**Title Page**

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# Association between Occupational Exposures and Sarcoidosis: an Analysis from Death Certificates in the United States, 1988-1999

**Running title:** Sarcoidosis mortality and occupational exposures

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## Introduction

Sarcoidosis is a multisystem, granulomatous disease, characterized by noncaseating epithelioid cell granulomas, usually in more than one organ. Recent studies suggest increasing mortality over the past few decades.[1-3] A prevailing theory is that a genetically susceptible host is exposed to yet unknown antigens[4,5] through occupational and/or environmental exposures and subsequently develop sarcoidosis.[6,7] Supporting this notion, a case-control study reported the occurrence of sarcoidosis clusters among individuals with shared work.[8] A number of investigators have described an increased risk of sarcoidosis among those with specific occupational exposures,[9-11] including firefighters,[12,13] navy recruits,[14-16] workers in the lumber industry,[17] rock wool or glass wool workers,[18] and sales[19] to name a few. Other specific exposures, such as the World Trade Center 9/11 event, have also been found to be associated with an increased risk of sarcoidosis.[20,21]

Difficulties characterizing and collecting germane data around occupational exposures over an individual's lifespan have limited understanding of the relationship between such exposures and sarcoidosis. In very few studies have investigators attempted to systematically and fully assess the association between occupation and sarcoidosis; instead, most have chosen to focus on a single or small group of occupational exposures while ignoring others. Although a study of sarcoidosis siblings considered many occupational exposures, the occupational factors were only limited to those held by the affected siblings prior to the date of diagnosis.[22]

Previous studies have shown that sarcoidosis is relatively more common in women than men, and in blacks than whites[23, 24] and that the phenotype of disease and genetic risk differ by gender and race. These findings prompted us to question if differences in sarcoidosis risk for women and men could be explained, in part, by differences in occupational exposures[25] or specific exposures could induce a stronger response in women than men. In the U.S., when a person dies, a death certificate is generated; besides data on cause of death, for certain years, it contained information on occupation. The aims of our study were to use death certificate data to investigate the link between sarcoidosis and certain occupational exposures previously reported to be associated with sarcoidosis, and to determine which exposures were associated with sarcoidosis-related death.

## Materials and Methods

### *Study Population and Design*

The dataset was derived from United States death certificates which had been compiled by the National Center for Health Statistics (NCHS) from 1988-1999. Our study dataset only included 25 states decedents with Occupational Classification Codes (e-Table 1). Cause of death was coded according to the 9th Revision of the International Classification of Diseases (ICD-9) from 1988-1998 [26] and 10th revision (ICD-10) after 1999.[27] The ICD9-code 135 and ICD10-code D86 were used to identify decedents with sarcoidosis (including all its 4-digit subcodes). Following convention, we considered death to be sarcoidosis-related if sarcoidosis was recorded as one of the multiple causes of death, or the underlying cause of death (UCD), among all certified causes of death. If only sarcoidosis was recorded as the UCD or the immediate cause of death, then the cause of death was termed "sarcoidosis-UCD" for the purposes of our study.

### *Codes of Occupational Exposure*

Occupational Classification Codes was available in 25 states during the years 1988-1999. For individuals whose death was recorded before 1993, the usual occupation on the death certificate was coded according to the 1980 Bureau of the Census classification system.[28] Starting in 1993, 1990 Occupational Classification Codes were used. There is considerable overlap between the 1980 and 1990 codes, as stated by the bureau: "classifications used for the 1990 Census… were similar to those used in 1980, with no major changes." To address the few instances where minor changes or additions were made to the coding system, we created a crosswalk for any codes which were not the same in the 1990 codes as the 1980. Finally, all decedents in our study were identified the same codes in certain occupation.

For the purposes of this study, we considered exposures and job titles that have been found to be associated with sarcoidosis in prior studies. [9-22] An industrial hygienist created an exposure matrix, linking occupational codes to these specific jobs, and then designated how likely various exposures were for the individuals (e-Table 1). The abbreviations of specific occupational exposures are listed in Table 1 and are used to describe the findings in the results and discussion. Decedents with more than one potential occupational exposure were categorized as having "any exposure".

