

## **Coccidioidimycosis in Kern County, California: Past, Present, and Future**

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## Abstract

Kern County, California is an area rich in economic resources and endemic to *Coccidioides* the agent causing Valley Fever. Valley Fever, coccidioidomycosis, usually manifests a respiratory illness caused by spores of *Coccidioides* found in dust throughout the San Joaquin Valley. For decades, *Coccidioides*, has been studied in California and the surrounding endemic areas and monitoring increasing case rates to formulating targeted audience, primarily workers exposed to dust disturbing activities. Public Health professionals aim to increase education about transmission in efforts to prevent infection and increase awareness about when to seek medical intervention.

*Keywords:* *Coccidioides*, *Coccidioides immitis*, Coccidioidomycosis, Valley Fever, air pollution, particulate matter (PM), Kern County, California, Public Health, COVID-19.

## **Kern County, California and *Coccidioides***

Located about 100 miles north of Los Angeles, Kern County lies at the southern tip of California's Central Valley. The Central Valley is made up of two inner valleys: to the north is the Sacramento Valley and the larger, lower portion is the San Joaquin Valley which is an integral part of California's agricultural domain (United States Geological Society, 2021). To grasp the enormity of natural resources within the Central Valley the United States Geological Survey (2021) provided some brief statistics:

- More than 250 different crops are grown in the Central Valley with an estimated value of \$17 billion per year
- Approximately 75% of the irrigated land in California and 17% of the Nation's irrigated land is in the Central Valley
- Using fewer than 1% of U.S. farmland, the Central Valley supplies 8% of U.S. agricultural output (by value) and produces 1/4 of the Nation's food, including 40% of the Nation's fruits, nuts, and other table foods.
- The predominate crop types are cereal grains, hay, cotton, tomatoes, vegetables, citrus, tree fruits, nuts, table grapes, and wine grapes.
- The Central Valley is one of the more notable structural depressions in the world.

Geographically, Kern County is a basin with mountain ranges to the south, east and west (United States Geological Society, 2021). Kern County also provides the majority of California's oil production making Kern County's natural resources plentiful (Michieka et al, 2018). The largest city within Kern County is Bakersfield and it is located at the base

of the valley alongside a major, well-traveled interstate. Kern County settlement and development began as Americans stretched west towards California in the 1800's (Alexander, 2009). In 1899, oil was discovered in Kern County and oil combined with the agricultural resources brought people to the area for potential economic opportunities (Alexander, 2009). The Depression and then The Dust Bowl migrations (1920s – 1930s) brought the largest influx of new residents from Oklahoma, Missouri, Texas and Arkansas to work in the Kern County oil fields or agricultural crops (Alexander, 2009). The inflow of new workers developing symptoms of illness attracted the attention of public health physicians (Alexander, 2009).

Currently, Kern County's largest population identifies as Hispanic (54.6%), followed by non-Hispanic white (32.8%) and with 51% male population and 10% living in rural areas (Robert Wood Johnson's County Health Rankings, 2021). The Kern County Registered Voter Count Statistics shows registered Republicans as the majority at 36.5% with Democrat registration at 34.5% (2021). Kern County provides many natural resources that should address the community needs to support healthy residents. In contrast, the health outcomes and health factors in Kern County are ranked among the least healthy in California (Robert Wood Johnson's County Health Rankings, 2021). The agricultural industry employs farm workers throughout California. The majority of farm workers identify as Hispanic and USDA data from 2019 indicates 64% of farm workers identify as Hispanic with 57% identifying as Hispanic of Mexican origin (United States Department of Agriculture, 2021). The farmworker population is vulnerable to factors affecting health; particularly, the physical environment leading to exposure of PM, the social and economic disparity preventing access health care and the ability to control

environmental factors (McCurdy et al, 2020). Since Kern County is an agricultural oasis, economic disparity and rural living may be contributing factors the residents face accessing education and other societal resources that should be available in the setting of abundant natural resources (Michieka et al, 2018).

