employees at the prisons, (2) assess the ventilation systems at the prisons, and (3) recommend ways to improve coccidioidomycosis-related occupational health and infection control practices. During visits in June 2013, we observed workplace conditions and work processes and practices and spoke with employees. We excluded inmate employees from this evaluation because inmates were the focus of another concurrent Centers for Disease Control and Prevention (CDC) investigation.

Our evaluation included the following methods: (1) a review of relevant occupational health policies and practices, (2) a review of work and medical information about confirmed coccidioidomycosis cases among prison employees (Appendix B), (3) confidential medical interviews with employees, (4) assessment of the ventilation systems in selected buildings, and (5) assessment of environmental mitigation practices to reduce exposures to *Coccidioides*.

Review of Occupational Health Policies and Practices

We reviewed relevant work and occupational health policies and practices obtained from the corrections agency and the correctional healthcare services agency. These included excerpts from the supplemental operations manual, the written respiratory protection plans, the aerosol transmissible diseases exposure control plans, and the excavation safety plan for prison B.

Review of Coccidioidomycosis Among Prison Employees

Coccidioidomycosis Confidential Morbidity Reports

We obtained annual employee rosters for each prison from 2009–2013 from the correctional agency and the prisons. With assistance of the California Department of Public Health (CDPH) Infectious Diseases Branch, we matched the names on these rosters to the CDPH database that contains confidential morbidity report data on reported confirmed coccidioidomycosis cases in California. CDPH uses the Council of State and Territorial Epidemiologists (CSTE) case definition for coccidioidomycosis, which includes clinical and laboratory criteria [CDC 2012a]. Details about the case definition can be found in Appendix B. We identified 276 possible matches at prison A and 216 possible matches at prison B. We then obtained more information from agency headquarters and the prisons on the possible employee matches, including sex, dates of birth, last four digits of social security numbers, home addresses, and dates of employment, to confirm that these coccidioidomycosis cases reported to CDPH occurred in individuals employed at either prison. We considered a match to be a coccidioidomycosis case reported to CDPH with the same name and same date of birth and/or same last four digits of social security numbers. For cases reported to CDPH that were missing date of birth or social security numbers, we considered a confirmed match if the employee was listed as a correctional facility employee in the confidential morbidity report. We excluded coccidioidomycosis cases among employees that were reported to CDPH prior to their date of hire.

We calculated the crude (unadjusted) 4-year incidence and the crude average annual incidence of coccidioidomycosis for prison A employees and prison B employees. First, we calculated the crude 4-year incidence by dividing the total number of coccidioidomycosis cases among employees at each prison during 2009–2012 by the mid-point number of employees at the respective prison between 2010 and 2011. We then divided this crude 4-year incidence by 4 to obtain the crude average annual incidence during 2009–2012.

Using information from the confidential morbidity report and the corrections agency, we described personal and work characteristics of the employees with coccidioidomycosis.

Coccidioidomycosis Reports from Other Sources

We obtained and reviewed information on the coccidioidomycosis-related reports from the Occupational Safety and Health Administration (OSHA) 300 Logs of Work-Related Illnesses and Injuries from 2009 through mid-2013 for both prisons. Employer representatives at each prison extracted all entries that reported coccidioidomycosis infection, and we eliminated duplicate entries. According to agency representatives at the time of the evaluation, employees were not required to submit laboratory documentation of infection.

We attempted to obtain coccidioidomycosis-related Doctor's First Reports of Occupational Injury or Illness from the California Department of Industrial Relations for employees at both prisons from 2009–2013. These reports are required to be completed by an employee's physician within 5 days of initial examination for every occupational injury or illness. These reports are then sent to the employer's workers' compensation insurance carrier or the insured employer.

Confidential Medical Interviews with Employees

We invited employees from all job categories working during regular business hours and employees working first, second, and third watch (a non-probability, convenience sample) to participate in individual, semi-structured confidential medical interviews to obtain information about working conditions and possible risk factors for disease. During these interviews, we discussed their work, time spent outdoors at work and outside of work, work tasks such as soil disrupting activities, respirator use, pertinent medical history, and residence in areas where *Coccidioides* is found.

Assessment of Environmental Practices

We met with headquarters and local facilities and engineering staff at both prisons to learn about environmental mitigation efforts to minimize employee and inmate exposures to *Coccidioides*. We obtained copies of soil stabilization plans proposed for both prisons using Soil-Sement® (a water-based acrylic and polyvinyl acetate polymer). We reviewed policies and practices that could disturb the soil, such as excavation, mowing, soil disking (shallow plowing), and security sweeps along the perimeter of the prisons.

Ventilation Assessment

We met with facilities and engineering staff to discuss the ongoing upgrade to the air filters used in many of the ventilation systems at the prisons. We visited offices, health clinics, and inmate housing units to observe the types of ventilation systems and air filters used in these systems, and to look for evidence of mold or water intrusion. Because of the expansiveness of the prisons, where dozens of structures were spread across 600+ acres at each complex, we selected buildings where more prison employees worked (such as health clinics and administrative offices). Because the inmate living units were structurally similar within each prison complex, we randomly selected one or two living units at each prison for our walk-through building survey and ventilation assessment. We measured temperature, relative humidity, and carbon dioxide. Carbon dioxide levels are used to evaluate the adequacy of ventilation systems in providing outdoor air to occupied spaces. We used ventilation smoke tubes to visually evaluate airflow patterns, and a TSI Model EBT731 Balometer to measure the amount of air provided by air handling units to some occupied spaces.

Results

Review of Occupational Health Policies and Practices

We reviewed excerpts from the supplemental operations manual, the written respiratory protection plans, the aerosol transmissible diseases exposure control plans, and the excavation safety plan for prison B. According to the June 2013 supplemental operations manual for both prisons, the watch commander can put an institutional yard recall into place for prolonged power outages during non-daylight hours. An institutional yard recall means that all inmates on the exercise yards must return to their assigned housing units. The watch commander can also initiate limited visibility operations when the guards at the perimeter tower posts are unable to see one another clearly and distinctly. Implementing limited visibility operations means that yard exercise and outdoor programs within the security perimeter must stop. At the time of the evaluation, neither prison had procedures for stopping yard exercise and outdoor programs for dust storms or unusually dusty or windy days. At prison A, the chief medical executive reportedly had the authority to instruct custody staff to make announcements to the general inmate population on days with high winds, advising them to refrain from outdoor recreation and to remain indoors. This was an unwritten policy.

The February 2011 aerosol transmissible diseases exposure control plan covered both the corrections agency and the correctional health care services agency. This plan included sections on engineering and work practice controls and personal protective equipment, respiratory protection, medical services, training, and record keeping. Appendix B of this plan contained a list of aerosol transmissible pathogens or diseases for the purposes of Section 5199 of the California Aerosol Transmissible Diseases standard [8 CCR 5199]. This list identifies diseases and pathogens requiring airborne infection isolation, such as tuberculosis and measles, and those requiring droplet precautions, such as influenza and bacterial meningitis. The list does not include *Coccidioides*. Generally, this standard does not apply to *Coccidioides* outside of the laboratory setting [8 CCR 5199].