### *Statistical Analysis*

Counts and crude mortality rates were calculated for the different occupational exposures among decedents with sarcoidosis. Because the total number of individuals holding a given occupation at any one time is generally unknown—i.e., the denominator is indeterminable, making it impossible to generate an incidence rate—mortality odds ratio (MOR) were used to measure the association between occupational exposures and sarcoidosis mortality.[29] Because of the disparity of the incidence and mortality of sarcoidosis in gender and race[23,24,30] and the possible interaction of occupational exposures, multiple Poisson regression was used to evaluate the risk effect of certain occupational exposure on sarcoidosis mortality after adjustment for age, year of death and other occupational exposures. To further examine the effect of occupational exposure, we carried out the same analyses for the decedents for whom sarcoidosis was coded as the UCD instead of excluding those decedents that were sarcoidosis-related but were not directly attributable to sarcoidosis (that is those without sarcoidosis-UCD). Analyses were performed using SAS, version 9.3 (SAS Institute; Cary, North Carolina). Multiple Poisson regression was performed using PROC GENMOD with a log link function, and the natural log of the population size treated as an ‘offset’ in the calculations of MOR.

## Results

### *Characteristics of Sarcoidosis Decedents*

From 1988-1999 in the U.S., 26,449,303 individuals died. Analysis was limited to 7,118,535 decedents older than 14 years, from 25 states with occupational coding. Of these 7,118,535 decedents, 3,393 deaths were coded as sarcoidosis-related, including 1579 coded as UCD. Table 2 shows that the proportion of men and women is approximately 1:1, but sarcoidosis-related mortality was higher in women than men. The adjusted-MOR for sarcoidosis-related death was 2.25 (95% CI 2.10 - 2.42, $P < .0001$) for women compared to men. There were 2,763,665 decedents with any occupational exposure. The adjusted-MOR for sarcoidosis-related death was 1.52 (95% CI 1.35 - 1.71, $P < .0001$) for any occupational exposure (reference, no exposure). Among women, those with any exposure had greater odds of sarcoidosis-related death than those without exposures (MOR 1.65, 95% CI 1.45 - 1.89, $P < .0001$); this was not observed for men (MOR 1.12, 95% CI 0.86 - 1.46, $P = .408$).

### *Characteristics of Occupational Exposures*

Figure 1 shows significant differences in occupations between women and men; female decedents were more likely to have worked in the following job categories: “Admin”, “Health”, and “Teach”, “Organic”, “Sale”; men were more likely to have worked in “Organic”, “Metal”, “Silica”, “Animal”, “Agri”. The distribution of occupations in whites and blacks was similar, although the absolute number of whites working in those occupations was higher than blacks.

### *Occupational Exposures Associated with Sarcoidosis*

Table 3 shows crude mortality rates and adjusted-MORs for specific occupational exposures (compared with no exposure) among decedents with sarcoidosis-related death and decedents for whom sarcoidosis was considered the UCD. The crude mortality rates of sarcoidosis-related deaths were the highest in decedents with occupations that involved “Child” (0.16%). No decedents worked in “Mail”. The risk for sarcoidosis-related death was elevated among decedents exposed to the following occupation categories: “Metal”, “Health”, “Teach”, “Sale”, “Bank” and “Admin”. However, “silica” showed like a protective effect on sarcoidosis-related death (Adjusted-MOR 0.56, 95% 0.42-0.74) and sarcoidosis-UCD (Adjusted-MOR 0.44, 95% 0.29-0.66). For the sarcoidosis-UCD decedents, the risks of the same occupational exposures were found to be

significantly elevated except for “Metal” and “Sale”, which were not statistically significant in the analyses (Table 3). The MOR for “Bank” occupation was 44.9% greater for sarcoidosis-UCD than sarcoidosis-related death.