The County Health Rankings (2021) identifies poor air quality as a Kern County concern. There are two negative factors affecting air quality in Kern County; geography and physical environment. Kern County is a basin that traps dust and industrial air pollution and with poor air flow to move out the particulate matter (United States Geological Survey, 2021). Environmentally, emissions from the interstate commercial and leisure travel are a source of air pollution and particle matter from agricultural interventions (pesticide/soil additives) (Environmental Protection Agency, 2021). Additionally, the Santa Ana winds are a seasonal, weather phenomena where high-speed winds blow from the desert to the ocean and stir up and carry large amounts of dust (National Weather Service, 2021). The particulate matter (PM) quantity in Kern County is 16 ug/m<sup>3</sup>. That is double the California representation reported of 8.1ug/m<sup>3</sup> (Environmental Protection Agency, 2021). The air pollution data utilized in the ranking is derived from the United States Environmental Protection Agency (2021). Particle pollution is defined as “particulate matter (sic), including acids, organic chemicals, metals, soil or dust particles, and allergens (fragments of pollen or mold spores).” The ongoing exposure to PM may cause and/or exacerbate existing lung and heart problems (Environmental Protection Agency, 2021). Kern County’s poor air quality packs a double punch because its dust is loaded with *Coccidioides*; the mold spore causing coccidioidomycosis and often referred to as Valley Fever (McCurdy, 2020).

Coccidioidomycosis is an illness caused by fungi *Coccidioides* that may present as a respiratory illness or have other body manifestations, like skin lesions, and can lead to hospitalization and rarely death (California Department of Public Health, 2021).

Although many residents are exposed and skin test positivity, it is estimated that 60% of exposures are asymptomatic (McCurdy et al, 2020). Spores of *Coccidioides* live in the soil and infect residents when the soil is disturbed and spores are inhaled.

Coccidioidomycosis is considered endemic to the San Joaquin Valley and to Kern County (Sondermeyer Cooksey et al, 2020). The winds and the geographical-basin effect combined with the dust from dirt that is ploughed during agricultural seasons has created an ongoing public health concern for decades surrounding coccidiomycosis (Sondermeyer Cooksey et al, 2020).

The *Coccidioides immitis* is considered the species endemic to the area in California (Lauer et al, 2014). Since 2000, cases of coccidioidomycosis have steadily risen in the state of California. The *Coccidioides* infection rate is growing with the largest rate increase in the northern San Joaquin Valley while Kern County continues with high incidence rates (Sondermeyer Cooksey et al, 2020). Between 2000-2011 hospitalization costs associated with Valley Fever were greater than 2 billion dollars in California alone (Sondermeyer Cooksey et al, 2013). Exposure to *Coccidioides* remains an environmental hazard for Kern County residents as well an occupational hazard for its agricultural and oil field workers as well as inmates of correctional facilities located in the area (Sondermeyer Cooksey et al, 2020). Additionally, Coccidioidomycosis may be a potentially a confounding factor in COVID -19 infection (Heaney et al, 2021).

Although *Coccidioides* can be found elsewhere in the world, the history of coccidioidomycosis and Kern County is intertwined by the residents and the attention of public health physicians. Public Health interests in the 1930's worked identify the source of Valley Fever and was a focus of work by several California physicians: most notably, Myrnie Gifford, MD, MPH, Stanford and Johns Hopkins, respectively, a Public Health physician who would become Chief Assistant Health Officer of Kern County led work to identify the agent responsible for Valley Fever along with, then medical student, Harold Chope MD (Deresinski et al, 2018). Dr. Gifford presented a causal relationship between the fungus *Coccidioides* and Valley Fever that became the basis for developing treatment strategies (Deresinski et al, 2018). By 1931, the California Department of Public Health was reporting poor outcomes from available therapies and outcomes did not start to improve until antifungal agents were available (Deresinski et al, 2018). Antifungal treatment regimens, the first was intravenous Amphotericin B, was not available until 1957 (Deresinski et al, 2018) with more available anti-fungal options showing up in the 1990s (Kern County Department Public Health Services, 2021). California began mandatory reporting of *Coccidioides* infection in 1995 and rates have steadily risen through the years (Kern County Department Public Health Services, 2021).

