Evaluating the Relationship of Inhalable Particulate Exposures by Occupational Categories, in Relation to Lung Function, Among Kentucky State Fair Patrons

CAPSTONE PROJECT PAPER

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ABSTRACT

Objective: The purpose of this study was to evaluate the relationship between occupational inhalable exposures and the presence of respiratory impairment, and to identify higher risk probable exposed occupations, compared to low risk unexposed occupations.

Methods: In August 2015, data on 623 Kentucky State Fair patrons were collected via self-reported survey and lung function test using the Vitalograph COPD-6®. Verbal consent was obtained and participants completed questions on demographics, occupational history, personal protective equipment use, and medical and smoking history. Analysis was performed by comparative Chi-Square, linear, and logistic regression. Obstructed impairment was classified by an FEV1/FEV6 <0.70, and restricted impairment was classified by FEV1/FEV6 ≥ 0.70 and FEV1 <0.80. Occupational categories were defined in crude analysis by job tasks, and final models were collapsed into 'Blue Collar' and 'White Collar' jobs. Statistical significance was considered if $p<0.05$.

Results: The participants had a mean age of 51.9 years, 62.7% were female, 60.8% were currently employed, and 40.5% reported being ever-smokers. Of the total sample 5.1% had lung obstruction and 24.9% had restricted lung function. The occupations of Construction, Manufacturing/Production, and Protective Services reached statistical significance with crude logistic regression ($p<0.01$). There was a statistically significant crude odds ratio of those working in a dusty environment for ≥1 year, having 1.65 (95% C.I.=1.15-2.36) times the odds of screening into lung obstruction or restriction, compared to those reporting no occupational exposure. For final logistic regression analysis, there was statistical significance in restrictive lung impairment versus neither condition with those classified as Blue Collar Laborers, age groups 40-59 and ≥ 60 years, and ≥10 total pack years smoked. For obstructive impairment versus neither condition, only a suggestive relationship was found for variable occupational exposure to dusts.

Conclusion: These findings suggest that occupationally-related particulate exposure could be contributing to lower lung function in this sample. Data in this analysis appears

to be more suggestive of the relationships between restrictive lung impairment versus obstructive impairment. This could be a limitation of the sample size and power.

INTRODUCTION

Lung impairment can present as multiple different conditions such as asthma, chronic obstructive pulmonary disease (COPD), including emphysema and chronic bronchitis, and restrictive diseases such as pneumoconiosis. For the purpose of this paper, obstructive lung impairment was the original focus, but both obstructive and restrictive lung impairment were evaluated as outcome measures. According to the Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD), COPD is "a common preventable and treatable disease, characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lungs to noxious particles or gases"[1]. Szczyrek and associates state that airway impairment is related to inflammation mostly in the distal airways leading to obstruction, which can lead to the pathological remodeling of lung tissue[2]. When the lung is exposed to cigarette smoke, dusts, and gases, alterations occur that lead to disease development[3]. COPD is characterized by common and distressing symptoms such as dyspnea on effort, wheeze, cough, and sputum production[4]. COPD can be undetectable by physical examination during the early stages of the disease[2].

Lung impairment is diagnosed most often using a pulmonary lung function test[1]. Obstructive lung function is defined using the COPD GOLD classifications FEV_1/FVC (or FEV_6) <0.70, and FEV_1 % Predicted <0.80, respectively[1]. FEV stands for Forced Expiratory Volume in 1 second, and FVC is Forced Vital Capacity also interchangeable with FEV_6[5]. FEV_1 % predicted measurements compares the subject's lung function test (FEV_1) to persons of the same height, gender, and race with "normal" lung function[5]. Treatment for COPD and obstructive lung impairment care consists of improving patients quality of life and function status, using symptomatic drug therapy, which does not change the disease prognosis or survival in these patients[4]. Therefore, this disease is burdensome and has no known cure. Through this present research, an attempt to look at the burden of stratified lung impairment throughout different occupations, and what relationship those occupations have to particulate exposures have on odds of lung impairment development. This study's main objectives were to determine:

Primary Analysis Objectives:

1. What types of inhalable particulate exposures were related to greater prevalence of respiratory impairment?
2. What occupational categories have the highest prevalence of respiratory disease related to inhalable particulate exposure?
3. What is the relationship between length of time in longest-held occupation, and lung function?

Sub-Analysis:

1. What is the reported exposure experience of participants from agricultural populations?

LITERATURE REVIEW

Epidemiology & Burden:

It is reported that by the year 2020, COPD will be the 3rd leading cause of death globally[2]. As of 2011 in the United States, chronic lower respiratory disease, mostly consisting of COPD, was the 3rd leading cause of death[6]. Based upon national BRFSS (Behavioral Risk Factor Surveillance System) data from 2011, including all 50 states and D.C., Puerto Rico, crude COPD prevalence was 6.3% translating to about 15 million people with the condition[7]. Obstructive respiratory conditions are imposing a great burden on the state of Kentucky, with 9.3% of the adult population in 2011 self-reporting the disease; 71.8% of those surveyed with COPD, reported a decreased daily quality of life[8].