***Differences of Occupational Exposures by Gender and Race***

Table 4 displays the statistically significant adjusted-MORs for the sample stratified on gender and race. There was a statistically significant excess sarcoidosis-related mortality risk among black women with occupational job categories: “Metal”, “Teach”, “Bank” and “Admin”, which were further verified based on elevated sarcoidosis-UCD mortality risk. Among black men decedents, some occupational exposures were also significantly associated with increased mortality risk for sarcoidosis-related deaths. With only 5 individuals with sarcoidosis-related death in other races except for blacks and whites, occupational exposures didn’t significantly impact the sarcoidosis mortality in other race, regardless of gender. Table 5 shows that some occupational exposures had a higher mortality risk in women than men except for “Child” and that blacks had a statistically significant excess sarcoidosis-related risk based on occupation. The results were also identified in the analyses on sarcoidosis-UCD.

## Discussion

There are several studies showing that specific occupational exposures are associated with increased risk of sarcoidosis.[11,17,19,22] These studies imply that occupational exposures may be of particular importance in sarcoidosis risk and/or in conjunction with a susceptible genotype,[31] as demonstrated in the study of firefighters exposed to the World Trade Center (WTC) disaster.[32] Our results showed that sarcoidosis mortality was higher among those with "any exposure" than without exposure, and sarcoidosis mortality risk was higher in women than men. However, of decedents with any exposure, the MOR of sarcoidosis-related deaths was considerably increased among women compared with men, at about 35.4%. These results in total give further support to the existing evidence that occupational exposure is important in the development of sarcoidosis, since sarcoidosis risk is increased in women.[33] Our results suggest that certain occupational exposures have an association with specific genders and race.

In our study, "Admin" occupation had a larger impact on sarcoidosis mortality among women. But the finding of this occupation and its relationship to sarcoidosis is quite limited.[22] Furthermore, the possible exposures that these individuals sustained as well as the mechanism that would put individuals with sarcoidosis at greater risk are uncertain. Employment in "Bank" demonstrated an increased risk for sarcoidosis mortality in women, especially in black women. The potential exposures in "Admin," "Teach," and "Bank" are similar in occupational characteristics, in that there is often person-to-person contact, which could be associated with transmission of an exposure. In addition, these occupations are unlikely to result in exposure to chemicals, or particles, such as dust, organic material, etc. The disparity of exposures between genders may explain the increasing risk of sarcoidosis in women, which should be further evaluated in future studies. We also found that all statistically significant occupational exposures associated with sarcoidosis-related deaths were further confirmed in the analyses of sarcoidosis-UCD, regardless of race or gender. The consistency of these results provides evidence for a strong link between occupational exposures and sarcoidosis among women. The ACCESS study's findings that cases or sarcoidosis were more likely to be teachers in a middle or high school than controls (OR 1.80, 95% CI 1.14 -2.83),[8] were similar to our findings of increased sarcoidosis risk in those with the occupation "Teach."

It is interesting that among men, the occupations associated with sarcoidosis mortality varied more than those in women and did not include the occupations "Admin" and "Bank", associated with

increased risk in women. Based on our understanding of exposure in these occupations, men were more likely to inhale and/or have contact with inorganic or organic substances or microorganisms based on these occupations [11,17-19] and would be less likely to result in person-to-person contact. Our findings support gender specific occupational exposures, with occupations related to "possible inhalational exposures" associated with sarcoidosis mortality in men, and occupations related to "person-to-person contact" associated with sarcoidosis mortality in women. These findings may provide support to the studies demonstrating that women are more prone to skin and eye involvement (organs impacted by contact), while men tend to have higher rates of pulmonary and cardiac involvement, as inhalation of particulates is more likely to impact both the cardiac and pulmonary systems.[34-36] Additionally, gender differences may also be related to genetics and/or other confounders. A recent study indicated that genetic and exposure interactions could result in the female predominance in many autoimmune diseases including sarcoidosis.[37] Surprisingly, we did not find associations with the risk of sarcoidosis and occupational exposures to pets, firefighting and lumber in any of our analysis, although other studies have shown these associations,[10,12,13,17] It is possible that these exposures are associated with a less severe forms of sarcoidosis that do not contribute to mortality. An episodic, high-intensity exposure might lead to enhanced effect of specific occupation on sarcoidosis, such as those from the WTC. [32] Certainly, these exposures which may have been misclassified or overlooked on the death certificates could result in the differences between our study findings and others.