At the time of the evaluation, the respective fire chiefs managed the respiratory protection programs for prisons A and B. Both programs covered employees and inmate workers and contained the basic elements required by the OSHA respiratory protection standard, including respirator selection, medical evaluation, respirator training, fit testing, respirator use, and handling of disposable respirators [29 CFR 1910.134]. The programs also listed employees assigned to areas or jobs that required the use of respiratory protection. The list for prison A included most plant operations employees as well as hazardous material specialists. The list for prison B included some plant operations employees, all custody employees, and some healthcare employees. Neither program included procedures for using respirators to protect employees or inmate workers from potential exposures to *Coccidioides*. However, in June 2013, a memorandum was issued to all prison A employees by the chief medical executive, which recommended that staff wear an N95 filtering facepiece respirator when outdoors on windy or dusty days.

The associate warden for business services directed the excavation safety program at prison B. This written program included information on training, excavation requirements such as use of structural ramps and ladders, protective system requirements such as sloping and benching systems, and accident investigations. This program did not include procedures for wetting down surfaces prior to excavation. The program had information about using eye protection, hard hats, harnesses with lifelines, and hearing protection, but respiratory protection was not mentioned.

Review of Coccidioidomycosis Among Prison Employees

Coccidioidomycosis Confidential Morbidity Reports

We identified 65 confirmed cases of coccidioidomycosis reported to CDPH among prison A employees from January 1, 2009, to June 10, 2013. We identified 38 confirmed cases of coccidioidomycosis reported to CDPH among prison B employees from January 1, 2009, to July 16, 2013. The coccidioidomycosis cases were reported among prison A and B employees by nine California counties of residence during this time period. Reporting counties included Fresno, Kings, Tulare, Kern, San Luis Obispo, Santa Clara, Madera, Riverside, and Los Angeles.

We calculated crude 4-year and crude average annual incidence rates of coccidioidomycosis for prison A and B employees from 2009 to 2012. The crude 4-year incidence rate of coccidioidomycosis among prison A employees was 4,156 cases per 100,000 employees from 2009 to 2012. The average annual incidence for prison A employees was 1,039 cases per 100,000 employees over this time. The crude 4-year incidence rate of coccidioidomycosis among prison B employees was 2,044 cases per 100,000 employees from 2009 to 2012. The average annual incidence for prison B employees was 511 cases per 100,000 employees over this time.

For the confirmed cases among employees in 2009–2012, the 12-month combined incidence over this 4-year period did not display a clear seasonal pattern (Figure 1).

Of the 65 confirmed cases of coccidioidomycosis among prison A employees, 57 (88%) were male, and 8 (12%) were female. The median age of cases was 41 years (range: 24–67 years). Two deaths were reported; the number of hospitalizations is unknown. The median amount of time worked at the prison before onset of symptoms was 4 years (range: 2 months–16 years). Other demographic and work characteristics of the 65 employees are shown in Table 1. All but two employees with confirmed cases of coccidioidomycosis resided in one of the six hyperendemic California counties (Table 1).

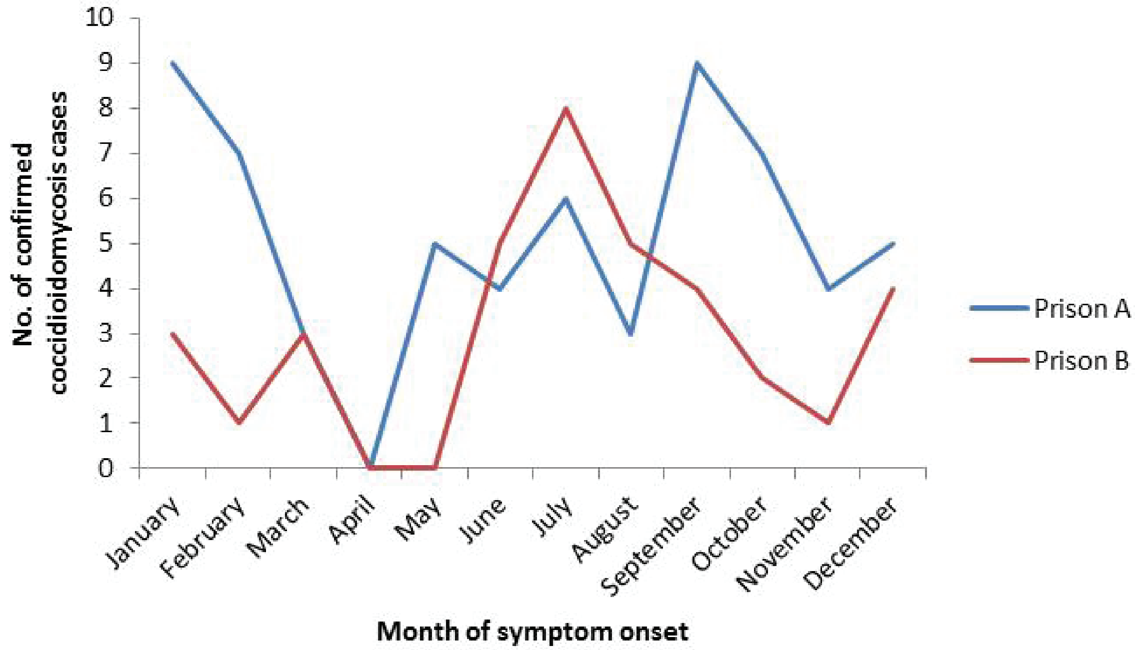

Figure 1. Number of coccidioidomycosis cases among prison A and B employees by month of symptom onset during 2009–2012.

The most common job categories at the time of diagnosis, as collected from agency employee rosters, of the 65 prison A employees with confirmed coccidioidomycosis were custody (n = 48), healthcare (n = 7), and administrative (n = 5). Only seven cases had occupation/job title and occupational setting recorded in the confidential morbidity report that was submitted to CDPH. One case incorrectly had a school listed as the occupational setting. For the other 57 cases, these fields were blank.

Of the 38 cases of coccidioidomycosis among prison B employees, 27 (71%) were male, and 11 (29%) were female. The median age of cases was 44 years (range: 24–63 years). One death was reported; the number of hospitalizations is unknown. The median amount of time worked at the prison before onset of symptoms was 8 years (range: 2 months–23 years). Other demographic and work characteristics of the 38 employees are shown in Table 1. All but one employee with confirmed cases of coccidiodomycosis resided in one of the six hyperendemic counties (Table 1).

The most common job categories at the time of diagnosis, as collected from agency employee rosters, were custody (n = 26), administrative (n = 5), and healthcare (n = 4). Only three cases had occupation/job title and occupational setting recorded in the confidential morbidity report that was submitted to CDPH. For the other 35 cases, these fields were blank.

Table 1. Demographic characteristics of employee cases of coccidioidomycosis

Demographic characteristic	No. (%) prison A employees n = 65	No. (%) prison B employees n = 38
Male	57 (88)	27 (71)
Race		
White	17 (26)	9 (24)
African-American/Black	3 (5)	3 (8)
Asian	2 (3)	1 (3)
Other	2 (3)	1 (3)
Unknown	40 (62)	24 (63)
Ethnicity		
Hispanic/Latino	16 (25)	10 (26)
Non-Hispanic/Non-Latino	11 (17)	6 (16)
Unknown	38 (59)	22 (58)
California county of residence		
Fresno	34 (52)	13 (34)
Kings	22 (34)	13 (34)
Tulare	4 (6)	6 (16)
Madera	3 (5)	0 (0)
Kern	0 (0)	3 (8)
San Luis Obispo	0 (0)	2 (5)
Other	2 (3)	1 (3)
Job Category		
Custody	48 (74)	26 (68)
Administrative	5 (8)	5 (13)
Healthcare	7 (11)	4 (11)
Plant operations	2 (3)	0 (0)
Education/vocation	0 (0)	1 (3)
Other*	3 (5)	2 (5)

*Job titles in the other category included chaplain, industrial supervisor, and correctional supervisory cook.

