ALPHA FOUNDATION FOR THE IMPROVEMENT OF MINE SAFETY AND HEALTH

Final Technical Report

Grant Number and Title: AFC618SP-88 "Coal Mining Employment as a Risk Factor for Rheumatoid Arthritis"

Organization Name: The Regents of the University of California, San Francisco

Principal Investigator: Paul D. Blanc, MD MSPH

Contact Information: Paul.Blanc@ucsf.edu; 415-476-7377

Period of Performance: January 1 2019 to June 30 2022

This study was sponsored by the Alpha Foundation for the Improvement of Mine Safety and Health, Inc. (ALPHA FOUNDATION). The views, opinions and recommendations expressed herein are solely those of the authors and do not imply any endorsement by the ALPHA FOUNDATION, its Directors and staff.

1. Executive Summary

"Coal Mining Employment as a Risk Factor for Rheumatoid Arthritis" had the overarching objective of addressing the important knowledge gaps concerning the magnitude of and risk factors for arthritis in coal miners to better inform occupational health practice and policy. Its specific aims built directly on the findings from our previous exploratory study ("Coal Mining Risk of Arthritis, Including Auto-Immune Rheumatologic Disease"). The first Aim was to delineate risk factors for all forms of arthritis in a population survey of adult males in geographic areas manifesting a high burden of coal workers' pneumoconiosis (CWP). The second was to delineate the risk factors for autoimmune rheumatologic disease in the same population. Our underlying research hypotheses, reinforced by our earlier exploratory study findings, were that that coal mining employment is associated with increased risk of degenerative arthritis, in particular related to work-related ergonomic exposures. We further hypothesized that coal mining employment also is associated with increased risk of autoimmune rheumatologic conditions. We further suspected interactions between selected combined risk factors, including combined dust and specific ergonomic exposures such as use of vibrating equipment.

We carried out a random digit dial (RDD) population survey by telephone, in English, among a random sample of males age 50 or older living in the same counties in Appalachia previously chosen for the 2017 exploratory pilot study (in Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia with historically high mortality rates from CWP). We developed the telephone survey instrument to maximize data pooling with the pilot data. We also included additional items refining the definition of rheumatoid arthritis (RA) by eliciting respondents' report of a set of medications given (so called Disease-Modifying Anti-Rheumatic Drugs or DMARDs). The new survey also asked additional mining exposure questions and used a refined ergonomic factor assessment. After preliminary analysis establishing remarkably similar frequencies of risk factors and outcomes, we pooled data for the shared variables while restricting analysis to the new survey of its unique measures. We used multivariable logistic regression analysis to model separately the risk of arthritis and RA in association with coal mining employment. Our metric of risk was the odds ratio (OR), which estimates the odds of an outcome (e.g., RA) among those with the risk factor (e.g., coal mining work) relative to those without. The associated confidence interval (CI) assesses the confidence that the observed OR is unlikely to be due purely to chance. Based on the OR and the proportion of cases at risk, we also estimated the population attributable fraction (PAF). This estimates the proportion of preventable disease if the risk factor were to be eliminated.

The new survey completed 2,008 telephone interviews meeting our 2000 interview target. We established that the data from these interviews were very close to those from the pilot survey in demographics, exposures, and outcome prevalence, allowing us to carry out pooled analyses. We analyzed pooled data for 2981 survey respondents (mean age 66.6 years; 15% current, 44% ex-smokers). The prevalence of glucocorticoid- treated and DMARD-treated RA (new data only) was 11% and 4%, respectively. Glucocorticoid- treated RA was associated with coal mining (OR 3.5; 95% CI 2.5 to 4.9) and non- coal mining silica exposure (OR 3.2; 95% CI 2.4 to 4.4). For DMARD-treated RA analyzed in the new sample only), the odds associated with coal mining and other silica remained elevated: OR 2.3 (95% CI 1.2, 4.5) and OR 2.7 (95% CI 1.5, 5.0), respectively. In the same model, the highest intensity ergonomic exposure (new data only) also was associated with increased odds of RA (OR 4.3; 95% CI 2.0 to 9.6). In summary, we observed a strong association between coal mining and other silica-exposing dusty trades and RA. These data supported our study hypotheses, confirming and amplifying the findings from our pilot study, extending it to a more conservative definition of disease based on DMARD-usage.

2. Problem Statement and Objective

Our study "Coal Mining Employment as a Risk Factor for Rheumatoid Arthritis" was solicited and awarded in follow-up to our successful exploratory study award, "Coal Mining Risk of Arthritis, Including Auto-Immune Rheumatologic Disease." Our current study objectives were:

1. To delineate risk factors for arthritis in a population survey of adult males in geographic areas manifesting a high burden of CWP

2. To delineate the risk factors for autoimmune rheumatologic disease in a survey of the same population.

Rates of arthritis are known to be elevated in states with large numbers of coal miners. Based on 2015 data, West Virginia has the highest prevalence of arthritis among adult males (30%, age adjusted) and the narrowest gender gap (only 4% less than women) of any state in the U.S (Centers for Disease Control. State-Specific 2015 BRFSS arthritis prevalence estimates (CDC). Further, Tennessee and Kentucky have the third and fourth leading state rates for arthritis among adult males (both rounding to 26%), while Pennsylvania and Ohio both have state rates for adult males within the top 15 for arthritis in the U. S. (despite large numbers of non-miners in those two states diluting any coal-associated impact on rates). By comparison, the age-adjusted adult male arthritis prevalence rate in California, a state without many coal miners, is 16%. The cause of this geographic clustering is unknown, either for degenerative arthritis or for inflammatory/autoimmune arthritis.

Multiple independent studies have found that occupational exposure to mineral dust is strongly associated with rheumatologic disease risk. Rheumatoid arthritis (RA) has been the condition most strongly implicated in mineral dust inhalation. In the early 1950s, there were nearly simultaneous observations that both silica dust (nearly pure silica "flour") and coal mining work were associated with RA. These observations were made by Colinet in Belgium and Caplan in the UK. By the 1990s, researchers identified mineral dust, predominantly silica, as a factor in a range of autoimmune diseases. Although the predominance of research has focused on silica, there has been re-emerging recognition that coal dust (with likely silica co-exposure) represents an important factor in what has come to be recognized more broadly as "coal mine dust lung disease."

Nonetheless, other than our Alpha Foundation supported exploratory study, there has been no other recent research into RA among U.S. coal miners. Nearly 50 years ago, a 1969 community-based study that included 560 miners aged 20 to 69 in West Virginia observed that radiographic osteoarthritis of the hands was present in 40.2% of the miners. A 1973 serologic study of 207 Pennsylvania and West Virginia underground coal miners, all with radiographic disease, found 6% positive for rheumatoid factor (RF) and 34% positive for antinuclear antibodies (ANA). Contemporaneous clinical studies of coal miners from the same region suggested that exposure-related RA was more common than appreciated. Only one other study of rheumatologic disease in Appalachian coal miners has appeared since that time (1981), finding that, among 353 (130 without radiographic lung disease), 69 (19.5%) were rheumatoid factor (RA) positive. Regions in the U.S. in which coal mining is concentrated and where there is a high prevalence of arthritis among males are co-located. The explanation for this this co-location is unclear and represents an important knowledge gap in occupational health.

3. Research Approach

We carried out a cross-sectional, random-digit dial (RDD) population-based telephone survey. The RDD surveys included landline and cellular phone sampling, targeting exchanges likely to be in counties in Appalachia (including parts of Kentucky, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia) with historically high mortality rates from CWP. We identified the targeted areas using data from the National Institute for Occupational Safety and Health. We limited eligibility for survey

participation to males 50 and over who were English language speakers, had a history of any past or current labor force participation, and confirmed current residence in one of the targeted counties.

For the sampling there were 62,948 call attempts resulting in 23,729 (38%) contacts with potential participants; 15,731 (66% of contacts) were ineligible because of age, sex, language, lack of labor force participation, or county of residence. Among eligible individuals, 5,990 declined participation yielding 2,008 respondents with data available for analysis (25% of eligible contacts). We also had available for analysis the exploratory sample of 973 men surveyed using the same methods (interviewed in 2017). For combined analyses, the study population consisted of 2,981 survey respondents.