According to the National Institute of Occupational Safety and Health (NIOSH), approximately 15% of all COPD cases are occupationally related[9]. According to the literature, 10 to 20% of COPD cases may be attributed to occupational exposures[10,11]. In 2010, an estimated $36 billion dollars was spent on medical costs for COPD, and including total work absenteeism, this could rise to $49 billion in the U.S. by 2020[12]. Ford and associates reported in 2010 that 16.4 million work days were missed due to COPD related causes[12].

Cigarette smoking has been shown to be the predominant risk factor for COPD, but inhalable particulate and gas exposures are also contributing factors[13]. Commonly studied occupational exposure in relation to COPD are vapors, dusts, gases, and fumes, and vary by occupation and industry[14-17]. COPD due to occupational exposures is generally not observed until after a person's midlife[18].

COPD generates a great financial, physical, and resource burden among patients and families, making it vital to understand the implications beyond disease prevalence. Paulin and associates conducted a study to assess the role of occupational exposures on COPD morbidity. They discovered that subjects with COPD categorized with intermediate/high risk exposure by a job exposure matrix (JEM), that 85% ($P<0.01$) reported 'Health Care Utilization' in the past 12 months for a COPD exacerbation; on average had a FEV_1 % predicted of 59.2% (p-value = 0.08), and lower reports of quality of life according to the St. George's Respiratory Questionnaire at 38.7 ($p<0.0002$)[13]. The higher exposed group was compared to the low JEM exposure group in and were found to have a higher prevalence of COPD, and suffer from increased disease symptomology[13]. Therefore, the authors suggested with greater implied risk of exposure is greater risk of disease.

Lung Impairment by Exposures and Occupations:

Based on the National Health Interview Survey from 2004 to 2011, COPD prevalence among currently employed U.S. adults ages 40-70 was 4.2% (95% CI: 4.0-4.3) within occupations of healthcare support, followed by food preparation and service[19]. The total sample size was 73,799 subjects, and participants were categorized into 23 occupational groups by using the Standard Occupational Classification codes (SOCs)[19]. Results suggested that COPD prevalence was greater in white women who were current smokers[19]. They did not include data on retired persons or those unemployed indicating the underestimation of true COPD prevalence in the population, potentially creating the healthy worker effect. Investigators noted that prevalence of lung diseases were lower than those reported in the BRFSS data[19], which measures the entire general population, including those not working. Limitations of the survey were use of self-report, without biological evaluations to confirm diagnosis, failure to capture number of pack years smoked, and exclusion of subjects with both COPD and asthma in analysis[19]. These limitations could lead to misclassification, recall bias, and an under- or over-estimation of disease prevalence.

In 2009, investigators utilized data from the FLOW study to assess the role of occupational exposures in already diagnosed COPD patients (N=1,202) aged 40-65, who were seeking treatment within the Kaiser Permanente managed care organization (KPMCP)[16]. Exposures were assessed by self-reported exposure to vapors, gases, dusts, and fumes (VGDF) associated with the participant's longest-held job[16]. Job exposure matrices (JEMs) were developed by an expert panel to estimate the probability of exposure to VGDF job type[16]. A total of 1,202 subjects completed both phone interview and in-person clinical evaluation[16]. VGDF exposures were associated with COPD diagnosis with an odds ratio (OR) of 2.11 (95% CI: 1.59-2.82) compared to controls, and a population attributable risk (PAR) of 31% (95% CI: 22-39%)[16]. Researchers noted a strong influence of smoking (current and former) and occupational exposure, where joint exposures were associated with a 14-fold increased risk for COPD, and smoking just a 7-fold increased risk[16]. Even among lifetime never smokers a 2.0 odds (95% CI: 1.28-3.18) of COPD was present[16]. This study exemplifies a strong desgin due to large sample size, use of referent group, controlling for confounding covariates such as smoking in analyses, and ability to confirm COPD diagnosis. Limitations noted by the authors were generalizability to the general population because all subjects had health insurance, and a potential selection bias due to demographic differences in non-participants[16]. Exposure misclassification of VGDF could also have impacted results due to self-report and non-differential random misclassification of JEMs[16].