Coccidioidomycosis Reports from Other Sources

We reviewed coccidioidomycosis-related reports from the OSHA Logs from 2009 to 2013 for both prisons. Prison A recorded 61 employees with reported work-related coccidioidomycosis in the OSHA Logs from 2009 to May 23, 2013. Forty (66%) of these employees were also reported to CDPH as confirmed coccidioidomycosis cases.

Job title groups of the 61 employees included custody (n = 43), healthcare (n = 7), administration (n = 5), plant operations (n = 4), and other (n = 2). Of these 61 employees, 41 (67%) were reported to miss days from work. The median number of days away from work for these 41 employees was 70 (range: 2–367 days).

Prison B recorded 42 employees with reported work-related coccidioidomycosis in the OSHA Logs from 2009 to June 12, 2013. Job title groups of the 42 employees included custody (n = 22), healthcare (n = 8), administration (n = 5), other (n = 5), education/vocation (n = 1), and plant operations (n = 1). Of these 42 employees, 29 (69%) were reported to miss days from work. The median number of days away from work for these 29 employees was 95 (range: 11–730 days). Only 21 (50%) of the 42 employees in the OSHA Logs were also reported to CDPH as confirmed coccidioidomycosis cases.

We were unable to obtain physician documentation or laboratory testing results for cases reported in the OSHA Logs from each prison. We were also unable to obtain the Doctor's First Reports of Occupational Injury or Illness from the California Department of Industrial Relations from 2009–2013.

Confidential Medical Interviews with Employees

At prison A, we interviewed 98 of 99 invited employees. At prison B, we interviewed all 74 invited employees.

Demographic and Health Characteristics of Interviewed Employees

The median age of interviewed employees was 45 years (range: 25–74 years) at prison A and 48 years (range: 27–67 years) at prison B. Most employees were male (64% at prison A and 70% at prison B). Only one employee reported being pregnant at the time of the interview. Interviewed employees most commonly self-reported their race as white (64% for prison A and 54% for prison B). Between 5%–6% of interviewed employees at both prisons self-identified their race as Filipino and between 2%–3% self-reported their race as black/African American. Forty-two percent of interviewed employees at both prisons self-reported their ethnicity as Hispanic/Latino.

The median number of years that employees reported living in one of the six hyperendemic California counties was 35 (range: 0.5–67 years) at prison A and 34 years (range: 6–61 years) at prison B. The median number of years employees reported living in one of the six endemic states or Mexico was 38 (range: 6.5–67 years) at prison A and 40 years (range: 14–63 years) at prison B.

Work Characteristics of Interviewed Employees

All interviewed prison employees were employed full time. The median hours worked per week was 40 hours for both prisons, although some employees reported working up to 80 hours. The median time worked at the prison was 7 years (range: 6 months–19 years) at prison A and 8 years (range: 4 days–22 years) at prison B. Other work characteristics are shown in Table 2.

Table 2. Work characteristics of interviewed employees

Work characteristic	No. (%) prison A employees n = 98	No. (%) prison B employees n = 73–74*
Job title group		
Custody	46 (47)	32 (43)
Administration	19 (19)	11 (15)
Plant operations	13 (13)	9 (12)
Healthcare	12 (12)	10 (14)
Education/vocation	8 (8)	4 (5)
Other†	0 (0)	8 (11)
Work shift		
First watch	12 (12)	9 (12)
Second watch	24 (25)	16 (22)
Third watch	14 (14)	17 (24)
Business hours	48 (49)	31 (42)
Has another job	9 (9)	5 (7)

*Sample sizes varied because of missing values.

†Other more common job title groups included cook and prison industry employee.

The median time spent outdoors during the workday was 2 hours (range: 10 minutes–8 hours) for prison A, and 1.5 hours (range: 0–9 hours) for prison B. Work activities of the interviewed employees are shown in Table 3.

Table 3. Work activities of interviewed employees

Work activity	No. (%) prison A employees n = 97–98*	No. (%) prison B employees n = 73–74*
Eat outside during work	10 (10)	13 (18)
Outside work activities		
Walking from building to building	98 (100)	73 (99)
Security checks	27 (28)	15 (20)
Patrolling	22 (22)	13 (18)
Maintenance	12 (12)	9 (12)
Landscaping	3 (3)	2 (3)
Delivery	12 (12)	7 (9)
Other†	33 (34)	32 (43)
Soil disruption activities	29 (30)	13 (18)
Outside in dust storm during job	78 (80)	63 (85)

*Sample sizes varied because of missing values.

†Other outside work activities included alarm testing and response, escorting, supervising inmates, and riding in carts.

In total, 30% of prison A employees and 18% of prison B employees who were interviewed reported that their job involved disruption of soil. At prison A, of the 29 employees who reported disrupting soil, they reported doing this constantly (n = 2), sometimes (n = 14), and rarely (n = 13). At prison B, of the 13 employees who reported disrupting soil, 4 reported doing this constantly, and 9 reported doing this sometimes. The most commonly reported soil disruption activities at both prisons included grid searches and digging for contraband in the soil by custody employees, and drilling/digging for maintenance and repairs by plant operations employees. Equipment used included shovels, rakes, pick axes, backhoes, and garden tractors.

All 172 interviewed employees reported having heard of coccidioidomycosis or valley fever prior to the start of the interview. At each prison, 66% of interviewed employees reported having received training on coccidioidomycosis related to their work. Types of training reported by employees included on-the-job training, pamphlets in paychecks, memos, bulletin board posters, department safety meetings, classroom training (given by the medical director at prison A), and modules as part of annual block or in-service training.

Regarding respirator access, 67 (68%) employees at prison A and 55 (76%) employees at prison B reported having access to an N95 filtering facepiece respirator or other respirator. In total, 24 (25%) employees at prison A and 21 (28%) employees at prison B reported ever using an N95 filtering facepiece respirator or other respirator when exposed to dust during their work at the prisons. At prison B, the most common facial protection devices reported to be used were N95 filtering facepiece respirators (n = 19), half-mask elastomeric air purifying respirators (n = 3), and non-National Institute for Occupational Safety and Health (NIOSH) approved masks including surgical masks (n = 7) and dust masks (n = 7). At prison B, the most common facial protection devices were N95 filtering facepiece respirators (n = 18) and non-NIOSH approved masks including surgical masks (n = 13) and dust masks (n = 1). Employees reported using respirators or masks when walking or working outside during dusty days or during dust storms, digging/jackhammering, and changing air filters in the ventilation systems. At prison B, employees reported wearing respirators or masks when passing out medications during pill call. Employees dispensed medication to inmates through an open window, and many wore respirators to protect themselves from outdoor dust that would blow into the building.

Potential Exposures Outside of Work

The median time spent outdoors outside of work was 2 hours per day (range: 10 minutes–6.5 hours) for prison A employees and 2.5 hours (range: 0–14 hours) for prison B employees. Only one employee from prison B reported spending no time outdoors outside of work. The most common outdoor activities of interviewed employees outside of work included hiking, walking, running, gardening, biking, golf, and other outdoor sports.