Study interviews averaged 10 min in the 2017 survey and 18 min in this study, which was more extensive in its survey items than the exploratory survey. Both the previous exploratory and current surveys contained identically worded core items addressing employment, smoking history, socio-demographics and arthritis and related diagnoses. They also both ascertained duration and type of coal mining experience, as well as exposure to inhaled dusts in non-coal mining jobs. The health sections queried whether the respondent had ever received a diagnosis from a health professional of arthritis of any kind, with follow-up items specifying RA, psoriatic arthritis, or gout. The two surveys also elicited diagnoses of other autoimmune conditions, including systemic lupus erythematosus, psoriatic arthritis and systemic sclerosis. Interviews asked about joint swelling, stiffness or pain, and asked those who responded affirmatively if they had ever received oral glucocorticoids ('prednisone or steroid pills') in treatment for those symptoms. Importantly, the current survey included expanded batteries with items that were not present in the 2017 exploratory study. The expanded items addressed additional coal mining activities in order to further delineate exposure and additional questions related to treatments received for arthritis, in order to improve the specificity of the self-reported diagnoses of RA. The 2019 survey also restructured its assessment of ergonomic factors in order to better differentiate among higher intensity exposures. We worked closely with Davis Research (our interviewing contractor) to refine and then field test our study instrument insuring that skip patterns functioned as designed, that subjects' responses were consistent with item intent, and that the overall length of the interview conformed to our specifications.

Arthritis was defined by an affirmative response to a primary stem question about receiving a healthcare provider's diagnosis of arthritis. We defined RA based on a follow-up item about type of arthritis, further defined by also reporting having received glucocorticoids for joint symptoms. An alternative, more specific definition for RA (limited to items elicited in the current survey only), required a diagnosis of RA and report of receiving at least one of a standard list of disease-modifying antirheumatic drugs (DMARDs). As a sensitivity analysis, we also created a restrictive definition requiring both glucocorticoids and a DMARD. We defined a category of non-RA arthritis for all those who responded positively to the initial arthritis question, but did not meet the main study definition of RA. This category is likely to be predominantly degenerative arthritis (osteoarthritis), but includes reported RA without glucocorticoid use (or, in 2019 survey, without DMARDs) as well as infrequent reports of other autoimmune arthritis. We defined coal mining based on any coal mining employment, with additional survey items eliciting underground and/or surface coal mining. Other silica dust exposure (not from coal mining) was defined by affirmative responses to any of a list of specific job tasks including: underground mining (other than coal); work with silica, sand or concrete dust; sandblasting; rock drilling or roof bolting (in other mining); rock crushing or quarry work; foundry work; concrete finishing, cutting or drilling; or masonry work or tip-pointing. The current expanded survey allowed classification of coal jobs that likely would result in higher intensity silica exposure: roof bolter, slope or shaft construction work, and, in surface mining, bulldozer, dragline or scraper operator. We also ascertained the number of years spent working underground and the proportion of that time spent at the coal face, as that also confers higher silica exposure.

The current survey elicited responses on multiple ergonomic exposures from any occupation grouped by the body part involved or physical movement (eg, hand/wrist twisting). The categories surveyed included: neck and upper extremities (three items); hands (two items); back (four items); feet and lower extremities (three items); and work activities involving vibration (three items). Respondents reporting any work-related ergonomic exposures in these five categories were asked to specify the number of years worked in such jobs. We used these responses to generate a summary score in which one point was given for any group in which the respondent endorsed all of its items and reported at least 5 years exposure. This yielded a summary score from 0 to 5. Although ergonomic exposures also were elicited in the previous exploratory survey, that battery was more limited, had a lower threshold of positive response, and did not allow application of the same scoring schema. Smoking exposure assessment included age started, number of years smoked (for former smokers), and average number of cigarettes per day. This allowed for categorizations based on smoking status—never/former/current—and on number of years of exposure, yielding an estimate of pack-years of exposure.

We compared the demographic, occupational and arthritis prevalence characteristics of the exploratory and current surveys Because the frequencies of all characteristics were extremely similar, this allowed a pooled analysis of the two samples for these measures. Using multivariable logistic regression analyses, we modelled the risk of all arthritis, RA (defined by glucocorticoid use), and non-RA arthritis associated with coal mining employment and other silica exposure, or either exposure. These models controlled for age and smoking status (current, former, never). We also tested interaction terms between coal/silica exposure and smoking status for the odds of disease.

Using the maximum likelihood estimates from the regression models, we calculated the population attributable fraction (PAF) of RA prevalence to estimate the proportion of prevalent cases among men that could be attributed to coal and/or silica exposure. We further estimated the odds of RA from models stratified by never versus ever smoking and, among ever smokers, stratified by former vs current or recent and by years of exposure (dichotomized at the median, 25 years), also testing interaction terms in these analyses. As a sensitivity analysis, we re-estimated the main models using generalized estimating equations (GEE) including the survey (exploratory or current) as an additional variable. Using the additional variables only available in the current study that could not be pooled, we modelled the risk of disease using the overall approach described above but adding the two specific definitions of RA with DMARDs and with both glucocorticoids and DMARDs. In these models, we additionally included an ordinal measure of ergonomic exposure from the current survey based on score (0, 1, 2–3 or 4–5 points). We further defined coal mining exposure based on high intensity silica exposure tasks and on the number of years in underground mining. Each of these models also controlled for age and smoking (never/former/current).

Finally, a validation component of the research plan recruited patients with RA confirmed by rheumatology specialists in Appalachia. Rheumatologists who participated described our study to their eligible patients, obtaining permission to have our study staff contact them. The key requirement was that patients were recruited based on age, sex, and county of residence (the larger survey criteria) but without regard to occupational history. In this multistage process, patients then consented to release information from the treating rheumatologist, documenting diagnosis; the presence of rheumatoid factor and/or cyclic citrullinated peptides; the presence of radiographic erosions; and the usage of DMARDs or glucocorticoids. Later the recruited patients completed the very same telephone interview as the larger sample. The analysis of these data examined whether these patients' survey responses on diagnosis and treatment are consistent with medical record confirmation, thus supporting the validity of the self-report methodology. Additionally, these data were used to compare the prevalence of occupational exposures in specialist-confirmed cases of RA to that in the broader survey population.

4. Research Findings and Accomplishments

The results of the current survey, combined with those of the exploratory survey where relevant, are presented in tables over pages that follow. These tables reflect that data that was presented in a peer-reviewed research publication based on our study that appeared in February 2022 in the journal Occupational and Environmental Medicine.

Table 1 presents the demographic, disease outcome, and exposure factors. For all of the variables common to both the exploratory and current surveys, these data convincingly show that the data can be combined, thus increasing study size and study power to observe outcomes. Table 1 also shows the added variables only available in the current survey: rheumatoid arthritis (RA) therapy, classification of high intensity coal work, and our more detailed ergonomic exposure measure that we developed for this survey.