In our study, the exposure to silica was found as a protective factor for sarcoidosis with an MOR <1.

The result is puzzling in light of other studies findings that work with silica is positively associated with sarcoidosis, including a case-control study which observed a significant association between employment with crystalline silica exposures and sarcoidosis (OR = 13.2, $P < .05$).[38] Of note the results maybe confounded by the fact that a person exposed to silica is more likely to be diagnosed with silicosis because of the following clinical findings: a history of occupational exposure and chest x-ray that may be similar between sarcoidosis and early silicosis. Indeed, one study with a negative association noted that once silicosis is diagnosed it is difficult for individuals to change the diagnosis or to obtain another diagnosis such as sarcoidosis[39] since patients with silicosis are compensated by workers compensation or the government.[40] A diagnosis of silicosis and sarcoidosis could end up being exclusive[41] which could result in a false protective effect of silica exposure. In

an animal model silica dust induced an immune-mediated granulomatous and inflammatory reaction that is characteristics of sarcoidosis, supporting silica's involvement in granulomatous inflammation.[42] In addition, silica is likely a macrophage poison or toxin, and may also functions as an immunosuppressant. There is evidence that silica causes the production of free radicals and reactive oxygen species[43-45] and that alveolar macrophages cells die due to activation of the apoptotic cascade. [46-48] While these molecular mechanisms are not entirely understood, it is possible that silica's potential immunosuppressant effects might explain the protective findings in our study.

Although the death certificate records lack information on length of employment and the time of diagnosis, and the dataset in our study may be a skewed population as individuals came from 25 US states and some individuals with mild forms of the disease may not have had sarcoidosis listed on their death certificate, the advantages of this approach over other studies include its simple and relatively inexpensive approach, larger sample size, and broader geographic coverage.[49] While the analysis of MORs cannot provide a causal relationship between occupational exposures and death, it is particularly useful for the study of occupational groups as it can be difficult to assemble occupational cohorts to obtain information regarding risk and occupational exposure, especially for a rare disease like sarcoidosis. Using this dataset, the present analyses from death certification provided associations between occupational exposures and sarcoidosis mortality risk. But, due to the limitation of data available, we did not consider some lifestyles including smoking, use of hairspray and cosmetics, and environmental exposures, etc. They could be indirectly related to sarcoidosis mortality in our study or a confounder. In this study, we focused on reported direct occupational exposure, which is an additional limitation. Additionally, there may miscoding of death cause and/or occupational exposures in this study when the death certificates were filled out or due to our use of an exposure matrix. In all analyses, we had controlled for other occupational exposures; as a result, we did not further correct the p-value for multiple tests to avoid the probability of increasing false negative associations. Certainly, this could be a limitation as some of the results could be false positives.

## Conclusions

This study verified findings of prior occupations and risk of sarcoidosis based on sarcoidosis mortality rates, mainly in the job categories: "Metal", "Health", "Teach", "Sales", "Bank", and "Admin". The effects of occupational exposures on sarcoidosis mortality were more significant in

women than men and in blacks than whites, with the most prominent findings in black women. While these findings are associative, they may suggest potential interactions between occupational exposures and gender and race that could spur the greater risk of death noted in women and blacks. It is possible that differences in disease risk based on gender and race could be in part related to differences in exposure.

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**Author contributions:**

H.L. had full access to all the study data and assumes responsibility for the integrity of the data and the accuracy of the analysis and drafted the initial manuscript. H.L, D.P. and L.M. conceptualized and designed the study. D.P., A.W., C.W. and M.M. contributed to data collection and management. A.W., C.S., M.V., J.S. and L.M. contributed to categories of occupations codes; all authors contributed to revising the manuscript.