Health Characteristics of Interviewed Employees

In total, 21 (21%) employees at prison A and 14 (19%) employees at prison B reported having at least one current underlying medical condition placing them at higher risk for disseminated disease. These conditions included lung disease such as asthma or emphysema, diabetes mellitus, taking immunosuppressive medications, heart disease, kidney disease, and cancer requiring chemotherapy or radiation therapy. At each prison, 9% of employees reported smoking tobacco at the time of the interviews.

At prison A, 13 (13%) employees reported being diagnosed with coccidioidomycosis since starting work at the prison. Symptom onset ranged from 1999–2012, and three employees reported being hospitalized. Of the 13 employees, 11 reported this illness to their employer, and employees reported being absent from work from 0 days to 5 months for this illness. Job title groups of these employees included custody (n = 9), education/vocation (n = 2) healthcare (n = 1), and plant operations (n = 1). The median number of years these 13 employees lived in the Central Valley was 34 (range: 2.5–49 years). None of these 13 employees self-identified as Black or African American or Filipino; seven reported being of Hispanic or Latino ethnicity. Only one of the 13 employees reported having an underlying medical condition (diabetes) placing him/her at higher risk for disseminated disease.

At prison B, three (4%) employees reported being diagnosed with coccidioidomycosis since starting work at the prison. Symptom onset ranged from 2001–2011, and one employee reported being hospitalized. All three employees reported this illness to their employer, and they reported being absent from work from 7 days to 7 months for this illness. Job title groups of these employees included custody (n = 1), and other (n = 2), which consisted of cook and prison industry employee. The median number of years these three employees lived in the Central Valley was 45 (range: 12–54 years). None of these three employees self-identified as Black or African American or Filipino; two reported being of Hispanic or Latino ethnicity. Only one of the three employees reported having an underlying medical condition at higher risk for disseminated disease.

Of the five prison A employees who reported a coccidioidomycosis diagnosis between 2009 and the time of the interviews, three had their diagnoses reported to CDPH. The one prison B employee who reported a coccidioidomycosis diagnosis between 2009 and the time of the interviews had his diagnosis reported to CDPH.

Assessment of Environmental Practices

The facilities and engineering staff at both prisons reported not conducting major soil disruption activities when wind speeds were "unusually high." Dry road sweeping was not done, and water was used to suppress dust during major soil disrupting activities. Staff at both prisons reported reducing the amount of soil disking at the perimeter of the prison complex. Disking was done for security because it removed unwanted vegetation and evened the ground, thus minimizing potential hiding spots for inmates and contraband. Prison B staff estimated they had reduced disking by 90% in 2013 compared to prior years, and had stopped disking inside the prison fence. Prison B also limited mowing to between February and April.

Soil stabilization had been done at prison A in 2011, but not at prison B. New plans called for stabilizing approximately 93 acres at prison A, and 276 acres at prison B. Most of the stabilized acreage was at the perimeter of each prison complex, although soil surrounding inmate housing units, offices, and clinics was also scheduled for treatment.

We discussed re-vegetation plans with the facilities and engineering staff at both prisons. Because the prisons are areas with arid climates, state and county water restrictions and the cost of purchasing water present challenges to maintaining vegetation. At the time of our evaluation, the inmate exercise yards at both prisons were grass-covered. However, much of the soil around clinics, offices, and along the perimeter of the prison complex was bare or covered with gravel. The facilities and engineering staff at prison B told us that watering the inmate exercise yards had restarted in the spring of 2013, and that prior to this the exercise yards had bare soil. Re-vegetation efforts elsewhere at prison B had slowed because of the cost of purchasing water.

In discussions during and after our site visit, prison managers asked us about the usefulness of environmental sampling for dust and for *Coccidioides* and monitoring wind speed and direction at the prisons to predict environmental conditions that may place prison employees at greater risk of exposure to this fungus. At the time of our evaluation, no environmental sampling for dust or *Coccidioides* had been done. A meteorological station at prison A recorded wind direction, wind speed, and rainfall. However, according to prison managers, these data were used for wastewater treatment reporting requirements and not to monitor for high wind conditions. We were also asked about the effectiveness of respiratory protection in minimizing employee exposures to *Coccidioides*.

Ventilation Assessment

Both prisons were replacing minimum efficiency reporting value (MERV) 8 air filters with MERV 13 or 14 rated air filters at the outdoor air supply for air handling units, beginning with inmate housing units. No air filter upgrades had yet been made to the mechanical heating and air-conditioning units (package units) serving the clinics and administrative offices. However, some clinic buildings that we evaluated were already using high efficiency air filters per their original ventilation design.

During our walk-though evaluations of selected offices, clinics, and inmate housing units, we looked for visual evidence of mold or water intrusion and saw none. We measured temperature, relative humidity, and carbon dioxide. We used the latter to evaluate the adequacy of ventilation systems in providing outdoor air to occupied spaces. Most of the offices and clinics that we surveyed were mechanically ventilated (air-conditioned). Temperatures were within recommended summer comfort guidelines of 75°F to 80.5°F, assuming slow air movement and 50% relative humidity [ASHRAE 2010a]. ASHRAE also recommends maintaining relative humidity at or below 65%, which it was. Excessive humidity can promote the excessive growth of microorganisms and dust mites [ASHRAE 2010a]. Finally, indoor carbon dioxide concentrations were similar to outdoor concentrations, suggesting that an adequate amount of outdoor air was being provided [ASHRAE 2010b].

Inmate housing units were cooled with roof-mounted indirect and direct evaporative units (described in detail below). Because the housing units were not air-conditioned, temperature and relative humidity levels were generally higher than in the offices and clinics, and occasionally exceeded ASHRAE summer comfort guidelines of 75°F to 80.5°F, assuming 50% relative humidity.

Prison A Ventilation Assessment

At prison A, the inmate living units, except for the administrative segregation building that we did not evaluate, had two-person cells positioned across three of the four sides of each two-story living unit. The inmate housing units were cooled with roof-mounted indirect and direct evaporative units. Per design, the evaporative coolers switched from indirect evaporative cooling to indirect and direct evaporative cooling based on indoor air temperature. Heat was provided by natural gas.

We visually examined evaporative air cooler #2 in inmate living unit B5. The state correctional and rehabilitation agency had installed testing equipment on this air cooler to evaluate the impact of the new air filters. The evaporative air cooler appeared well maintained with no evidence of microbial contamination, and the air filters appeared clean and correctly installed.

We examined the airflow patterns in two inmate housing units (B4 and B5) using ventilation smoke tubes to see if the buildings were under positive pressure relative to the outdoors as is recommended, meaning that indoor air would flow from an open door or window to the outdoors. When measured at the one entrance door in each building, B5 was under positive pressure, and B4 was under negative pressure relative to the outdoors. There was a gap around both entrance doors when closed. We observed a similar airflow pattern at the single operable window in the second floor control booth in each building. The window in building B5 was slightly open, and the control booth was under positive pressure relative to the outdoors. The window in building B4 was open about halfway and this control booth was under negative pressure relative to the outdoors. We were told that the control booth officer decided whether the exterior window was opened. The airflow direction at the entrance door and operable window could change depending on ambient wind direction and wind speed.

We measured the airflow provided to the second floor control booths in B4 and B5. Unlike the inmate housing areas, the control booths were air-conditioned and heated by roof-mounted package units. The unit serving the B4 control booth was not initially operating when we arrived, and the thermostat in the control booth had been turned off. The bathroom exhaust fan in the B4 control booth was also not operating. The airflow measured at the ceiling diffusers ranged from 97–299 cubic feet per minute (cfm) in the B4 control booth and 224–336 cfm in the B5 control booth.