### **Current Public Health Approaches**

In December of 2020, California Department of Public Health released a press release indicating the number of Valley Fever cases in 2019 was at a peak in numbers and named Kern County as one of the counties with the highest incidence. This was at a crucial time in the COVID-19 pandemic (prior to the availability of public vaccinations)

and the Public Health Department of California issued a warning advising residents to seek treatment for lingering illness symptoms due to the similarity COVID and Valley Fever presentations (2020). Air quality, inclusive of dust carrying *Coccidioides*, is of importance to many public health and government regulating agencies. Agricultural and oil industries have an interest in improving air quality. Dust mitigation has been regulated through policy development requiring water applications and/or soil stabilizers during dirt disturbance, employing methods of crop selection (dirt disturbance is lessened by ploughing and rotation) and managing dirt roads in place by agencies EPA, OSHA, and USDA with local agencies providing guidance (California Department of Food and Agriculture, 2021). The CDC, California Department of Public Health and Kern County Public Health as well as the agencies throughout the *Coccidioides* endemic region of California, Arizona and New Mexico (Deresinki et al, 2018) continue to monitor and work to prevent Valley Fever. Kern County and other valley communities provide air quality index with advisement on the news regarding outdoor activities (2021). The Public Health Department in Kern County teaches the community to reduce the risk of Valley Fever transmission through reducing dust inhalation by keeping windows closed at home and while in the car, reduce outdoor activities, and wear a mask (recommended N-95) if you must be outside during dusty and/or wind (2021). The Public Health focus in managing Valley Fever has been primary and secondary targeted at prevention and early detection and treatment. Despite advances in treatment and ongoing measures to mitigate the dust carrying spores, cases of Coccidioidomycosis have continued to rise and the area considered endemic has grown since monitoring has been in place (Sondermeyer Cooksey et al, 2020).

In an article examining a study “Risk for Coccidioidomycosis among Hispanic Farm Workers, California, USA, 2018” (McCurdy et al) the farm worker continues to be at the highest risk through occupational exposure. The symptoms and health effects range from mild to requiring medical attention. Farm workers in the study reported management of minor symptoms like lethargy, headaches, and other minor symptoms as well as seeking medical treatment remains the responsibility of the farm worker. The study identified higher risk occupational jobs within farm worker tasks that related to increased dirt disturbing. The study also reviewed the economic disparity between the farm worker and the available natural resources that are controlled by industry as a source of inequality. As more is learned about the risk stratification related to exposure of dust carrying spores and continuing efforts to educate in areas where rates of incidence are increasing rapidly in the northern areas of San Joaquin Valley, Public Health educational efforts will adjust and, hopefully, reduce the cases of coccidioidomycoses (Sondermeyer Cooksey et al, 2020).

### **Future Directions**

Coccidioidomycosis continues to be a public health focus for California, Kern County, and other areas endemic to *coccidioides*. In a review of articles addressing *Coccidioides*, future interest directs epidemiological assessments to work at controlling the fungi with advanced soil assessment. In a study looking at soil growth sites of *Coccidioides immitis* in Kern County, satellite imagery was used for the investigation of environmental factors associated with known *Coccidioides* for direction of areas to plan future surveillance (Lauer et al, 2014). Additionally, monitoring the identification of *Coccidioides* by polymerase chain reaction (PCR) to identify new or changing strains.

