

# Pediatric Coccidioidomycosis Analysis

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# Context

Pediatric coccidioidomycosis (Valley fever) is a **fungal infection acquired by inhaling soil-dwelling fungal spores**, often presenting in children with symptoms like fever, cough, and extreme fatigue, though many infections are asymptomatic. Complications, more common in children than adults, can include pleural effusion, **empyema**, and mediastinal involvement, with rare but serious cases potentially leading to disseminated disease affecting the brain, spine, or bones. Diagnosis involves **serologic testing** and imaging, while treatment for moderate to severe cases uses **antifungal medications** like **fluconazole**, sometimes requiring lifelong therapy for central nervous system involvement.

## Symptoms

- **Common:** Fever, cough, fatigue, headache, muscle and joint aches, chills.
- **Chest-related:** Shortness of breath, chest pain.
- **Skin manifestations:** A rash and **erythema nodosum** (tender red bumps under the skin) can occur.
- **Severe complications:** Pleural effusions (fluid around the lung), empyema (pus in the chest cavity), and mediastinal involvement are more frequent in children.

## Severe & Disseminated Disease

- **Spread to other areas:** In rare cases, the fungus can spread from the lungs to other parts of the body.
- **Central Nervous System (CNS) involvement:** Coccidioidomycosis can infect the brain or spinal cord, which is a serious and life-threatening condition.
- **Bone and joint infections:** The infection can also cause bone or joint disease.

## Diagnosis

- **Imaging:**  
Chest X-rays and CT scans can show signs of the infection, such as lung nodules or inflammation.
- **Blood tests:**  
Serologic tests (antibody tests like IgM and IgG) are crucial for diagnosis.
- **Other tests:**  
In some cases, antigen tests and PCR (polymerase chain reaction) testing of blood, cerebrospinal fluid, or respiratory samples may be performed.

## Treatment

- **Supportive care:**  
Mild cases may only require rest and over-the-counter pain and fever reducers.

- **Antifungal medications:**

Moderate to severe infections or those with a high risk of complications are treated with antifungal drugs, most commonly fluconazole.

- **Serious infections:**

Amphotericin B may be used for severe, diffuse, or disseminated infections.

- **Lifelong therapy:**

Some very severe cases, such as those with meningitis (infections of the brain and spinal cord), may require lifelong antifungal treatment.

## **Prevention**

- **Reduce dust exposure:**

In endemic areas (like the Southwestern United States), efforts can be made to reduce dust during construction, and children may need to reduce outdoor play during windy conditions.

- **Wear masks:**

Face masks can protect children and adults from inhaling fungal spores in dusty environments.

# Data Exploration

## Data Loading and formatting

### Data Types:

- **Study ID:** Categorical. ID of the patient. (Not typical useful here)
- **Erythema nodosum:** Erythema nodosum is an inflammatory skin condition characterized by the development of painful, red, and tender nodules or lumps, typically on the shins (rash). Since it sounds like a more severe symptom, there should be an order on it, but we only have two categories (Yes or No) - Categorical without order.
- **Age at diagnosis:** Age - Continuous.
- **Ethnicity:** Without assume any superior ethnicity - Categorical without order.
- **Race:** Without assume any superior race - Categorical without order.
- **Gender:** Without assume any superior gender - Categorical without order.
- **Disseminated disease:** refers to a condition where an infection or other pathological process spreads throughout the body from its original site. It might be related to Erythema nodosum. - Categorical without order.
- **Associated hospitalization:** means the hospital within or in association with which a body corporate pursues its objects. (useful? maybe) - Categorical without order.
- **Antifungal treatment:** as it means. We do not know what happens after the treatment. - Categorical without order.
- **Comorbidity:**
  - **Pulmonary disease:** refers to a group of conditions that affect the lungs and respiratory system. These diseases can cause inflammation, damage, or obstruction of the airways, leading to various symptoms and complications. **This feature might be highly correlated to the rash.**
  - **DM:** diabetes.
  - **Primary or congenital immunodeficiency:** refers to a group of rare, genetic disorders where the immune system doesn't work correctly, leaving individuals vulnerable to recurrent, severe, or unusual infections. **This feature might be highly correlated to the rash.**
  - **Current malignancy:** refers to a pre-existing chronic condition or other disease (a "comorbidity") that coexists with cancer ("malignancy") at the same time.
  - **Prior malignancy:** Similar to the previous one. With cancer before.
  - **Immunosuppressant medication:** are drugs that weaken the immune system to prevent the body from rejecting transplanted organs or treating autoimmune disorders.
  - **Autoimmune disease:** the body's immune system mistakenly attacks its own healthy tissues and organs.
  - **HIV:** everyone knows.