Table 1 Characteristics of 2981 survey participants from the exploratory and current samples

Characteristics	2017 Sample (n=973)	2019 Sample (n=2008)	Combined Samples (n=2981)
Sociodemographics	n(%) (unless otherwise noted)		
Age, mean±SD	66.0±9.6	66.9±9.7	66.6±9.7
Race/ethnicity			
Black	31 (3%)	48 (2%)	79 (3%)
Hispanic	16 (2%)	24 (1%)	40 (1%)
Asian/other	38 (4%)	61 (3%)	99 (3%)
White, non-Hispanic	888 (91%)	1875 (93%)	2763 (93%)
Currently employed	407 (42%)	716 (36%)	1123 (38%)
Cigarette Smoking			
Never smoked	452 (46%)	845 (42%)	1297 (44%)
Former smoker	394 (40%)	832 (41%)	1226 (41%)
Current/recent smoker	127 (13%)	331 (16%)	458 (15%)
Among ever smokers			
Years smoked, median (IQR)	25 (12–40)	25 (13–40)	25 (12–40)
Pack-years, mean±SD	29.8±28.8	32.0±30.3	31.3±29.8
Arthritis			
No dx of arthritis reported	456 (47%)	837 (42%)	1293 (43%)
Any arthritis dx reported	517 (53%)	1171 (58%)	1688 (56%)
Arthritis, excluding RA	329 (34%)	759 (38%)	1088 (37%)
Any RA reported	188 (19%)	412 (21%)	600 (20%)
RA, with glucocorticoids	112 (12%)	202 (10%)	314 (11%)
RA, with DMARD	–	88 (4%)	–
RA, with DMARD and glucocorticoids	–	62 (3%)	–
Exposures			
Any coal mining exposure	181 (19%)	409 (20%)	590 (20%)
Years coal mining, median (IQR)	19 (7–30)	17 (5–30)	18 (5–30)
Underground mining	133 (14%)	263 (13%)	396 (13%)
Surface mining	97 (10%)	210 (10%)	307 (10%)
High intensity silica coal mining jobs	–	258 (13%)	–
Silica exposure, not from coal mining	264 (27%)	557 (28%)	821 (28%)
Ergonomic exposure score, median (IQR)	–	2 (0–3)	–
Ergonomic score=0	–	613 (31%)	–
Ergonomic score=1	–	326 (16%)	–
Ergonomic score=2–3	–	613 (31%)	–
Ergonomic score=4–5		456 (23%)	

Table 2 provides the results of a risk analysis that recapitulates but reinforces the results we observed in our exploratory analysis as previously published in Arthritis Care and Research in 2019. The odds ratio for age is expressed per year of age. Recent smokers include those who stopped in past 3 years. The RA definition is based on report of doctor's diagnosis of RA, plus treatment with glucocorticoids. Note that the column n values present the n for persons without any arthritis (1293) + those with any arthritis (1688) or non-corticosteroid use RA arthritis (1374) or RA defined by corticosteroid use (314).

Table 2 Arthritis conditions associated with coal and silica exposure, adjusted for smoking and age combined datasets

	Arthritis (Any)	**Non-RA arthritis (Excluding RA)**	**RA (Excluding non-RA)**
	(n=2981)	**(n=2667)**	**(n=1607)**
Arthritis prevalence	57% (55%–58%)	46% (44%–48%)	11% (9%–12%)
Risk factors	Odds Ratios (95% CI)		
Coal and silica exposure			
Coal (±silica)	2.3 (1.8 to 2.8)	2.1 (1.7 to 2.5)	3.5 (2.5 to 4.9)
Silica exposure only	2.0 (1.7 to 2.4)	1.8 (1.5 to 2.2)	3.2 (2.4 to 4.4)
Neither	Referent	Referent	Referent
Age	1.02 (1.01 to 1.03)	1.02 (1.01 to 1.03)	1.02 (1.01 to 1.03)
Smoking			
Current/recent	1.1 (0.9 to 1.4)	1.0 (0.8 to 1.3)	1.7 (1.2 to 2.5)
Former smoker	1.3 (1.1 to 1.5)	1.3 (1.1 to 1.5)	1.5 (1.2 to 2.1)
Never smoked	Referent	Referent	Referent

Table 3 provides a detailed analysis of the interactions between smoking and coal work and other silica-associated RA risk. This analysis is important because cigarette smoking is a known risk factor for RA, but we could show the risk was present in non-smokers as well. The interaction based on duration of smoking may have implications for targeted smoking cessation among selected working groups. It should also be noted that the epidemiological relationship between cigarette smoking, past or current, and RA is complex. Based on observational data it even has been argued the active smoking may be protective against severity, a conclusion that may not sufficiently consider time varying confounding. Analyzing the relationship between occupation and smoking is similarly fraught with time varying confounding in the context of 'the healthy worker survivor effect' which refers to the real word situation in which workers in poorer health (related to smoking or RA or both) leave work earlier and those with longer work duration stay longer. Thus, when taking into account the potential the concomitant effects of smoking, RA, and occupation, caution is warranted. Although we estimated greater silica risk among former smokers and lower packyear smokers, somewhat counterintuitive, a clear explanation could be that continuing to smoke (thus being a current smoker or a smoker with more pack years) selects for workers without illness that led to smoking cessation.

Table 3 Rheumatoid Arthritis associated with coal mining and other silica exposure, stratified on smoking status

		RA Prevalence	**Exposure**		
			Coal ± Other Silica	**Non-coal Silica**	**Interaction term**
Stratified models	**Model n**	**Percent**	**ORs (95% CI) for RA**		**P value**
Never and ever smokers					0.84
Never smokers	729	8	3.0 (1.7 to 5.2)	2.9 (1.8 to 4.8)	
Ever smokers	878	13	3.8 (2.5 to5.8)	3.5 (2.4 to 5.1)	
Former and current smokers*					0.02
Former smokers	615	12	5.4 (3.3 to 9.0)	3.5 (2.2 to 5.5)	
Current/recent smokers	263	15	1.6 (0.8 to 3.6)	3.2 (1.7 to 6.2)	
Shorter and longer smoking*					0.02
<25 years	441	11	6.5 (3.5 to 12.1)	4.0 (2.2 to 7.3)	
≥25 years	419	15	2.1 (1.2 to 3.7)	3.1 (1.8 to 5.1)	

Table 4 presents an analysis limited to the 2019 sample utilizing variables only available in that cohort. As in Table 2, the column n values exclude those with arthritis by another definition. Importantly this analysis showed a step-up in risk of RA with higher silica exposure coal mining jobs and, in a separate analysis, a step-up in risk with longer duration of work, both findings supportive of a causal relationship to dust exposure. These analyses also showed a step-up in risk with greater ergonomic exposure and, as importantly, that such exposure, nonetheless, did not account for dust-associated risk. All models shown in Table 4 control for the other variables shown in the model, plus age and smoking (never, former, current/recent). Sensitive RA case definition is based on report of doctor's diagnosis of RA, plus treatment with glucocorticoids. Specific RA case definition is based on report of doctor's diagnosis of RA, plus treatment with DMARDs.

Table 4 Arthritis conditions associated with coal and silica exposure, adjusted for ergonomic exposures, smoking and age (2019 sample only)