We visually examined two of the roof-mounted package units that served the clinical treatment center. Air handler RTU-6 had a metal mesh prefilter and a high-efficiency particulate air filter (Airguard Variflow VMB-604). The duct lining near the return air duct in RTU-6 was dirty and damaged. Another package unit (RTU-5) was not operating (cause unknown). The main entrance to the clinical treatment center was under positive pressure relative to the outdoors with the door closed. However, when we arrived at the clinical treatment center, the entrance door had been propped open with a rock. This practice allows unfiltered air to enter the building. An employee in the clinical treatment center explained that the entrance door was propped open during inmate transfers.

The airflow pattern at the main (west) entrance to office building 800 was positive to the outdoors. The airflow pattern at the east doorway leading from the office building to the prison yards was in the opposite direction, meaning that air flowed into the building. However, airflow direction at either entrance could change depending on prevailing wind direction and wind speed. Several restrooms and one inmate restroom/custodial closet in building 800 were under positive pressure relative to the hallway. This is not recommended because odors from these restrooms could enter occupied areas.

Prison B Ventilation Assessment

At the time of the evaluation, inmates lived in open dormitories with no individual cells except for administrative segregation. We toured the “270 building” and “E bed” dormitory styles. The direct evaporative coolers for the inmate living units were on the roof (“270 buildings”) or on the back wall (“E-bed”). A central power plant provided steam or hot water for building heat, showers, laundry, and cooking. Most of the clinics and administrative areas were mechanically cooled and heated with roof-mounted package units.

According to facility managers, for approximately the past 10 years, the direct evaporative coolers for the inmate living units used MERV 8 panel air filters and no sock filters even though the evaporative coolers were designed for both. In 2013, the prison began installing MERV 13 panel prefilters and MERV 14 sock filters (as the secondary filter) in the evaporative coolers. Because such an air filter upgrade could affect the quantity of air provided by the ventilation system to the indoor spaces, we measured the airflow to inmate dorms in building 410 under different air filter arrangements. The evaporative air cooler that we evaluated appeared well maintained with no evidence of microbial contamination, and the air filters were clean and correctly installed.

Airflow to the inmate dorms decreased by as much as 10% when the MERV 8 filter was replaced by MERV 13 and 14 filters (Appendix C, Figures C1 and C2). In response to inmate concerns regarding perceived poor ventilation in building 410, we measured airflow from all three evaporative air coolers. As shown in Table 4, airflow averaged 286 cfm among the eight dorms serviced by unit C, compared to an average of 551 cfm among the dorms serviced by unit A, and 607 cfm among the dorms serviced by unit B. We visually checked unit C; it appeared to be operating normally, and the dampers inside the supply air diffusers in the inmate dorms were open. We were unable to determine why the airflow varied between these identical air coolers in building 410.

Table 4. Airflow to inmate dorms in Building 410 at prison B, June 6, 2013

Evaporative cooler	Floor	Inmate dorm	Airflow (cfm)	Comments
Unit A*	1st	1	673	
		2	675	
		3	185	Damper closed
		4	738	
	2nd	13	636	
		14	447	Plastic on bottom of grill
		15	757	
		16	300	Plastic inside grill
Unit B*	1st	5	849	
		6	659	
		7	708	
		8	809	
	2nd	17	409	
		18	572	
		19	383	
		20	466	
Unit C*	1st	9	317	
		10	223	
		11	370	
		12	436	
	2nd	21	207	
		22	276	
		23	287	
		24	178	

cfm = cubic feet per minute

*Airflow measurements were taken with MERV 13 prefilters and MERV 14 sock (secondary) filters in place.

In response to concerns from some clinic employees about outdoor dust entering their work area, we checked the airflow patterns in two rooms in the old clinic used to dispense medication to inmates. Using ventilation smoke tubes, we found that outdoor air flowed into the room when employees opened an exterior pass-through service window in order to dispense drugs to the inmates.

Discussion

We identified 65 confirmed cases of coccidioidomycosis among prison A employees and 38 confirmed cases among prison B employees from January 1, 2009, through mid-2013. The crude average annual incidence of coccidioidomycosis between 2009 and 2012 was 1,039 cases per 100,000 employees at prison A and was 511 cases per 100,000 employees at prison B. We are unable to state whether the difference between the prisons reflects a real difference in risk and, if so, whether it is related to work or non-work factors.

The crude average annual incidence among prison employees appears to be higher than the crude average annual incidence reported among the general non-inmate adult population in the surrounding Fresno (40 cases per 100,000 persons) and Kings (110 cases per 100,000 persons) [Mohle-Boetani 2013; Tabnak 2013]. However, comparisons of crude incidence rates between employees and the adult population of the surrounding county should be interpreted cautiously because of unmeasured confounding factors in the background population. We were not able to obtain age-, sex-, and race-adjusted incidence calculations for the comparison populations, and therefore, avoided making any statistical comparisons. It is also possible that reporting or testing bias (or increased reporting or testing among the employees) due to heightened awareness and concern could have contributed to the difference in crude incidence rates.

It was not possible to determine if each confirmed case of coccidioidomycosis among prison employees was due to an exposure at work or outside of work. The vast majority of prison employees with confirmed cases of coccidioidomycosis resided in a hyperendemic area, and our interview findings revealed that employees are likely exposed to *Coccidioides* both at work and outside of work. At work, almost all interviewed employees at each prison reported spending some time outdoors. Even walking from building to building could pose a risk for exposure to *Coccidioides*. Almost one-third of interviewed employees reported having a job that involved disruption of soil. Activities included grid searches and digging for contraband in the soil by custody employees and drilling/digging for maintenance and repairs by plant operations employees. These activities could increase the risk of exposure to *Coccidioides*. The excavation safety plan for prison B did not include wetting down soil prior to excavation, although it was reportedly done in practice. The written respiratory protection program did not include guidance for respirator use during soil disruption activities.

About 80%–85% of interviewed employees reported being outside in dust storms during their job. This could increase their risk of exposure to *Coccidioides*. According to the supplemental operations manual we reviewed, there are no written procedures for ending yard exercise and outdoor programs for dust storms or for unusually dusty or windy days.

Environmental mitigation efforts, such as reducing soil disking, less frequent mowing, paving roads, and wetting soil before it is disturbed, can reduce the dust levels. Soil stabilization can reduce a form of wind erosion called saltation, the direct entrainment of fine dirt and dust particles by wind. Saltation contributes to an effect called sandblasting, where airborne dirt and dust particles repeatedly impact the soil surface downwind, dislodging even more particles in the process. Researchers have speculated that saltation may rupture the fungal structure of *Coccidioides*, and sandblasting can disperse the airborne *Coccidioides* spores at wind speeds lower than those required to directly entrain either the fungus or its spores [Zender and Talamantes 2005]. However, naturally occurring dust storms, combined with ongoing soil disturbing activities such as farming and construction that occur on land adjacent to each prison, can recoat stabilized soil and may reduce or shorten the possible benefit of soil treatment. Consultation with the local Air Pollution Control District may be valuable when considering environmental mitigation projects for dust control.

The prisons also face ongoing challenges to maintain and/or restore vegetation around office buildings and clinics and to maintain grass in the inmate exercise yards. These challenges result from external state and county water restrictions and the cost of purchasing water above their allotment. Like soil stabilization, maintaining grass and other vegetation can reduce saltation and sandblasting.