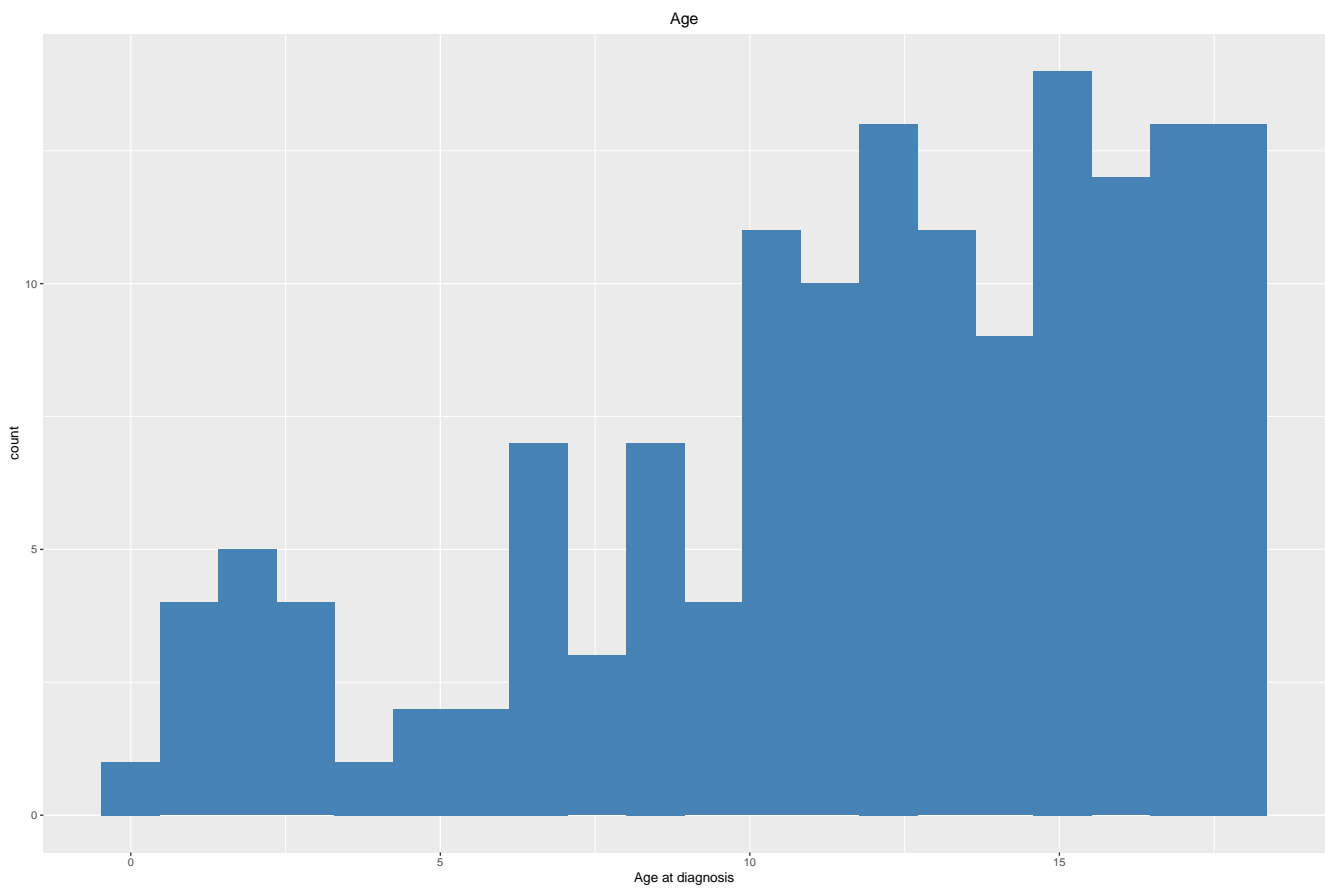
- **Prematurity:** health issues that are more likely to occur in individuals born preterm, including respiratory problems (like bronchopulmonary dysplasia), infections due to immature immune systems. **This feature might be highly correlated to the rash.**
  - **Congenital heart disease:** refers to structural defects in the heart that are present at birth.
  - **comorbidities (choice=None):** Not sure what it is. Maybe it means comorbidity in general?
  - All the categories of comorbidity are coded in yes or no. We can assign them categorical without order or take look at the correlations among them first.
- **EIA IgG:** Detection of rubella IgM by enzyme immunoassay (EIA) is used to confirm suspected cases of acute rubella infection and congenital rubella syndrome (CRS). (Categorical without order)
  - **EIA IgM:** An EIA IgM test uses a form of enzyme immunoassay (EIA) to detect Immunoglobulin M (IgM) antibodies, which are the first antibodies the body produces in response to a new infection, indicating recent or active exposure to a specific virus, bacterium, or other pathogen. (Categorical without order)
  - **Titer 1:** A blood test that measures the level of specific antibodies in the blood (This might be highly correlated to the rash, IgG, IgM) (Categorical with order by taking  $\log_2$ )
  - **CXR: Normal:** X - ray
  - **CXR: Lymphadenopathy:** chest X-ray
  - **CXR: Pleural effusion:** Pleural effusion" is commonly used as a catch-all term to describe any abnormal accumulation of fluid in the pleural cavity
  - **CXR: Cavitation:**
  - CXR: Consolidation/Opacity
  - CXR: Nodules/Micronodules
  - CXR: Pneumothorax
  - No CXR performed
  - Was tissue/fluid cultured?
  - Was specimen sent for pathology?