Multivariate logistic models	Any arthritis (Model n=2008)	Non-RA arthritis (Model n=1806)	RA (sensitive) (Model n=1039)	RA (specific) (Model n=925)
Prevalence of arthritis by type (95% CI)	58% (56% to 60%)	48% (46% to 50%)	10% (9% to 11%)	4% (3% to 5%)
Model 1: coal and/or silica exposure	ORs (95% CIs)			
No exposure to coal mining or other occupational silica	Referent	Referent	Referent	Referent
Coal mining exposure	1.8 (1.4 to 2.3)	1.7 (1.27 to 2.2)	2.3 (1.52 to 3.6)	2.3 (1.18 to 4.5)
Silica exposure from non-coal occupations only	1.3 (1.1 to 1.7)	1.2 (0.97 to 1.6)	1.8 (1.20 to 2.7)	2.7 (1.51 to 5.0)
Ergonomic hazard score (referent category=0)				
one point	1.5 (1.2 to 2.0)	1.5 (1.09 to 1.9)	2.4 (1.30 to 4.2)	1.8 (0.76 to 4.4)
2–3 points	2.0 (1.5 to 2.5)	1.8 (1.43 to 2.4)	3.2 (1.91 to 5.4)	2.4 (1.12 to 5.2)
4–5 points	2.6 (2.0 to 3.5)	2.3 (1.68 to 3.1)	5.4 (3.14 to 9.5)	4.3 (1.96 to 9.6)
Model 2: intensity of exposure				
No exposure to coal mining or other occupational silica	Referent	Referent	Referent	Referent
High silica coal mining exposure	1.9 (1.4 to 2.6)	1.8 (1.27 to 2.4)	2.6 (1.60 to 4.4)	2.6 (1.21 to 5.5)
All other coal mining exposure	1.6 (1.1 to 2.3)	1.5 (1.04 to 2.3)	1.9 (1.05 to 3.6)	1.9 (0.76 to 4.9)
Silica exposure from non-coal occupations only	1.3 (1.1 to 1.7)	1.2 (0.97 to 1.6)	1.8 (1.20 to 2.7)	2.7 (1.51 to 5.0)
Ergonomic hazard score (referent category=0)				
1 point	1.5 (1.2 to 2.0)	1.4 (1.09 to 1.9)	2.4 (1.31 to 4.3)	1.8 (0.77 to 4.5)
2–3 points	2.0 (1.5 to 2.5)	1.8 (1.42 to 2.4)	3.2 (1.90 to 5.4)	2.4 (1.11 to 5.2)
4–5 points	2.6 (2.0 to 3.5)	2.3 (1.68 to 3.1)	5.4 (3.12 to 9.4)	4.3 (1.94 to 9.5)
Model 3: underground coal mining exposure				
No exposure to coal mining or other occupational silica	Referent	Referent.	Referent	Referent
No underground work	1.5 (1.0 to 2.2)	1.5 (1.02 to 2.2)	1.5 (0.78 to 2.9)	1.5 (0.58 to 4.1)
1–17 years	1.6 (1.1 to 2.4)	1.5 (0.96 to 2.2)	2.4 (1.27 to 4.4)	2.7 (1.08 to 6.5)
≥18 years	2.5 (1.6 to 3.9)	2.3 (1.43 to 3.6)	3.8 (1.99 to 7.2)	3.1 (1.19 to 8.3)
Silica exposure from non-coal occupations only	1.3 (1.1 to 1.7)	1.2 (0.97 to 1.6)	1.8 (1.19 to 2.7)	2.7 (1.51 to 5.0)
Ergonomic hazard score (referent category=0 points)				
1 point	1.5 (1.2 to 2.0)	1.4 (1.08 to 1.9)	2.4 (1.30 to 4.3)	1.9 (0.77 to 4.5)
2–3 points	2.0 (1.5 to 2.5)	1.8 (1.42 to 2.4)	3.1 (1.85 to 5.2)	2.4 (1.10 to 5.1)
4–5 points	2.6 (1.9 to 3.5)	2.3 (1.67 to 3.1)	5.5 (3.15 to 9.5)	4.4 (1.97 to 9.6)

A key strength of the multivariable approach shown in Table 4 is that this provides estimations of risk that also take into account the simultaneous effects of the other variables included, in particular ergonomic factor + different sources of silica (Model 1 coal vs. non-coal silica sources; Model 2, high silica coal mining vs. other coal vs other; Model 3 duration underground vs. other). We did not model underground vs. surface coal as such, because Model 2 addresses higher exposure jobs whether underground or surface.

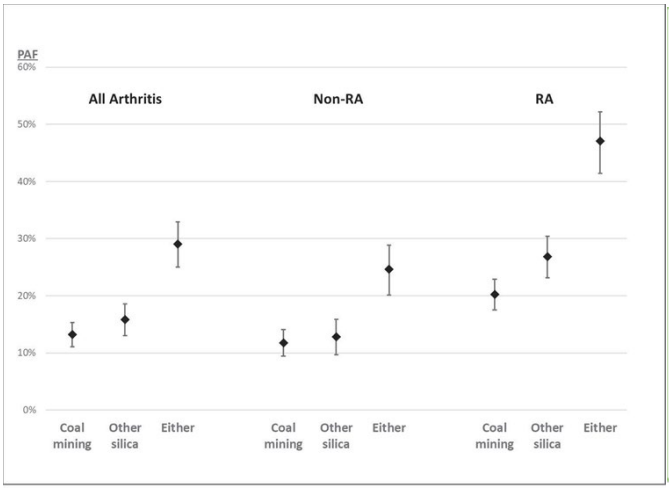

Figure 1 Population attributable fractions (PAF) for arthritis conditions. Estimates based on logistic regression models using combined surveys, controlling for smoking (never, former, current/recent) and age. Error bars represent 95% CIs. These data show that on a population basis, 20% of the RA among adult males in the age range studied is attributable to coal mining. For either coal mining or other silica, nearly one in every two cases is attributable.

Figure 1 uses the data derived from the combined surveys to estimate how much arthritis would not have occurred absent the exposures in question. Note that for RA the confidence intervals for the PAF estimates overlap for coal vs. silica from other sources (meaning that they do not statistically differ). It is also important to keep in mind that the PAF reflects the estimate risk combine with the prevalence of the exposure.

For our physician validation subset study, we ultimately recruited 32 participants. All 32 were DMARD-treated RA. Of these 32, 22% reported coal mining exposure. This proportion is very close to the 24% proportion who reported coal mining work among the survey respondents with DMARD-defined RA (n=88) and higher than the 15% among those with no arthritis of any type (n=837). Combining the 32 and the 88 and compared to those without arthritis, the proportion of coal mining exposure is statistically different (p=0.02). The agreement between treatment reported in interviews and treatment documented in medical records for the 32 is quite high, especially for DMARD treatment. These data support the validity of the findings from the general survey.

Meeting our timeline and work plan for the population-based survey, we successfully: designed, refined and field-tested our survey instrument; carried out the survey as proposed; achieved our targeted participation numbers; and carried out the analyses we had proposed. Moreover, our results were highly consistent with our exploratory survey, allowing us to combine data for the same variables and increasing study power. Thus, we met our primary study aims. Our validation cohort, whose recruitment experienced severe negative impacts from the COVID-19 pandemic, nonetheless obtained sufficient data to address its primary goal which was to serve as a validation measure of the key questionnaire-based definition of disease as well as the generalizability of the reported exposure.

5.0 Publication Record and Dissemination Efforts

Our findings were presented in a peer-reviewed research publication that appeared in February 2022 in the journal Occupational and Environmental Medicine (Schmajuk G, Trupin L, Yelin EH, Blanc PD. Dusty trades and associated rheumatoid arthritis in a population-based study in the coal mining counties of Appalachia. Occup Environ Med 2022; 79:308–14). OEM has a relatively high impact in the field of occupational medicine (above the American Journal of Industrial Medicine and the Journal of Occupational and Environmental Medicine). The publication was picked up by Reuters Health https://www.mdedge.com/rheumatology/article/251628/rheumatoid-arthritis/coal-mining-silica-dust-associated-rheumatoid and cited in Faculty Opinions https://facultyopinions.com/article/741700565.

Our data were previously presented to a major rheumatology meeting and disseminated in in abstract form (Trupin L, Schmajuk G Yelin E, Blanc PD. Intensity and duration of silica exposure increase rheumatoid arthritis risk among coal miners. Arthritis Rheumatol. 2020; 72 (Suppl 10). Meeting Abstract 1462.) Our preliminary study findings (later pooled in this analysis) were also published in a peer-reviewed journal (Schmajuk G, Trupin L, Yelin E, Blanc PD. Prevalence of arthritis and rheumatoid arthritis in coal mining counties of the U.S. Arthritis Care Res [Hoboken] 2019; 71:1209-15). That study was also covered in the medical press by Helio Rheumatology including a perspective from Eileen McCullagh https://www.healio.com/news/rheumatology/20190402/coal-mining-linked-to-33-of-ra-cases-in-appalachia as well at https://www.medpagetoday.com/rheumatology/arthritis/78670 (MedPage Today). Those earlier data had also been presented at an international meeting t (Blanc PD, Trupin L, Yelin EH, Schmajuk G. Occupational exposure to coal and silica dust and risk of rheumatoid arthritis in Appalachia. Am J Respir Crit Care Med 2018;197: A2579). Dr. Schmajuk featured out work in a presentation that she made to the 2020 UCSF Occupational and Environmental Medicine Continuing Medical Education course in a lectured titled, "Autoimmune Disease and Occupation."