Regardless of the environmental mitigation effort, little to no data exists that demonstrate the effectiveness of these measures in reducing airborne dispersal of *Coccidioides* [Brown et al. 2013]. For example, airborne spores can travel for miles, and focal *Coccidioides* sites may be small and/or unevenly distributed within endemic areas [Kirkland and Fierer 1996; Fisher et al. 2000; Brown et al. 2013]. Although these dust reduction measures may lower the risk for localized airborne dispersion of *Coccidioides*, they neither eradicate the organism from the soil nor prevent exposure to dust from areas outside of the prison grounds. Nevertheless, reducing dust is a reasonable risk-based strategy to help to try to reduce occupational coccidioidomycosis.

Managers from the state correctional health care services agency asked whether measuring wind speed or doing air sampling for *Coccidiodes* may be useful in deciding how to reduce employee's exposure to *Coccidiodes*. Collecting local meteorological data, specifically wind speed, may be useful in defining "unusually windy" conditions and making risk management decisions on when outdoor work or exercise is permitted. However, we do not have specific guidance on acceptable or unacceptable wind speeds in relation to the risk of exposure. Regarding sampling, sensitive DNA-based methods for air or surface sampling specifically for *Coccidioides* have not been widely accepted [Nguyen et al. 2013]. Though current limited sampling methods are not likely to be helpful in assessing employee exposures or developing risk-based control measures, future research to explore how improved testing and strategies may yield valuable information are needed.

Our observations and discussions with employees during our walk-through surveys and environmental assessments indicate that exposure to dust can occur indoors and outdoors. For example, we saw open doors and windows in several buildings that allowed unfiltered air to enter the occupied space. Employees can carry dust indoors on their clothing and shoes. The practice of dispensing medication to inmates through an open exterior window in the old clinic building at prison B resulted in an unnecessary employee exposure to outdoor dust.

Switching from a medium efficiency (MERV 8) filter to a higher efficiency (MERV 13 or 14) filter should reduce employee and inmate exposure to dust while indoors. However, this filter change will affect the performance of the ventilation system. For example, at prison B we measured a 10% reduction in the volume of conditioned air provided to inmate housing units after MERV 8 air filters were replaced by both MERV 13 prefilters and MERV 14 secondary filters. This decrease in supplied air could affect occupant comfort. A lower efficiency and less expensive prefilter could be used that would extend the life of the more expensive secondary MERV 14 filter. Regardless, switching from lower to higher-efficiency air filters will require developing a new replacement schedule to prevent filter overloading and possible damage to the ventilation system. We understand that consideration was being given to further upgrading to MERV 16 (or higher) filters. Such a decision should balance concerns of reduced air flow, higher air filter cost, and more frequent maintenance. While there would be a modest increase in efficiency in removing very small particles, *Coccidiodes* spores adhere to soil particles of a wide size range [Das et al. 2012]. Thus, the benefits of modest increases in filter efficiency may not be realized.

While evaluating the air filter changes, we responded to inmate concerns regarding perceived poor ventilation in building 410 at prison B. We found differences in the quantity of outdoor air supplied by three apparently identical air handling units serving the inmate living areas (Table 8). The amount of outdoor air supply also differed between floors and between inmate living areas. We saw one supply air diffuser that was closed, and several that were partially blocked with plastic debris. These ventilation problems are unrelated to the primary objectives of this evaluation, but they can contribute to poor indoor environmental quality.

All interviewed employees reported living in one of the six counties hyperendemic for coccidioidomycosis, and the majority had spent many years in the area. Almost all interviewed employees at each prison reported spending time outdoors outside of work. Over 50% of employees reported gardening, another potential soil disruption activity. Thus, employees are at risk of exposure to *Coccidioides* outside of work. The relative contributions of work and nonwork exposure to the overall risk cannot be determined.

Nevertheless, coccidioidomycosis has been a recognized problem in inmates of state prisons in the San Joaquin Valley of California, particularly prisons A and B. Annual incidence was noted to be higher among inmates at these two prisons than in the general population of the surrounding counties from 2000–2010 [Pappagianis 2007; California Correctional Health Care Services 2012]. If this discrepancy in rates reflects actual differences, the reasons for the higher rates among inmates are not entirely clear, but may include the possibility that the inmate population includes a high proportion of immune-naïve or previously unexposed inmates relocated from less-endemic areas [Brown et al. 2013]. It is also possible that testing bias due to heightened awareness and health care access in the inmate population also could have contributed to high rates.

Most employees with confirmed coccidioidomycosis and most employees with coccidioidomycosis-related OSHA Log reports worked as custody employees. However, since custody employees make up the majority of the employee population, they do not appear to be represented in disproportionate numbers among cases. We do not know how much time these employees spent outdoors during their job, or whether their infection was due to an occupational exposure. We do know, however, that many custody employees have outdoor job activities such as performing security checks, patrolling, escorting and supervising inmates, and digging for contraband that may put them at risk. However, administrative and healthcare employees, whose job duties do not typically involve outdoor work, were also among the affected employees. We found that four licensed vocational nurses were among the confirmed cases. These employees have responsibilities that include handing out medications. At prison B nurses dispensed medication to inmates using pass-through windows that allowed unfiltered outdoor air to enter the pill room, unnecessarily exposing the nurses to outdoor dust.

Only 8%–11% of employees with confirmed coccidioidomycosis had occupation and job setting information included in their confidential morbidity reports. Enhanced efforts by the county and state health departments to ensure completeness of reporting, especially of the occupation and job information, are needed to improve occupational coccidioidomycosis surveillance and help identify future clusters in the prisons.

Our evaluation has several additional limitations. First, our analysis of the confirmed coccidioidomycosis cases among employees was limited to the information in the confidential morbidity report. This report did not contain information on what type of clinical illness, including disseminated disease, these case employees had. Therefore, we could not determine the severity of the illness for each case. We also did not have information on what personal risk factors these case employees had. Because employees sought medical care from several different health care providers and clinics, we did not obtain all of their medical records. Approximately 60% of these reports had missing race and ethnicity information. Completeness of reporting race and ethnicity information to the county and state health department will help to better characterize the epidemiology of coccidioidomycosis.

Second, we did not calculate 1-year crude incidence rates of coccidioidomycosis among employees due to the small number of cases each year and the difficulty in distinguishing random fluctuation from true changes in the underlying risk of disease inherent to rates based on small numbers. Therefore, we were limited in identifying annual trends.

Third, we were unable to obtain detailed information about the coccicioidomycosis-related OSHA Log reports. Thus, we are unable to explain the discrepancy between the confirmed cases reported to CDPH and the OSHA Log reports. Because the agency does not require physician and laboratory documentation for the OSHA Log reports, it is possible that some of the cases were not actually confirmed cases according to the CSTE definition.

Finally, we interviewed only a small subset of the more than 1,300 employees at each prison. Thus, the self-reported health characteristics and work practices may not be generalizable to the entire employee population.

Conclusions

Prisons A and B are located in hyperendemic areas for coccidioidomycosis, and prison employees are exposed to *Coccidioides* both at work and outside of work. We identified 103 confirmed cases of coccidioidomycosis among employees at the two prisons over a 4½-year period. Measures such as wetting soil before it is disturbed, maintaining grass on exercise yards, stabilizing soil, paving roads, improving building ventilation, and changing work practices (such as reducing time spent outdoors) would be expected to reduce dust exposures to varying degrees. However, none of these measures will eliminate exposure to *Coccidioides,* and their relative effectiveness in reducing occupational coccidioidomycosis is unknown.