Public Health professionals utilize current case monitoring at the state and regional level to better develop material targeted to the demographic audience (Sondermeyer Cooksey et al, 2020). Development of a vaccine and/or improvement to available antifungals continues to be a goal of the scientific community (Cole et al, 2021). Achieving an effective vaccine for *Coccidioides* has seemed attainable because use of skin testing to detect prior contact indicates the immune system has a memory response to a subsequent exposure (Cole et al, 2021). Antifungal agents a few in numbers compared to other anti-infectives. Immunocompromised individuals, like organ transplant recipients or patients undergoing chemotherapy, often require prophylaxis antifungals when they reside in a *Coccidioides* endemic area (Phonphok et al, 2018). The cost of medication to protect the compromised individuals plus the potential for creating resistant fungal strains is not ideal (Phonphok et al, 2018).

## **Conclusion**

*Coccidioides* rates continue to increase in the state and regions where it is endemic and despite studying, monitoring, treating the pathogen. *Coccidioides* remains elusive and challenging to the various entities that study its effects on both human and animal models. Vulnerable populations that are the most at risk, like farm workers, lack the ability to control their work environment when dust mitigation, air quality laws and masks mandates are not followed. Additionally, the farm workers face unfair responsibility of the cost and time to seek medical interventions and follow medical regimens. Although farm workers, oil field workers and other outdoor residents exposed to dirt disturbing activities are unionized, enforcement of dust abatement and proper masking for dust exposure is largely self-regulated with inspective reviews by regulatory

agencies. Industrial policy violations relating to Valley Fever may be fined but it appears that more education and policy development within the agricultural and oil industries needed.

Particle matter exposure from poor air quality and the subsequent harm to the respiratory system is one of the many concerns facing Kern County and especially amid the COVID pandemic (Heaney, 2021). Will the COVID pandemic and required masking decrease the incidence coccidioidomycosis cases in Kern County and throughout California? Extrapolating that the use of masks and following recommended guidelines during the COVID-19 pandemic could have seen a reduction in Valley Fever rates may not be as assumed. Farm workers and other agricultural and oil workers were deemed essential during the pandemic shut down and continued to work (McCurdy et al, 2020). A study examining COVID-19 mortality rates in 2020 prior to the availability of the vaccine may shed light on health practices and prevention and one factor discussed in COVID-19 vulnerability was political ideology (Chen et al, 2021). The study mapped COVID-19 deaths throughout 2020 and found that early in the pandemic, through April 2020, counties with majority registered voters as Democrat had the highest mortality rates (Chen et al, 2021). However, after government agencies instituted guidelines mandating masking and other preventative strategies aimed at reducing transmission of COVID-19, mortality rates in Republican dominated counties surpassed its Democratic neighbors and continued to rise (Chen et al, 2021). An inference could be made that political affiliation of the community influences health behaviors aimed at preventing COVID-19 (masking) affecting mortality rates. Since the primary prevention strategy for COVID-19 is wearing a mask, it is disappointing that the political affiliation may point to

health practices affecting COVID-19 and coccidioidomycosis infection rates. The studying and monitoring of *Coccidioides* will start to reveal a decrease in rates and illness. What will be learned about *Coccidioides* through the very studying and monitoring of COVID-19? Will areas endemic to *Coccidioides* see increased rates of infection of COVID-19 due to lung health in residents from exposure in increased Valley Fever rates? Or will the San Joaquin Valley see a rate increase in mortality associated with *Coccidioides* or COVID-19 co-infection?

I was born in Bakersfield and raised in the San Joaquin Valley. My paternal family are residents of Kern County and have been since the early 1940s when my grandparents left Oklahoma for California during the great Dust Bowl migration. My grandfather worked in the oil fields as a rough neck until his retirement in 1970s. Okies that came to Kern County to find work and overcome economic hardships were the vulnerable population of the times. My father became ill with Valley Fever after working in the tomato fields in the late 1950s. This was prior to the availability of antifungal therapy and my grandmother cared for him at home. My grandmother reported my father was in bed for weeks recovering from a terrible pneumonia. My father had a life-long susceptibility to lung infections from the scarring Valley Fever caused. My current, professional role is caring for transplant patients living throughout areas endemic to Valley Fever. My interests in the San Joaquin Valley and *Coccidioides* remain personal and professional.

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