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**Additional information:** The e-Table can be found in the Supplemental Materials section of the online article.

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## TABLE 1 Abbreviations of Occupational Exposures and Occupational text

| Abbreviation | Occupations-related | Occupational Text |
|---|---|---|
| Lumber | Lumber | Forestry and logging occupations |
| Metal | Metal | Metal-related including repairers, operators, engineers, installers, cutters, workers, etc. |
| Agri | Agriculture | Related agricultural occupations, including farmer, gardener, nursery workers, groundskeepers, etc. |
| Fire | Firefighting | Firefighting and fire prevention occupations |
| Silica | Silica-related | Related to mine, tile, oil, stone, glass, earth and concrete so on, including drillers, installers, scrapers, operators, sculptors, plasterers, etc. |
| Health | Healthcare | Medical staff touching with patients, including health aids, dentists, physicians, therapists, etc. |
| Child | Childcare | Childcare work, except private household |
| Teach | Teaching-related | Teachers except for post-secondary, counselors, and teacher aides |
| Animal | Animal | Persons touching with animals, including animals caretaker, farmers, gardener, pest control occupations, etc. |
| College | College | teachers for post-secondary, and counselors |
| Organic | Job-related to organic materials | Occupations which have some exposure to organic materials when working, including bakers, carpenters, dressmakers, food makers, garbage collectors, plasterers, shoe repairers, etc. |
| Mechanic | Mechanic | Machinery-related including repairers, operators, supervisor in aircraft, automobile mechanics, bus, etc. |
| Mold | Job-related to mold | Biology-related including janitors, cleaners, geodesists, geologists, housemen, etc. |
| Military | Military | Armed forces |
| Mail | Mail | Postmasters and mail superintendents |
| Rad | Radiation | Nuclear engineers, medical appliance technicians, airplane navigators, etc. |
| Bird | Bird | Animal caretakers except for farm |
| Sale | Sale-related | Sales occupations including services, representatives and wholesale in business and personal goods |
| Bank | Banking-related | Financial records processing occupations |
| Admin | Administration | Miscellaneous administrative occupations, secretaries, typists, stenographers, legal assistant |

**TABLE 2 Basic Characteristics of Sarcoidosis Decedents on the Gender and Race (%)**

| Characteristics | | All | | | Any exposure | | |
|---|---|---|---|---|---|---|---|
| | | Total N | Sarcoidosis-related | Sarcoidosis-UCD | Total N | Sarcoidosis-related | Sarcoidosis-UCD |
| Women | | 3549946 | 2064(0.058) | 977(0.027) | 1002806 | 833(0.083) | 403(0.040) |
| | B | 379289 | 1220(0.322) | 651(0.172) | 104873 | 533(0.508) | 285(0.272) |
| | O | 41025 | 5(0.012) | 4(0.010) | 10411 | 1(0.010) | 1(0.010) |
| | W | 3129632 | 839(0.027) | 322(0.010) | 887522 | 299(0.034) | 117(0.013) |
| Men | | 3568589 | 1329(0.037) | 602(0.017) | 1760859 | 594(0.034) | 289(0.016) |
| | B | 412680 | 754(0.183) | 387(0.094) | 206915 | 343(0.166) | 187(0.090) |
| | O | 51704 | 6(0.012) | 3(0.006) | 26134 | 3(0.011) | 2(0.008) |
| | W | 3104205 | 569(0.018) | 212(0.007) | 1527810 | 248(0.016) | 100(0.007) |
| Total | | 7118535 | 3393(0.048) | 1579(0.022) | 2763665 | 1427(0.052) | 692(0.025) |