Recommendations

On the basis of our findings, we recommend the actions listed below to create a more healthful workplace. We encourage the state correctional and rehabilitation agency and the state correctional health care services agency to use a labor-management health and safety committee or working group to discuss the recommendations in this report and develop an action plan. Those involved in the work can best set priorities and assess the feasibility of our recommendations for the specific situation at the two prisons. Our recommendations are based on the hierarchy of controls approach. This approach groups actions by their likely effectiveness in reducing or removing hazards. Additional recommendations can be found in CDPH's fact sheet "Preventing Work-Related Coccidiodomycosis (Valley Fever)" at http://www.cdph.ca.gov/programs/hesis/documents/CocciFact.pdf.

Engineering Controls

Engineering controls reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee.

As stated in our discussion section, wide-scale measures to reduce airborne dispersal of *Coccidioides* such as watering the soil during construction projects, paving roads, planting grass or other vegetation, and stabilizing the soil could reduce employee exposure to soil or dust. However, little to no data exists that demonstrate the effectiveness of these measures [Brown et al. 2013]. Although these dust reduction measures may lower the risk for localized airborne dispersion of *Coccidioides*, they neither eradicate the organism from the soil nor prevent exposure to dust from areas outside of the prison grounds. Nevertheless, reducing dust is a reasonable risk-based strategy to try to reduce occupational coccidioidomycosis.

1. Consider ongoing efforts to evaluate the effectiveness of environmental mitigation projects, such as soil stabilization, paving roads, and planting grass and other vegetation in reducing occupational coccidioidomycosis. Analyzing inmate and employee cases of coccidioidomycosis before and after an environmental mitigation project may be one method but may not be an accurate measure of the project's effectiveness considering the natural presence of *Coccidioides* and its inherent variability due to climate changes and other factors (such as construction or farming activities occurring near but outside the prison complexes).
2. Include soil-wetting procedures in the excavation safety plan.
3. Keep doors and windows in the office buildings, clinics, and inmate housing units closed except when entering or exiting.
4. Install door sweeps and seal gaps around doors and windows.
5. Develop a new inspection and replacement schedule following installation of the higher-efficiency air filters.

6. Consult with a ventilation engineer to examine the air handling units in building 410 at prison B. Consider expanding this ventilation assessment to the remaining buildings at both prisons.
7. Reduce outdoor dust exposures to employees in the old clinic building at prison B when they dispense inmate medication. Employee exposures could be reduced by maintaining positive pressure in the dispensing room relative to the outdoors, or ending the need to dispense inmate medication through an open window.

Administrative Controls

Administrative controls are management-dictated work practices and policies to reduce or prevent exposures to workplace hazards. The effectiveness of administrative changes in work practices for controlling workplace hazards is dependent on management commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that control policies and procedures are not circumvented in the name of convenience.

1. Provide education and training during working hours to all prison A and B employees on hire and annually thereafter on the symptoms and transmission of coccidioidomycosis, the risk factors for disseminated disease, and ways to minimize exposure both at work and outside of work. Training should be tailored to education level and job category. Additional information on coccidioidomycosis can be found at the following websites:
    a. CDC website at http://www.cdc.gov/fungal/coccidioidomycosis/
    b. CDPH website at http://www.cdph.ca.gov/healthinfo/discond/Pages/Coccidioidomycosis.aspx
2. Encourage state correctional and rehabilitation agency employees to promptly report suspected symptoms of possible coccidioidomycosis to a supervisor. They should receive prompt medical care.
3. Review the OSHA Logs yearly for reports of coccidioidomycosis infections among employees to assess trends over time and across job title groups.
4. Avoid driving vehicles on unpaved roads.
5. Close the prison yards and advise inmates and employees to stay indoors during dust storms and unusually windy or dusty days.
6. Consider hardship transfer requests from employees who have medical risk factors for disseminated coccidioidomycosis such as an immunocompromising condition and who wish to work in a geographic area with a lower incidence of coccidioidomycosis.
7. Consider the use of the coccidioidal spherulin skin test on employees when it becomes commercially available. Determination of prior *Coccidioides* exposure at baseline could be valuable to each employee to evaluate his or her personal risk for disease. This determination should not be used to terminate or reassign an employee to a different job class or work location. Rather, employees should discuss test results along with other personal risk factors with their personal physicians. More research is needed on determining the sensitivity and specificity of the test, improving these

characteristics, and determining how effective it may be in decreasing the burden of coccidioidomycosis among employees. Consideration in using this test should include who does the testing, how the results are used, and how often testing is done on employees.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place. The effectiveness of respiratory protection in preventing coccidioidomycosis has not been determined, and additional research is necessary in this area. Nevertheless, it is reasonable to expect that use of respiratory protection may confer some benefit to employees with high risk exposures by reducing dust exposures.

1. Consider the use of NIOSH-approved respirators for employees who must work outside during unusually dusty or windy conditions or for employees with job duties that may disturb soil such as disking, digging, excavating, and gardening. Given that the effectiveness of respirators in preventing coccidioidomycosis has not been evaluated, the conditions upon which respirators should be used (level of respiratory protection, voluntary vs. required use) are unclear. However, reduction in exposure to soil dust conferred by using respirators may provide benefits to employees. Respirator use must be in conformance with the California OSHA respiratory protection standard (http://www.dir.ca.gov/title8/5144.html). If required, the employees must be included in a written respiratory protection program, and be medically evaluated, trained, and fit-tested. If respirator use is voluntary, employees do not need to be included in the respiratory protection program but must be provided with Appendix D from the California OSHA respiratory protection standard (http://www.dir.ca.gov/title8/5144d.html). Because these prisons are located in areas that have very high daytime temperatures, it is important to consider the additional heat stress effects that may occur with respirator usage. Additional information on the symptoms and treatments for heat related illnesses and recommendations to reduce risk can be found at http://www.cdc.gov/niosh/topics/heatstress/.

2. If the use of respiratory protection is considered, consult the following documents in selecting respiratory protection against *Coccidioides,* based on job tasks and environmental conditions:

    a. "Histoplasmosis—Protecting Workers at Risk," [http://www.cdc.gov/niosh/docs/2005-109/pdfs/2005-109.pdf]
    b. "Preventing Work-Related Coccidiodomycosis (Valley Fever)," [http://www.cdph.ca.gov/programs/hesis/documents/CocciFact.pdf]

Appendix A: *Coccidioides*

Coccidioides

Coccidioides is a fungus that thrives in climates with hot summers and gentle winters, without harsh freezes, with an annual rainfall of about 4–20 inches [Pappagianis 1988; Laniado-Laborin 2007]. The fungus is found in soil, commonly about 2–12 inches beneath the surface [Pappagianis 1988; Fisher et al. 2000]. The organisms can have a sporadic or patchy distribution within a given locality. Environmental conditions, including drought, precipitation, temperature, and wind speed, appear to have an impact on coccidioidomycois incidence [Comrie 2005]. Previous studies have hypothesized that *Coccidioides* spores (vegetative fungal cells in a resting state) are most abundant in the soil after heavy rains and may be most effectively dispersed during dry, hot periods, such as prolonged droughts [Smith et al. 1946; Schneider et al. 1997; Kolivras and Comrie 2003; Comrie 2005]. Thus, increased incidence of infection often occurs after a heavy wet season followed by a prolonged dry spell [Zender and Talamantes 2005]. Incidence in California is thought to be seasonal, with peak incidence occurring during the winter months [Kirkland and Fierer 1996].