The original dataset has 157 instances. After dropped the empty rows, it still has 157 .

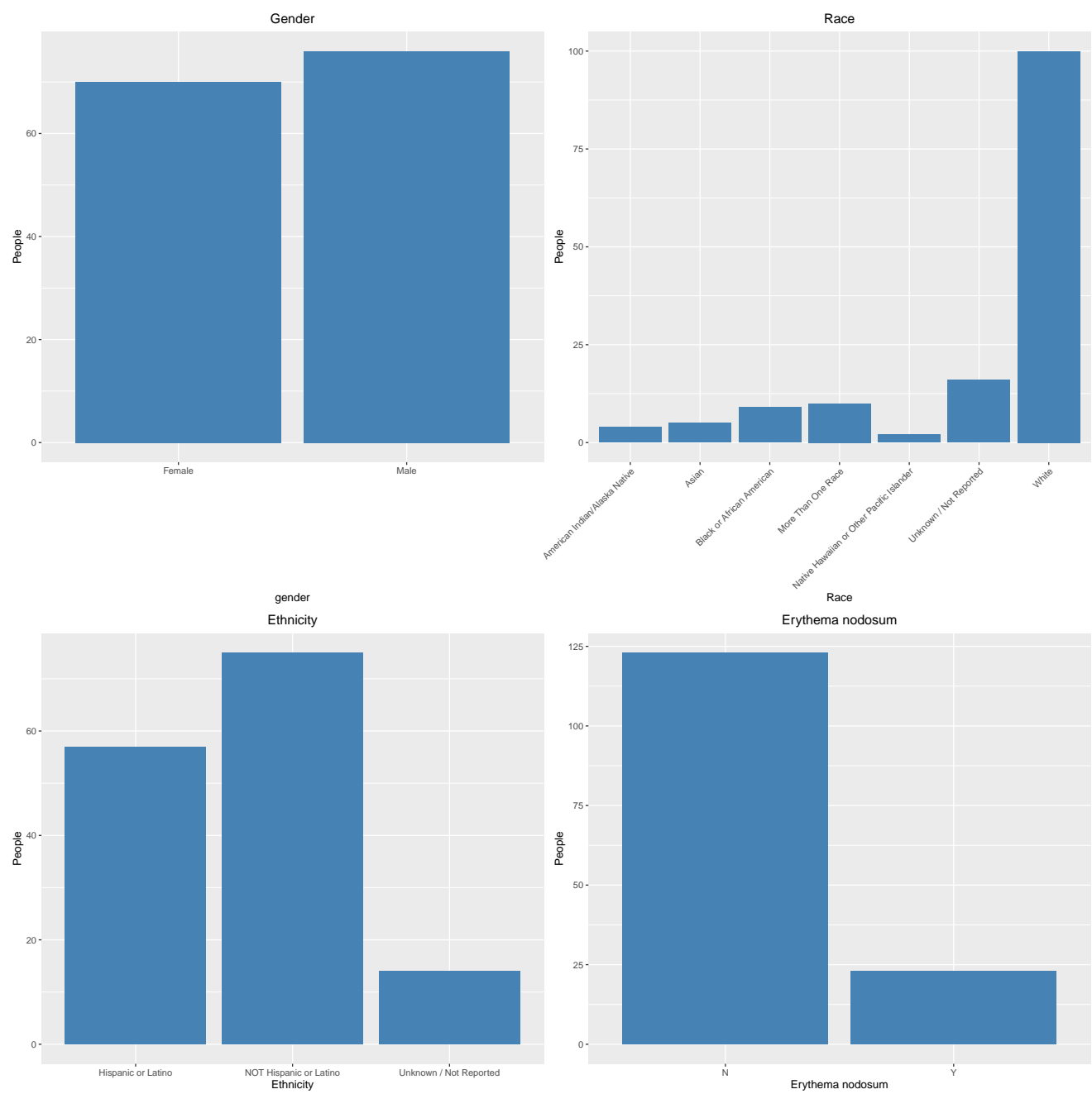
## Graph

First question, what does the distribution of age look like?