B, black; W, white; O, others

**TABLE 3 Crude Rate and Adjusted-MOR of Sarcoidosis in Different Occupational Exposures[#]**

| | Sarcoidosis-related | | | Sarcoidosis-UCD | | |
|---|---|---|---|---|---|---|
| | n | Crude rate (%) | Adjusted-MOR(95%CI) [&] | n | Crude rate (%) | Adjusted-MOR(95%CI) [&] |
| Lumber | 4 | 0.022 | 0.47(0.17-1.34) | 3 | 0.017 | 0.57(0.16-1.99) |
| Metal | 197 | 0.041 | 1.41(1.08-1.85)* | 89 | 0.019 | 1.43(0.98-2.09) |
| Agri | 58 | 0.018 | 1.30(0.28-6.04) | 25 | 0.008 | 1.35(0.13-14.57) |
| Fire | 2 | 0.018 | 0.75(0.19-3.03) | 1 | 0.009 | 0.75(0.11-5.40) |
| Silica | 125 | 0.023 | 0.56(0.42-0.74)* | 54 | 0.010 | 0.44(0.29-0.66)* |
| Health | 261 | 0.117 | 1.61(1.14-2.28)* | 133 | 0.060 | 1.86(1.11-3.11)* |
| Child | 16 | 0.162 | 1.40(0.78-2.52) | 7 | 0.071 | 1.31(0.54-3.16) |
| Teach | 154 | 0.076 | 1.90(1.34-2.71)* | 74 | 0.037 | 2.25(1.33-3.81)* |
| Animal | 59 | 0.018 | 0.81(0.18-3.76) | 26 | 0.008 | 0.83(0.08-8.83) |
| College | 14 | 0.069 | 1.52(0.87-2.66) | 5 | 0.025 | 1.20(0.48-2.98) |
| Organic | 367 | 0.032 | 1.03(0.76-1.40) | 186 | 0.016 | 1.38(0.87-2.17) |
| Mechanic | 55 | 0.036 | 0.79(0.57-1.10) | 26 | 0.017 | 0.94(0.57-1.55) |
| Mold | 114 | 0.060 | 0.94(0.65-1.36) | 58 | 0.031 | 1.08(0.62-1.86) |
| Military | 33 | 0.050 | 1.20(0.75-1.93) | 18 | 0.027 | 1.58(0.81-3.09) |
| Mail | 0 | 0 | - | - | - | - |
| Rad | 29 | 0.128 | 1.16(0.79-1.71) | 13 | 0.057 | 1.02(0.58-1.81) |
| Bird | 1 | 0.072 | 1.18(0.10-14.23) | 1 | 0.072 | 2.04(0.09-44.34) |
| Sale | 126 | 0.043 | 1.23(1.03-1.48)* | 52 | 0.018 | 1.14(0.86-1.51) |
| Bank | 34 | 0.049 | 1.71(1.22-2.40)* | 20 | 0.029 | 2.48(1.59-3.87)* |
| Admin | 175 | 0.077 | 1.86(1.59-2.18)* | 83 | 0.037 | 1.98(1.58-2.49)* |

[#] An individual can occur in more than one category.

[&] Adjusted for age, gender, race, year and other exposures.

[*] $P<0.05$

**TABLE 4 Sarcoidosis Mortality of Different Occupational Exposures with a Statistical Significance in Stratification of the Death Populations by Gender and Race[#]***

| | Sarcoidosis-related | | Sarcoidosis-UCD | |
|---|---|---|---|---|
| | Blacks | Whites (95%CI) | Blacks | Whites (95%CI) |
| Women | | | | |
| Metal | 2.62(1.28-5.37) | NS | 2.73(1.04-7.17) | NS |
| Teach | 2.74(1.21-6.21) | NS | 3.60(1.15-11.24) | NS |
| Bank | 3.36(1.98-5.71) | NS | 3.06(1.45-6.47) | 2.26(1.26-4.05) |
| Admin | 2.24(1.78-2.81) | 1.67(1.32-2.11) | 2.36(1.75-3.18) | 1.55(1.05-2.29) |
| Men | | | | |
| Metal | 1.78(1.16-2.74) | NS | NS | NS |
| Silica | 0.56(0.38-0.82) | NS | 0.40(0.24-0.68) | NS |
| Health | 0.40(0.24-0.68) | NS | NS | NS |
| Child | 13.26(4.31-40.80) | NS | NS | NS |
| Teach | 2.94(1.43-6.03) | 2.65(1.22-5.75) | 3.57(1.28-9.93) | NS |
| Military | 2.32(1.19-4.54) | NS | NS | NS |
| College | NS | 2.78(1.03-7.52) | NS | NS |