Coccidioides spores exhibit several properties including easy dispersion, respirability, and infectivity. Spores are thought to be 2–5 µm in diameter and are able to reach terminal bronchioles and alveoli [Converse and Reed 1966; Schmelzer and Tabershaw 1968].

Appendix B: Coccidioidomycosis Case Definition

Coccidioidomycosis is on the list of National Notifiable Diseases, although not all states have made it reportable [CDC 2012b]. California is among the states where coccidioidomycosis is a reportable condition. CDPH uses the CSTE case definition for coccidioidomycosis [CDC 2012a]. A confirmed case meets the clinical case definition and is laboratory confirmed. A clinical case is defined as an illness characterized by one or more of the following:

- Influenza-like signs and symptoms
- Pneumonia or other pulmonary lesion, diagnosed by chest radiograph
- Erythema nodosum (a deep skin inflammation) or erythema multiforme rash
- Involvement of bones, joints, or skin by dissemination
- Meningitis
- Involvement of viscera and lymph nodes

A confirmed case must also meet at least one of the following laboratory criteria for diagnosis:

- Culture, histopathologic, or molecular evidence of presence of *Coccidioides,* or
- Positive serologic test for coccidioidal antibodies in serum, cerebrospinal fluid, or other body fluids by:
    - Detection of coccidioidal immunoglobulin M by immunodiffusion, enzyme immunoassay, latex agglutination, or tube precipitin, or
    - Detection of coccidioidal immunoglobulin G by immunodiffusion, enzyme immunoassay, or complement fixation, or
    - Coccidioidal skin-test conversion from negative to positive after onset of clinical signs and symptoms

Coccidioidomycosis became laboratory reportable in California in 2010. Since 2008, the laboratory component of the CSTE definition has included cases with a single positive serologic test. Fresno County, in which prison A is located, and Kings County, in which prison B is located, use the CSTE definition.

Appendix C: Figures

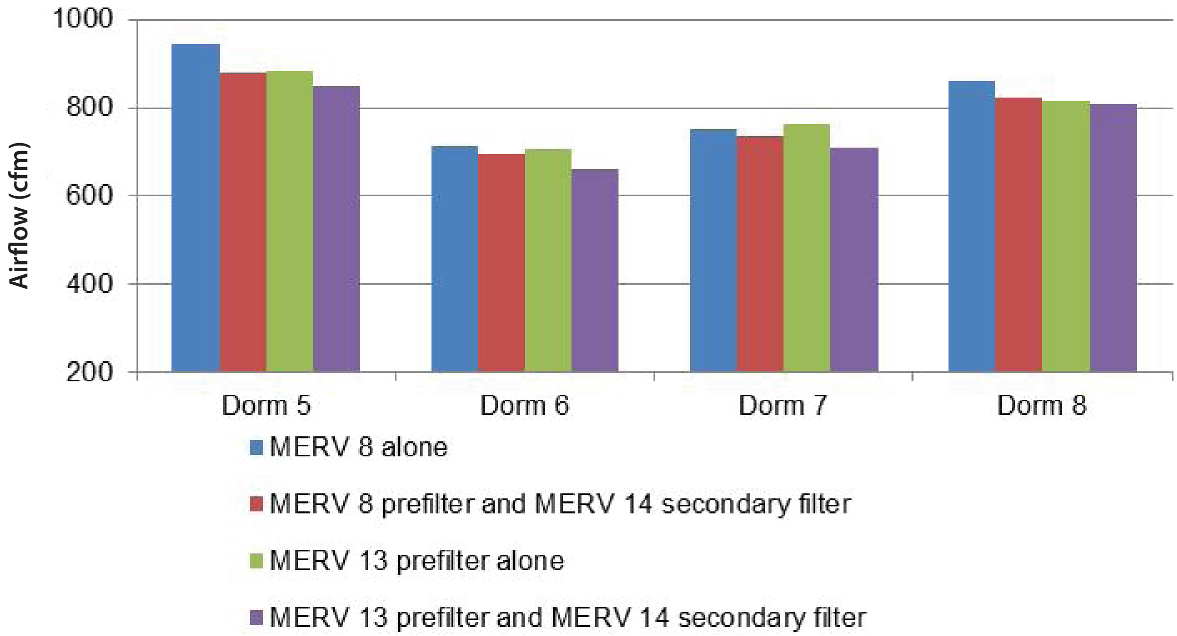

Figure C1. Airflow in cubic feet per minute (cfm) from air handler B to first floor inmate dorms in building 410 at prison B.

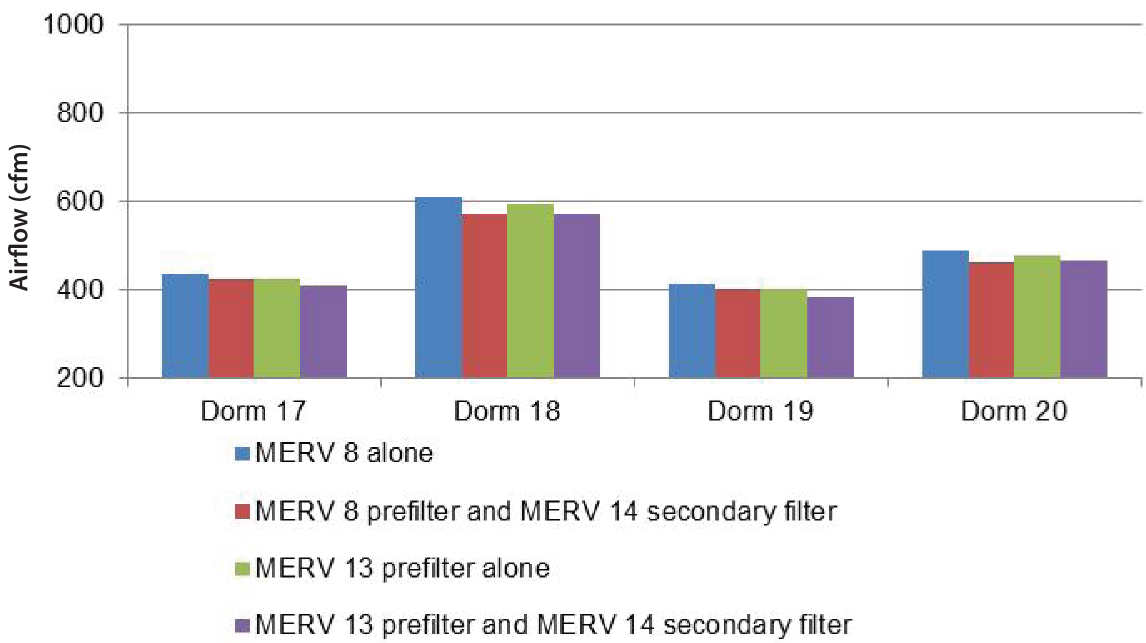

Figure C2. Airflow in cubic feet per minute (cfm) from air handler B to second floor inmate dorms in building 410 at prison B.

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Availability of Report

Copies of this report have been sent to the employer, employees, and union at the call center. The state and local health department and the Occupational Safety and Health Administration Regional Office have also received a copy.

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