6.0 Conclusions and Impact Assessment

In summary, our population-based survey data show that coal mining work and occupational silica exposure are both associated with threefold odds of RA, findings that are similar to our previous exploratory study. Further, using data generated only in the current survey, a step-up in odds of RA was manifested with greater silica risk coal jobs and longer duration of work underground, supporting a pattern of exposure-response consistent with a causal relationship. The current survey also provided greater detail on RA with a history of treatment with DMARDs, a more specific definition of disease. Defining RA in this narrower way reduced the prevalence of disease (from 11% to 4%) but did not substantively affect point estimates of the coal mining-associated odds of disease. This suggests that defining RA based on glucocorticoid treatment even without report of DMARD use provides a reasonable measure of disease and avoids the selection effect of requiring access to prescription medications that can be quite costly and require access to specialty care which is in short supply in this geographical area. Our current survey also benefits from more detailed ergonomic exposure. Using a more refined measure, we observed increased odds of both RA and non-RA arthritis, with a heightened exposure response with increasing ergonomic burden. The potential mechanism of ergonomic risk for osteoarthritis through mechanical stressors is straightforward, although in coal mining this only has been well studied otherwise in the case of knee complaints (i.e., "beat knee").

7.0 Recommendations for Future Work

The survey approach that we utilized in this research project serves as a useful methodologic model to approach other questions. We are completing a study using parallel methods among hard rock miners in Utah, Colorado, and New Mexico. We also have proposed this approach to investigate the prevalence of depression, anxiety, and post-traumatic stress disorder among coal miners in Appalachia.

8.0. References

Blanc PD, Trupin L, Yelin EH, Schmajuk G. Occupational exposure to coal and silica dust and risk of rheumatoid arthritis in Appalachia. Am J Respir Crit Care Med 2018;197: A2579.
Schmajuk G, Trupin L, Yelin E, Blanc PD. Prevalence of arthritis and rheumatoid arthritis in coal mining counties of the U.S. Arthritis Care Res (Hoboken) 2019; 71:1209-15.
Trupin L, Schmajuk G Yelin E, Blanc PD. Intensity and duration of silica exposure increase rheumatoid arthritis risk among coal miners. Arthritis Rheumatol. 2020; 72 (Suppl 10). Meeting Abstract 1462.
Schmajuk G, Trupin L, Yelin EH, Blanc PD. Dusty trades and associated rheumatoid arthritis in a population-based study in the coal mining counties of Appalachia. Occup Environ Med 2022; 79:308–14.

9. Appendix 2019 UCSF Alpha Survey II

– Screening Questions –

Hello, my name is _____, and I am calling from Davis Research, an independent public opinion research organization. We are conducting an important survey for one of the nation's leading schools of medicine about some work and health-related issues. This is a legitimate public opinion survey – we are not selling anything.

S1. We are only conducting this survey in certain states and counties in the U.S. In what state do you live?

KENTUCKY 1
OHIO 2
PENNSYLVANIA..... 3
TENNESSEE 4
VIRGINIA 5
WEST VIRGINIA..... 6
ALL OTHER STATES…7→**END**
REFUSED ..... . REF →**END**

S2. And, in what county do you live?

IF KENTUCKY

BELL 01
CLAY.....02
FLOYD.....03
HARLAN 04
HOPKINS 05
JOHNSON 06
KNOTT 07
KNOX.....08
LAUREL.....09
LESLIE 10
LETCHER.....11
MCCREARY.....12
MARTIN 13
MUHLENBERG.....14
PERRY 15
PIKE.....16
PULASKI.....17
UNION.....18
WHITLEY 19
ALL OTHER .. 20 →**END**
REFUSED .. REF →**END**

IF OHIO

ATHENS 01
BELMONT 02
GALLIA..... 03
JEFFERSON..... 04
LAWRENCE 05
MEIGS..... 06
MUSKINGUM..... 07
PERRY..... 08
TUSCARAWAS 09
ALL OTHER… 10→**END**
REFUSED …REF→**END**

IF PENNSYLVANIA

ARMSTRONG 01
BEDFORD 02
CAMBRIA 03
CARBON.....04
CENTRE 05
CLARION 06
CLEARFIELD 07
COLUMBIA 08
DAUPHIN 09
ELK.....10
FAYETTE 11
GREENE 12
INDIANA.....13
JEFFERSON 14
LACKAWANNA.....15
LUZERNE.....16
MONTOUR 17
NORTHUNMBERLAND18
SCHUYLKILL.....19
SOMERSET 20
SUSQUEHANNA.....21
WASHINGTON 22
WAYNE.....23
WESTMORELAND 24
WYOMING.....25
ALL OTHER .. 26 →**END**
REFUSED . .REF →**END**

IF TENNESSEE

ANDERSON.....01
CAMPBELL.....02
CLAIBORNE.....03
GRUNDY.....04
HAWKINS.....05
MARION.....06
MORGAN 07
ROANE 08
SCOTT 09
ALL OTHER .. 10 →**END**
REFUSED . .REF →**END**

IF VIRGINIA

BUCHANAN.....01
DICKENSON.....02
FAUQUIER 03
LEE.....04
NORTON CITY 05
RUSSELL.....06
SCOTT 07
TAZEWELL.....08
WASHINGTON 09
WISE.....10
ALL OTHER .. 11 →**END**
REFUSED ..REF →**END**

IF WEST VIRGINIA

BARBOUR.....01
BOONE.....02
BRAXTON 03
CLAY 04
FAYETTE 05
GREENBRIER.....06
HARRISON.....07
KANAWHA 08
LINCOLN 09
LOGAN.....10
MCDOWELL 11
MARION 12
MARSHALL 13
MERCER 14
MINERAL 15
MINGO 16
MONONGALIA 17
MONROE.....18
NICHOLAS 19
PRESTON.....20
RALEIGH 21
RANDOLPH.....22
SUMMERS 23
TAYLOR 24
UPSHUR.....25
WAYNE 26
WEBSTER.....27
WYOMING.....28
ALL OTHER .. 29 →**END**
REFUSED ...REF →**END**

S3. **RECORD GENDER:** (INTERVIEWER: I F YOU HAVE ANY DOUBT AS TO RESPONDENT'S GENDER, SAY: Because it is sometimes difficult to determine over the phone, I am asked to confirm whether you are male or female.)

MALE 1
FEMALE 2

LANDLINE SAMPLE

IF MAN IS ON THE TELEPHONE, SAY:

S4a. For this interview I need to speak to a male age 50 or older. Does a male age 50 or older live in your household? (IF YES, ASK) Is that you or someone else? (IF SOMEONE ELSE, ASK TO SPEAK TO THAT PERSON) (IF MORE THAN 1 MALE AGE 50 OR OLDER LIVING IN HOUSEHOLD, SAY: I'd like speak with the youngest male age 50 or older who is at home now.)

SPEAKING TO ELIGIBLE MALE 1 **CONTINUE WITH S5A**
ELIGIBLE MALE COMES TO PHONE 2 **REPEAT INTRO, THEN CONTINUE WITH S5A**
ELIGIBLE MALE NOT AVAILABLE NOW 3 **CALLBACK**
NO MALES AGE 50+ IN HOUSEHOLD 4 **END**
REFUSED…… REF **END**

IF WOMAN IS ON THE TELEPHONE, SAY:

S4b. For this interview I need to speak to a male age 50 or older. Does a male age 50 or older live in your household? (ASK TO SPEAK TO THAT PERSON) (IF MORE THAN 1 MALE AGE 50 OR OLDER LIVING IN HOUSEHOLD, SAY: I'd like to speak with the youngest male age 50 or older who is at home now.)

ELIGIBLE MALE COMES TO PHONE 1 **REPEAT INTRO, THEN CONTINUE WITH S5A**
ELIGIBLE MALE IS NOT AVAILABLE NOW 2 **CALLBACK**
NO MALES AGE 50+ IN HOUSEHOLD 3 **END**
REFUSED…… REF **END**

S5a. What is your age?

_____ **IF AGE 50+, GO TO S6A**
IF UNDER AGE 50..... X → **END**
REFUSED ..... REF → **ASK S5B**

IF REFUSED, ASK:

S5b. I don't need to know exactly, but can you tell me if you are under age 50, age 50-54, 55-59, 60-64, 65-69, 70-74 or 75 or older?