[#]The results on other race were not listed because they were statistically insignificant

[*]Adjusted for age, year and other occupational exposures

NS no significance

**TABLE 5 Mortality Risk for Sarcoidosis in Certain Occupational Exposures Comparing Different Gender and Race**

| | Sarcoidosis-related | | Sarcoidosis-UCD | |
|---|---|---|---|---|
| | Gender (WM/M)* | Race (B/W)# | Gender (WM/M)* | Race (B/W)# |
| Lumber | NS | NS | NS | NS |
| Metal | 2.99(2.08-4.29) | 10.57(7.87-14.20) | 2.68(1.53-4.72) | 12.41(7.94-19.40) |
| Agri | NS | 3.01(1.73-5.21) | NS | 3.78(1.66-8.63) |
| Fire | NS | NS | NS | NS |
| Silica | 2.31(1.30-4.10) | 4.32(3.01-6.20) | NS | NS |
| Health | 1.92(1.30-2.83) | 9.36(7.03-12.46) | 2.14(1.22-3.76) | 9.81(6.49-14.83) |
| Child | 0.28(0.09-0.91) | 10.73(2.42-47.61) | NS | 8.75(1.05-73.18) |
| Teach | 1.80(1.20-2.70) | 9.37(6.69-13.11) | 2.06(1.12-3.77) | 11.38(6.88-18.84) |
| Animal | NS | 3.17(1.85-5.45) | NS | 4.11(1.85-9.13) |
| College | NS | 8.51(2.68-26.99) | NS | 13.45(1.93-93.81) |
| Organic | 2.85(2.22-3.65) | 7.64(6.11-9.55) | 2.56(1.81-3.63) | 9.93(7.17-13.77) |
| Mechanic | NS | 8.11(4.72-13.92) | NS | 13.66(5.98-31.17) |
| Mold | 1.62(1.11-2.38) | 5.52(3.58-8.61) | NS | 8.27(4.15-16.47) |
| Military | NS | 19.70(8.35-46.48) | NS | 17.67(5.65-55.33) |
| Mail | NS | NS | NS | NS |
| Rad | 3.73(1.31-10.66) | 18.11(7.03-46.66) | | 31.3(5.70-172.02) |
| Bird | NS | NS | NS | NS |
| Sale | 2.11(1.47-3.02) | 7.65(5.14-11.40) | 2.72(1.513-4.89) | 12.06(6.62-21.97) |
| Bank | 7.75(1.05-57.19) | 16.54(7.45-36.73) | NS | 14.04(4.73-41.66) |
| Admin | 3.86(1.97-7.57) | 11.37(8.18-15.80) | 3.46(1.40-8.59) | 16.71(10.27-27.20) |