Age plot:

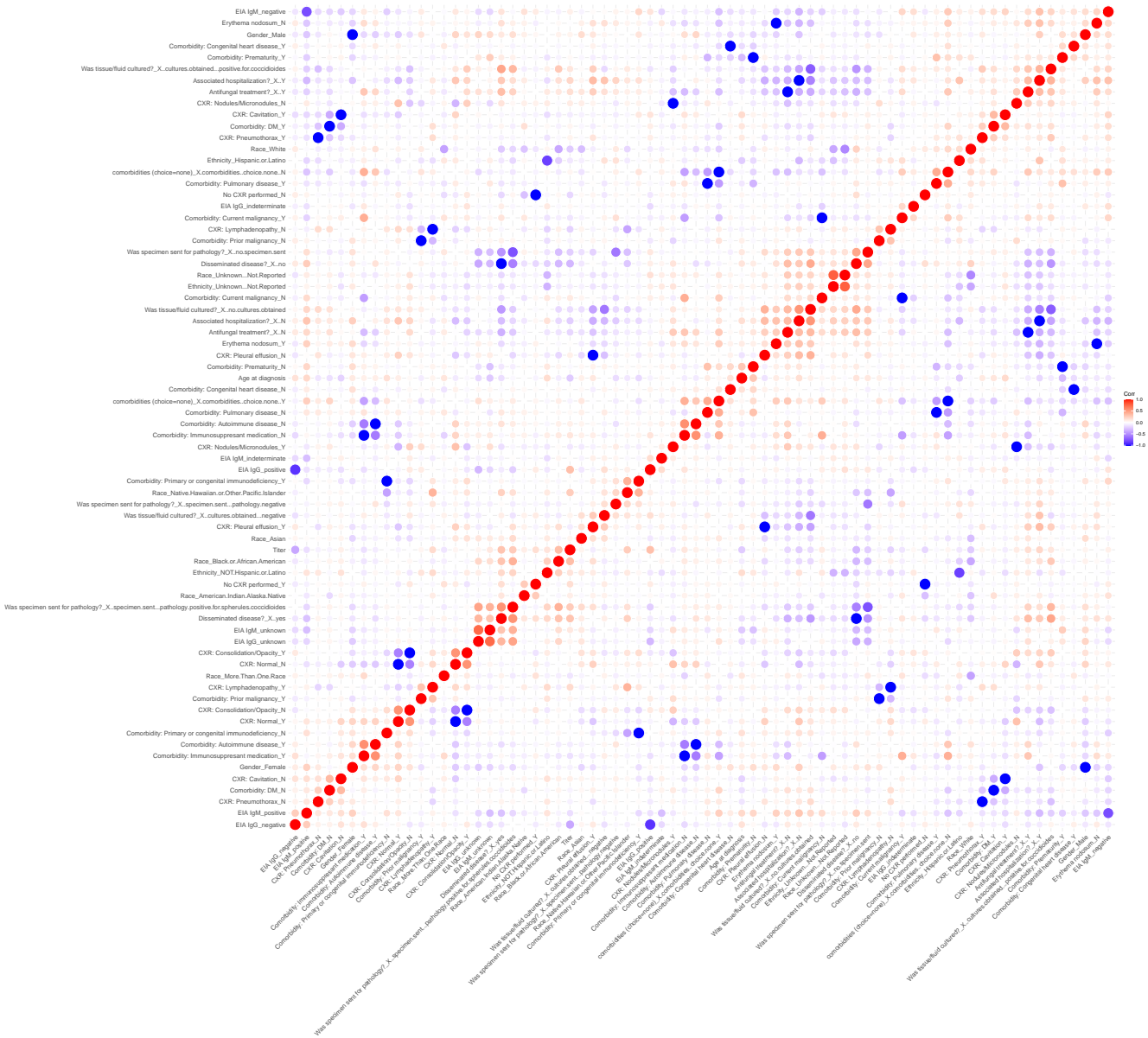


Common factor plot:





Correlation plot:



Positive correlated features:

Var1	Var2	value
Race_Unknown...Not.Reported	Ethnicity_Unknown...Not.Reported	0.7793646
Ethnicity_Unknown...Not.Reported	Race_Unknown...Not.Reported	0.7793646
EIA IgM_unknown	EIA IgG_unknown	0.7422541
EIA IgG_unknown	EIA IgM_unknown	0.7422541
Comorbidity: Autoimmune disease_Y	Comorbidity: Immunosuppressant medication_Y	0.5710393
Comorbidity: Immunosuppressant medication_Y	Comorbidity: Autoimmune disease_Y	0.5710393

Var1	Var2	value
Comorbidity: Autoimmune disease_N	Comorbidity: Immunosuppresant medication_N	0.5710393
Comorbidity: Immunosuppresant medication_N	Comorbidity: Autoimmune disease_N	0.5710393
Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	Disseminated disease?_X..yes	0.5503867
Disseminated disease?_X..yes	Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	0.5503867
CXR: Consolidation/Opacity_Y	CXR: Normal_N	0.5496825
CXR: Normal_N	CXR: Consolidation/Opacity_Y	0.5496825
CXR: Consolidation/Opacity_N	CXR: Normal_Y	0.5496825
CXR: Normal_Y	CXR: Consolidation/Opacity_N	0.5496825
Was tissue/fluid cultured?_X..no.cultures.obtained	Associated hospitalization?_X..N	0.5437659
Associated hospitalization?_X..N	Was tissue/fluid cultured?_X..no.cultures.obtained	0.5437659

### Negative correlated features:

Var1	Var2	value
Race_White	Race_Unknown...Not.Reported	-
		0.5172606
Race_Unknown...Not.Reported	Race_White	-
		0.5172606
Was tissue/fluid cultured?_X..no.cultures.obtained	Associated hospitalization?_X..Y	-
		0.5437659
Associated hospitalization?_X..Y	Was tissue/fluid cultured?_X..no.cultures.obtained	-
		0.5437659
CXR: Consolidation/Opacity_Y	CXR: Normal_Y	-
		0.5496825
CXR: Normal_Y	CXR: Consolidation/Opacity_Y	-
		0.5496825
CXR: Consolidation/Opacity_N	CXR: Normal_N	-
		0.5496825
CXR: Normal_N	CXR: Consolidation/Opacity_N	-
		0.5496825
Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	Disseminated disease?_X..no	-
Disseminated disease?_X..no	Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	0.5503867
Comorbidity: Autoimmune disease_N	Comorbidity: Immunosuppresant medication_Y	-
		0.5710393
Comorbidity: Immunosuppresant medication_Y	Comorbidity: Autoimmune disease_N	-
		0.5710393
Comorbidity: Autoimmune disease_Y	Comorbidity: Immunosuppresant medication_N	-
		0.5710393
Comorbidity: Immunosuppresant medication_N	Comorbidity: Autoimmune disease_Y	-
		0.5710393
Was tissue/fluid cultured?_X..no.cultures.obtained	Was tissue/fluid cultured?_X..cultures.obtained...negative	-
		0.5909525
Was tissue/fluid cultured?_X..cultures.obtained...negative	Was tissue/fluid cultured?_X..no.cultures.obtained	-
		0.5909525

Var1	Var2	value
Was specimen sent for pathology?_X..specimen.sent...pathology.negative	Was specimen sent for pathology?_X..no.specimen.sent	- 0.5927200
Was specimen sent for pathology?_X..no.specimen.sent	Was specimen sent for pathology?_X..specimen.sent...pathology.negative	- 0.5927200
Was tissue/fluid cultured?_X..no.cultures.obtained	Was tissue/fluid cultured?_X..cultures.obtained...positive.for.coccidioides	- 0.7039378
Was tissue/fluid cultured?_X..cultures.obtained...positive.for.coccidioides	Was tissue/fluid cultured?_X..no.cultures.obtained	- 0.7039378
Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	Was specimen sent for pathology?_X..no.specimen.sent	- 0.7531226
Was specimen sent for pathology?_X..no.specimen.sent	Was specimen sent for pathology?_X..specimen.sent...pathology.positive.for.spherules.coccidioides	- 0.7531226
EIA IgM_positive	EIA IgM_negative	- 0.7705141
EIA IgM_negative	EIA IgM_positive	- 0.7705141
Ethnicity_NOT.Hispanic.or.Latino	Ethnicity_Hispanic.or.Latino	- 0.8225151
Ethnicity_Hispanic.or.Latino	Ethnicity_NOT.Hispanic.or.Latino	- 0.8225151
EIA IgG_positive	EIA IgG_negative	- 0.8658604
EIA IgG_negative	EIA IgG_positive	- 0.8658604