UNDER AGE 50 ..... 1 → **END**
50-54…….2 **CONTINUE**
55-59…….3 **CONTINUE**
60-64…….4 **CONTINUE**
65-69…….5 **CONTINUE**
70-74…… .6 **CONTINUE**
75 OR OLDER…… .7 **CONTINUE**
REFUSED ..... REF → **END**

S6a. Did you ever work for pay or profit for one year or longer, including civilian and military duties?

YES……1 **GO TO S10**
NO ……..2 **ASK S6B**
NO ANSWER/REFUSED …..REF **ASK S6B**

IF NO OR REFUSED, ASK:

S6b. Did you ever work without salary or pay on a farm or family business for one year or more?

YES……1 **GO TO S10**
NO ……..2 **END**
NO ANSWER/REFUSED …..REF **END**

CELL PHONE SAMPLE

- **IF MALE FROM S3, GO TO S8A; IF FEMALE FROM S3, END**

S8a. What is your age?

_____ **IF AGE 50+, GO TO S9A**
IF UNDER AGE 50……X →**END**
REFUSED……REF →**ASK S8b**

IF REFUSED, ASK:

S8b. I don't need to know exactly, but can you tell me if you are under age 50, age 50-54, 55-59, 60-64, 65-69, 70-74 or 75 or older?

UNDER AGE 50 ……1 →**END**
50-54……..2 **CONTINUE**
55-59……..3 **CONTINUE**
60-64……..4 **CONTINUE**
65-69……..5 **CONTINUE**
70-74……..6 **CONTINUE**
75 OR OLDER…… .7 **CONTINUE**
REFUSED……REF →**END**

S9a. Did you ever work for pay or profit for one year or longer, including civilian and military duties?

YES……1 **GO TO S10**
NO ……..2 **ASK Q9B**
NO ANSWER/REFUSED …..REF **ASK Q9B**

IF NO OR REFUSED, ASK:

S9b. Did you ever work without salary or pay on a farm or family business for one year or more?

YES……1 **GO TO S10**
NO ……..2 **END**
NO ANSWER/REFUSED …..REF **END**

IF ELIGIBLE FROM S6 OR S9, SAY

S10. You are eligible to participate in an important study about the impact of work on health. Upon completing the survey, we will send you a $5 gift card to Amazon or Starbucks or we can mail you a check . . . . It will not take long, only about 15-20 minutes for most people . . . . It is completely voluntary and you can stop at any point. . . . The study's principal investigator is Dr. Paul Blanc at the University of California, School of Medicine. Would you like to participate?

YES, PROCEED…… 1 → **CONTINUE**
YES, BUT CALL BACK LATER 2 → **ARRANGE CALLBACK**
UNSURE/HAS QUESTIONS… 3 → **READ TEXT BELOW**
NO, REFUSED……REF →**END**

(**IF UNSURE OR HAS QUESTIONS, SAY)** If you have any questions, we can give you the telephone number of Dr. Blanc's office or for the Office of Research Affairs at the University. (**IF REQUESTED)** Dr. Blanc's research office telephone number is 415-476-7377. The University Office of Research Affairs telephone number is 415-476-1814.

IF CELL PHONE LISTING, ASK

S11. For your safety, are you currently driving a motor vehicle, operating heavy equipment or in a place that is unsafe to do the survey?

YES,……..……1→ **ARRANGE CALLBACK**
NO……..2→ **CONTINUE**

IF CALLBACK FROM S10 OR S11, ASK:

S12a. When would be a good time for us to call back? **RECORD DAY AND TIME OF CALLBACK**

S12b. So our interviewer can ask for you to speak to (that person) (you) by name, what is (his) (your) first name? **RECORD FIRST NAME FOR CALLBACK**

2019 UCSF Alpha Survey II
– Main Questionnaire –

Before we begin, I need to tell you that my supervisor sometimes monitors these interviews to ensure quality and courtesy.

The first questions concern work and employment.

1. Are you currently employed for pay or profit either full or part time?
   YES.....1 (ASK Q1A)
   NO.....2 (SKIP TO Q2)
   NO ANSWER/REFUSED…DK (SKIP TO Q2)

IF Q1=YES, ASK:

1a. Do you currently work in coal mining?
   YES.....1 (SKIP TO Q3)
   NO ..... 2 (ASK Q2)
   NO ANSWER/REFUSED . DK (ASK Q2)

IF Q1=NO OR DK OR Q1A=NO OR DK, ASK:

2. Did you ever work in coal mining?
   YES.....1 (ASK Q3)
   NO.....2 (SKIP TO Q7)
   NO ANSWER/REFUSED…DK (SKIP TO Q7)

IF Q1 OR Q2=YES, ASK:

3. Did this ever include underground mining?
   YES..... 1 (ASK Q3A)
   NO ..... 2 (GO TO Q4)
   NO ANSWER/REFUSED..... DK (GO TO Q4)

IF Q3=YES, ASK:

3a. Did this ever include room and pillar mining?
   YES.. .....1 (GO TO Q3AI)
   NO .....2 (GO TO 3B)
   NO ANSWER/REFUSED… DK (GO TO Q3B)

IF Q3A=YES, ASK:

3ai. Was this done by conventional mining?
   YES ..... 1 (GO TO Q3ai1)
   NO..... 2 (GO TO Q3aii)
   NO ANSWER/REFUSED .. DK (GO TO Q3aii)

IF Q3ai = YES, ASK:

3ai1. Were you ever a cutting machine operator or helper?
   YES..... 1
   NO..... 2
   NO ANSWER/REFUSED..... DK

3aii. Was the room and pillar work done with a continuous miner?
   YES.....1
   NO 2
   NO ANSWER/REFUSED .....DK

3aiii. Were you ever a loading machine operator or helper?
   YES.....1
   NO 2
   NO ANSWER/REFUSED .....DK

3b. Was your underground coal work ever longwall mining?

YES ..... 1 (GO TO Q3BI)
NO ..... 2 (GO TO Q3C)
NO ANSWER/REFUSED ..... DK (GO TO Q3C)

IF Q3B = YES, ASK:

3bi. Were you ever a longwall sheer operator or helper?

YES 1
NO 2
NO ANSWER/REFUSED ..... DK

3bii. Were you ever a longwall jack setter?

YES 1
NO 2
NO ANSWER/REFUSED ..... DK

3c. Were you ever a roof bolter?

YES 1
NO 2
NO ANSWER/REFUSED ..... DK

3d. Did you ever work in underground coal mine construction or development?

YES ..... 1 (ASK Q3DI)
NO ..... 2 (GO TO Q3E)
NO ANSWER/REFUSED .....DK (GO TO Q3E)

IF Q3D = YES, ASK:

3di. Did you cut through rock, for example in slope or shaft construction?

YES 1
NO..... 2
NO ANSWER/REFUSED ..... DK

3e. Considering all underground coal mining, for how many years in total did you do this work?

_____ YEARS
NO ANSWER/REFUSED.....DK

3f. What percentage of these years did you work at the coal face?

_____ PERCENT (O%-100%)
NO ANSWER/REFUSED ..... DK

IF Q1A OR Q2=YES, ASK:

4. Did your coal mining work ever include surface or strip mining?

YES ..... 1 (GO TO Q4A)
NO..... 2 (GO TO Q5)
NO ANSWER/REFUSED..... DK (GO TO Q5)

IF Q4=YES, ASK:

4a. In this work did you operate a bulldozer, dragline, or scraper?

YES 1
NO..... 2
NO ANSWER/REFUSED..... DK

4b. Were you a high wall or auger operator or helper?

YES 1
NO..... 2
NO ANSWER/REFUSED..... DK

4c. Considering all surface or strip coal mining, for how many years in total did you do this work?