*Adjusted for age, year, race and other occupational exposures

#Adjusted for age, year, gender and other occupational exposures

NS no significance; WM women; M men; B blacks; W whites

## Figure Legends

**Figure 1- Distribution of different occupational exposures in gender and race. A. Gender B. Race**

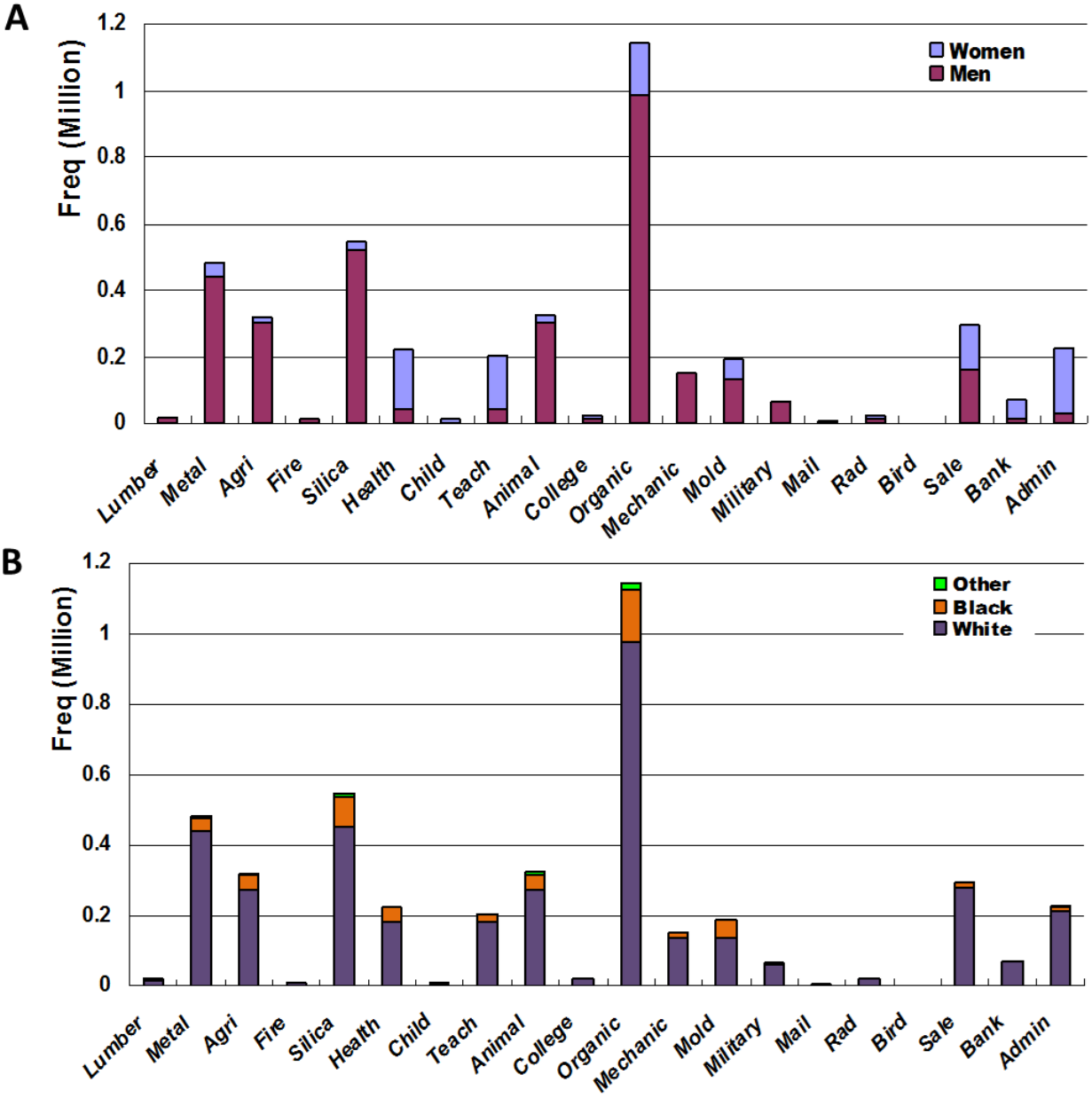
A
Freq (Million)
1.2
1
0.8
0.6
0.4
0.2
0
Women
Men
Lumber
Metal
Agri
Fire
Silica
Health
Child
Teach
Animal
College
Organic
Mechanic
Mold
Military
Mail
Rad
Bird
Sale
Bank
Admin
B
Freq (Million)
1.2
1
0.8
0.6
0.4
0.2
0
Other
Black
White
Lumber
Metal
Agri
Fire
Silica
Health
Child
Teach
Animal
College
Organic
Mechanic
Mold
Military
Mail
Rad
Bird
Sale
Bank
Admin

Figure 1