_____ YEARS
NO ANSWER/REFUSEDDK

5. Thinking about all coal mining jobs you have held for one year or more during your career, have you ever been (a) (an) . . .? **(READ ITEMS IN RANDOM ORDER, MULTIPLE YES ANSWERS ALLOWED)**

		YES	NO	DK/REF
a.	Coal drill operator	1	2	DK
b.	Shot firer	1	2	DK
c.	Timberman	1	2	DK
d.	Beltman or boomboy	1	2	DK
e.	Scoop or shuttle car operator	1	2	DK
f.	Mobile bridge operator	1	2	DK
g.	Electrician, mechanic or utility man	1	2	DK
h.	Return side face worker	1	2	DK
i.	Supply man	1	2	DK
j.	Tractor operator or motorman	1	2	DK
k.	Section foreman	1	2	DK

6. Has a medical doctor ever told you that you have black lung, or have you ever applied for benefits for this condition?
   YES ..... 1 (ASK Q6A)
   NO ..... 2 (GO TO Q7)
   NO ANSWER/REFUSED ..... DK (GO TO Q7)

IF Q6=YES, ASK:

6a. Did this include large lung nodules (nod-jewels) or Caplan's syndrome? (**IF NECESSARY:** Caplan's syndrome is a lung disease.)
   YES 1
   NO 2
   NO ANSWER/REFUSED ..... DK

7. Thinking about all of the types of work (**IF Q1A OR 2=YES, ADD** other than coal mining) that you have done for <u>one year or more</u> during your career, did any job involve regular exposure to breathing dusty air?
   YES ..... 1 (ASK Q7A)
   NO ..... 2 (SKIP TO Q8)
   NO ANSWER/REFUSED. DK (SKIP TO Q8)

IF Q7=YES, ASK:

7a. (**IF Q1A OR 2=YES, ADD** Other than coal mining), for how many years did your job regularly expose you to breathing dusty air?
   _____ YEARS
   NO ANSWER/REFUSED ..... DK

7b. (**IF Q1A OR 2=YES, ADD** Other than coal mining), did you ever have regular contact on the job with any of the following? **(READ ITEMS ONE AT A TIME IN ORDER)**

		YES	NO	DK/REF
i.	Coal dust or powder that was not from coal mining	1	2	DK
ii.	Underground mining other than coal	1	2	DK
iii.	Silica, sand, or concrete dust	1	2	DK
iv.	Sandblasting	1	2	DK
v.	Explosives or blasting fumes	1	2	DK
vi.	Rock drilling or roof bolting	1	2	DK
vii.	Rock crushing or quarry work	1	2	DK
viii.	Foundry work	1	2	DK
ix.	Concrete finishing, cutting, or drilling	1	2	DK
x.	Masonry work or tip-pointing	1	2	DK
xi.	Metal grinding or polishing	1	2	DK
xii.	Construction dust	1	2	DK
xiii.	Soil or agricultural dust	1	2	DK

8(1). Thinking about all of the types of work that you have done for one year or more during your career . . . did any job include the following manual activities on a daily or almost daily basis? **(READ ITEMS ONE AT A TIME IN ORDER)**

	YES	NO	DK/REF
a. Lifting or carrying objects weighing more than 30 pounds	1	2	DK
b. Back bending or twisting	1	2	DK
c. Stooping over	1	2	DK
d. Pushing or pulling objects weighing more than 50 pounds	1	2	DK

IF Q8A, Q8B, Q8C OR Q8D = YES, ASK

8e. For how many years altogether did your job regularly include any of these activities; that is, lifting, carrying, bending, stooping pulling or pushing?	_____ YEARS NO ANSWER/REFUSED..... DK

8(2). Did any job include the following manual activities on a daily or almost daily basis? **(READ ITEMS ONE AT A TIME IN ORDER)**

	YES	NO	DK/REF
f. Knee bending, squatting or kneeling	1	2	DK
g. Applying pedal or treadle (TRED-el) pressure with the foot	1	2	DK
h. Standing or walking 8 hours or more a day	1	2	DK

IF Q8F, Q8G OR Q8H = YES, ASK

8i. For how many years altogether did your job regularly include any of these activities; that is, bending, kneeling, squatting, treadle work or extensive standing or walking?	_____ YEARS NO ANSWER/REFUSED..... DK

8(3). Did any job include the following manual activities on a daily or almost daily basis? **(READ ITEMS ONE AT A TIME IN ORDER)**

	YES	NO	DK/REF
j. Use of shaking or vibrating power equipment	1	2	DK
k. Using a pneumatic (noo-mat-ik) drill or compressed air power tool	1	2	DK
l. Use of hand tools to hammer, chisel, or saw	1	2	DK

IF Q8J, Q8K OR Q8L = YES, ASK

8m. For how many years altogether did your work include using these kinds of vibrating, pneumatic (noo-mat-ik) or hand tools?	_____ YEARS NO ANSWER/REFUSED..... DK

8(4). Did any job include the following manual activities on a daily or almost daily basis? **(READ ITEMS ONE AT A TIME IN ORDER)**

	YES	NO	DK/REF
n. Overhead use of the arms	1	2	DK
o. Repetitive or sustained reaching forward	1	2	DK
p. Neck twisting or bending back the neck	1	2	DK

IF Q8N, Q8O OR Q8P = YES, ASK

8q. For how many years altogether did your job include this kind of work with your arms overhead or reaching, or your neck twisted or bent?	_____ YEARS NO ANSWER/REFUSED..... DK

8(5). Did any job include the following manual activities on a daily or almost daily basis? **(READ ITEMS ONE AT A TIME IN ORDER)**

	YES	NO	DK/REF
r. Gripping with the hands or wrist bending	1	2	DK
s. Repetitive or sustained gripping or pinching with the hands	1	2	DK

IF Q8R OR Q8S = YES, ASK

8t. For how many years altogether did your job include this kind of gripping, bending or pinching work with your hands? _____ YEARS
NO ANSWER/REFUSED..... DK

8u. And finally, did any job that you have done for one year or more involve typing or keyboard work or sitting at a desk 6 hours or more a day?
YES.....1
NO.....2
DON'T KNOW/REFUSED.....DK

Now, some questions about your health.

9. In general, would you say your health is excellent, very good, good, fair, or poor?
EXCELLENT.....1
VERY GOOD.....2
GOOD.....3
FAIR.....4
POOR.....5
NO ANSWER/DON'T KNOW..... DK

10. Are you limited in any way in any activities because of a long-term physical condition? **(DO NOT COUNT RETIREMENT AS A LONG-TERM HEALTH PROBLEM)**
YES.....1
NO.....2
DON'T KNOW/REFUSED..... DK

11. Has a doctor, nurse, or other health professional EVER told you that you have arthritis?
YES.....1
NO.....2
DON'T KNOW/REFUSED.....DK

(IF Q11 = YES, ASK:)

	YES	NO	DK/REF
11a. Was this osteoarthritis (os-tee-oh-arth-right-us) or degenerative arthritis?	1	2	DK
11b. Was this rheumatoid (rue-ma-toyed) arthritis?	1	2	DK
11c. Was this arthritis due to psoriasis (sor-eye-ah-sis)?	1	2	DK
11d. Was this arthritis due to gout?	1	2	DK
11e. At what age did your arthritis first start? AGE: _____ NO ANSWER/REFUSED..... DK			

12. Has a doctor, nurse or other health professional EVER told you that you have any of the following medical conditions? **(READ IN ORDER)**

	YES	NO	DK/REF
a. Lupus (LOOP-us) or SLE?	1	2	DK
b. Scleroderma (sklare-oh-DERM-ah)?	1	2	DK

13. Does pain, swelling, stiffness or aching regularly affect your **(READ IN RANDOM ORDER)**?

	YES	NO	DK/REF
a. Hands or wrists?	1	2	DK
b. Hips?	1	2	DK
c. Knees?	1	2	DK
d. Back?	1	2	DK
e. Neck?	1	2	DK
f. Ankles or feet?	1	2	DK

(IF YES TO ANY Q13A-F, ASK:)

14. For the pain, swelling or stiffness you just identified, have you ever been given . . . **(READ IN RANDOM ORDER)**?

	YES	NO	DK/REF
a. Prednisone (PRED-nuh-zone) or steroid pills?	1	2	DK
b. Steroid injections into your muscles or joints?	1	2	DK

(IF Q11B =YES) OR (Q11C=YES) OR (Q12A=YES) OR (Q12B=YES) OR (Q11=YES AND Q14A=YES) OR (Q11=YES AND Q14B=YES) ASK:

15. In the past 10 years have you ever been given any of the following medicines . . . **(READ IN RANDOM ORDER)**?

	YES	NO	DK/REF
a. Methotrexate (meth-oh-TREX-ate), Rheumatrex (ROOM-ah-trex), Trexall (TREX-all), Otrexup (oh-TREX-up), or Rasuvo (rah-SOOV-oh)	1	2	DK
b. Sulfasalazine (sulf-ah-SAL-uh-zeen) or Azulfidine (ay-ZUL-fih-deen)	1	2	DK
c. Plaquenil (PLA-kwen-ill) or Hydroxychloroquine (hi-drox-ee-KLOR-oh-kwin)	1	2	DK
d. Azathioprine (AY-zah-THIGH-oh-prin), Imuran (IM-your-an), or Azasan (AY-zah-sahn)	1	2	DK
e. Arava (uh-RAVE-uh) or Leflunomide (leh-FLOON-oh-mide)	1	2	DK
f. Xeljanz (ZEL-janz) or Tofacitinib (TOE-fah-SIT-in-ib)	1	2	DK

16a. (**IF Q14B=YES, ADD:** Other than the steroid injections you mentioned earlier) in the past 10 years have you ever been treated with any injectable medications for arthritis or autoimmune disease? 1 2 DK

(IF Q16a = YES, ASK:)

16b. Has this included . . . **(READ IN ORDER UNTIL FIRST "YES", THEN SKIP TO Q17)**?

	YES	NO	DK/REF
i. Enbrel (EN-brel) or etanercept (ee-TAN-er-cept)	1	2	DK
ii. Humira (hugh-MEER-uh) or adalimumab (ah-duh-LIM-you-mab)	1	2	DK
iii. Remicade (REM-ih-kaide) or Infliximab (in-FLIX-ih-mab)	1	2	DK
iv. Simponi (sim-POHN-ee) or Golimumab (go-LIM-you-mab)	1	2	DK
v. Cimzia (SIM-zee-ah) or Certulizumab (sert-uh-LIZ-oo-mab)	1	2	DK
vi. Actemra (ack-TEM-rah) or Tocilizumab (toe-see-LIZ-oo-mab)	1	2	DK
vii. Orencia (oh-REN-see-yah) or Abatacept (ab-AT-ah-sept)	1	2	DK
viii. Rituxan (rih-TUX-an) or Rituximab (rih-TUX-ih-mab)	1	2	DK

17. Have you smoked at least 100 cigarettes in your entire life?

YES 1
NO 2
NO ANSWER/REFUSED .....DK

IF Q.17 = YES, ASK:

a. About how old were you when you first started smoking cigarettes?

_____ YEARS OLD
NO ANSWER/REFUSED .....DK

b. Do you now smoke cigarettes every day, some days, or not at all?

EVERY DAY 1
SOME DAYS.....2
NOT AT ALL 3
NO ANSWER/REFUSED .....DK

c. On the average, over the years you smoked, about how many cigarettes did you smoke a day?

_____ CIGARETTES
NO ANSWER/REFUSED .....DK

d. Not counting years you may have quit, for how many years altogether (have you smoked) (did you smoke) cigarettes?

_____ YEARS
NO ANSWER/REFUSED .....DK

And finally, some questions about yourself for classification purposes.

18. What is the highest level of school that you have completed or the highest degree that you have received? **(READ LIST ONLY IF NECESSARY)**

4TH GRADE OR LESS 1
5TH-8TH GRADE.....2
9TH-12TH GRADE (NO HIGH SCHOOL DEGREE).....3
HIGH SCHOOL GRADUATE 4
SOME COLLEGE / NO DEGREE 5
ASSOC. DEGREE / TRADE OR VOCATIONAL SCHOOL 6
COLLEGE GRADUATE OR HIGHER.....7
NO ANSWER/REFUSED .....DK

19. Are you married, separated or divorced, widowed, are you a member of an unmarried couple, or have you never been married?

MARRIED.....1
SEPARATED/DIVORCED.....2
WIDOWED 3
UNMARRIED COUPLE.....4
NEVER BEEN MARRIED 5
NO ANSWER/REFUSED .....DK

20. How many people, including yourself, live in your household?

_____
NO ANSWER/REFUSED .....DK

21. For classification purposes, are you Latino or of Hispanic origin or descent?

YES.....1
NO 2
NO ANSWER/REFUSED .....DK

22. What is your racial background? Are you white, black or African-American, Asian or Pacific Islander, or are you a member of another race? **(ANSWER CAN BE A MULTIPLE)**

WHITE/CAUCASIAN 1
BLACK/AFRICAN-AMERICAN 2
ASIAN/PACIFIC ISLANDER.....3
LATINO/HISPANIC (VOLUNTEERED).....4
OTHER (SPECIFY) _____5
NO ANSWER/REFUSED .....DK

23. About how tall are you without shoes?

_____ FEET
_____ INCHES
NO ANSWER/REFUSED .....DK

24. About how much do you weigh without shoes?

_____ LBS.
NO ANSWER/REFUSED .....DK

25. We don't need to know exactly, but just roughly could you tell me if your annual household income from all sources before taxes in 2018 was less than $20,000, $20,000 through $40,000, $40,000 through $60,000, $60,000 through $80,000, $80,000 through $100,000, or $100,000 or more?

LESS THAN $20,000 1
$20,000 – $39,999 2
$40,000 – $59,999 3
$60,000 – $79,999 4
$80,000 -- $99,999 5
$100,000 OR MORE 6
NO ANSWER/REFUSED .....DK

26. Is the telephone that I dialed to reach you a landline phone or a cell phone?

LANDLINE PHONE 1
CELL PHONE.....2
OTHER 3
DON'T KNOW/REFUSED .....DK

IF Q26=LANDLINE, OTHER OR DK, ASK:

26a. Do you make and receive personal calls from a cell phone?

YES.....1
NO 2
DON'T KNOW/REFUSED.....DK

IF Q26=CELL PHONE, ASK:

26b. Is there a telephone inside your home that you use to make and receive personal calls that is not a cell phone?

YES.....1
NO 2
DON'T KNOW/REFUSED.....DK

IF Q26A OR Q26B=YES, ASK:

26c. Of all the personal telephone calls that you receive, do you get most of them on a landline phone or on a cell phone?

MOST ON LANDLINE PHONE..... 1
MOST ON CELL PHONE..... 2
ABOUT EQUAL (VOLUNTEERED)3
DON'T KNOW/REFUSED..... DK

27. These are all the questions I have. To thank you for your participation, we would like to send you a $5 gift card from Amazon or Starbucks. What email address should we send that to?

PROVIDES EMAIL ADDRESS…1 (GO TO Q27A)
NO EMAIL/REFUSES EMAIL….2 (GO TO Q27C)
REFUSES INCENTIVE……REF (GO TO END)

IF Q27=1 (PROVIDES EMAIL), ASK:

27a.	**ENTER EMAIL ADDRESS (READ BACK SLOWLY TO CONFIRM)**	EMAIL:_____
27b.	Which would you prefer, an Amazon or a Starbucks gift card?	AMAZON……..1 (GO TO END) STARBUCKS……2 (GO TO END) REFUSES INCENTIVE……REF (GO TO END)

IF Q27= 2 (DOES NOT PROVIDE EMAIL), ASK:

27c.	Then we can mail you your $5 gift card or a check. Which would you prefer – a $5 Amazon gift card, a $5 Starbucks gift card or a check?	AMAZON GIFT CARD..... 1 STARBUCKS GIFT CARD..... 2 CHECK ..... 3 REFUSES INCENTIVE....REF (GO TO END)

27d. What is your name and mailing address? **(ENTER ADDRESS, READ BACK SLOWLY TO CONFIRM)**

NAME: _____

ADDRESS: _____

CITY: _____ ***(CATI DISPLAYS STATE)***

ZIP CODE: _____

Thank you very much for participating in this important survey.