A cross-sectional study of 338 COPD patients in 9 Spanish hospitals was completed by Rodriguez and colleagues from January 2004 to March 2006[20]. Their objective was to assess lung function by spirometry and bronchodilator testing, paired with a detailed lifetime occupational history interview, to determine associations between occupational exposures and COPD[20]. They focused on exposures to dust, gas/fumes, and inhalable particulates[20]. Researchers used job exposure matrices to classify occupations into categories of ‘none’, ‘low’ or ‘high’ exposure jobs according to cumulative lifetime exposures[20]. Among all participants, 67% had worked in a high-exposure occupation to biological dusts, mineral dust, and/or gases/fumes. Within this high-exposure group, 24% reported a history of high exposure to biological dusts, mainly agricultural workers, freight handlers, carpenters and bakers. And 40% of these highly exposed subjects reported a lifetime occupational history of exposure to mineral dusts, most in agricultural, construction, freight handling and mechanical trades[20]. The 42% who reported a history of high-exposure to fumes and gases were: drivers, mechanics, painters, shoemakers, metal workers, welders and machine operators. In conclusion, the investigators did not find statistical significance for the role of occupational exposures related to the COPD GOLD classification, or changes in FEV_1 and FVC (p=0.921, 0.651,0.336, respectively). Investigators did determine that these occupational exposures were associated with a lower quality of life, increased symptomology, presence of chronic bronchitis, and higher lung diffusion capacity[20]. Weaknesses were a high mean age of the sample (m= 68 years), non-use of a ‘moderate’ exposure category, recall bias, use of hospital based subjects, and non-differential misclassification of exposure in the JEMs. Some strengths of the methods were substantial sample size, an in-person occupational interview, and quality of life assessment.

In a study conducted by Hnizdo et al., investigators analyzed data from the third NHANES survey (1988-1994). They intended to identify the magnitude of effect of occupational exposures in relation COPD prevalence in subjects aged 30 to 75. Of the total 9,823 subjects, 693 or 7.1% had COPD[10]. COPD prevalence was stratified by smoking status, and COPD occurred in 2.5% of never smokers, 7.9% of former smokers, and 12.8% of current smokers[10]. Among never-smokers stratified by occupation, per 100.000 U.S. workers, occupations with prevalence odd ratios above 1.0 (95%

Confidence Intervals), were the following: armed forces with 11.8%, (OR=4.1, CI=0.9-19.4), records processing/distribution clerks with 5.5% (OR=2.9, CI=1.1-7.6), sales: retail/personal services with 3.8% (OR=2.1, CI=0.5-8.6), other machine operators 6.5% (OR=3.8, CI=0.9-16.1), construction trades/laborers with 4.8% (OR=3.4, CI=1.1-10.5), motor vehicle operators with 2.6% (OR=1.8, CI=0.2-14.3), and waitressing 4.8% (OR=2.0, CI=0.3-15.2)[10]. The authors mention there is overlap of multiple industry categories, that collapse into the defined occupational categories they utilized in analysis, which makes it difficult to synthesize, also leading to potential misclassification bias[10]. Further limitations of this design were the use of a cross-sectional approach and inability to identify types of occupational exposures attributable to COPD development. NHANES was not designed to represent the U.S. working population[10]. Though this research was published in 2002, it provides one of the largest resources for identifying COPD prevalence by occupation and actual lung function data. The application of estimates for the current working U.S. population (weights) at the time of the data collection to estimate actual disease prevalence in the general population was also a strong point.

A case-control study was conducted by Blanc and colleagues, which focused on self-reported occupational exposure to VGDFs in relation to self-reported doctor-diagnosed COPD, emphysema, or chronic bronchitis. The sample was stratified for analysis into subjects reporting VGDFs exposure only, Job Exposure Matrix only, and VGDF and JEM combine[21]. For initial analysis of all 233 cases using disease prevalence and VGDF exposure, when including chronic bronchitis, the VGDF only strata was associated with an odds ratio of 2.5 (95% CI=1.9-3.4) for COPD development, which was associated with a 32% population attributable fraction (PAF) for cases, compared to referent[21]. Those classified into a high-exposure JEM, experienced an increased odds of COPD, where OR= 1.8 (95% CI=1.1-3.1), with a 5% PAF for cases compared to reference group[21]. The next analysis consisted of 99 subjects, who completed the home visit and were defined by active chronic bronchitis symptoms (CBS), or abnormal spirometry suggestive of COPD and/or emphysema[21]. In these 99 subjects, VGDF exposure was associated with an OR of 2.1 (95% CI=1.3-3.2) with a PAF or 25% (95% CI= 8-39%)[21]. When excluding CBS, OR = 1.6 (95% CI=0.99-2.6) with a PAF of 17% (95% CI=-3-31%)[21]. These results suggested that occupational VGDF exposure increases the odds of COPD. The influence of CBS in this study could bias associations away from the null, inflating the effect of interest. Other limitations include small sample size, self-report, and a geographical restriction to Northern California residents[21]. Strengths include the use of valid lung function tests as biological makers, and use of three different exposure metric models/strata.

Boggia and associates conducted a longitudinal analysis between 1995 and 2005, gathering occupational and medial history, paired with spirometry tests of 2,019 Italian working men of various occupations[17]. Follow-up occurred at 5 years (2000) and 10 years (2005), and participants were reassessed for lung function, and occupational exposure was estimated by current VGDF exposure information[17]. A unique aspect to this study was use of lawfully granted records from the worker's companies, about the environmental presence and risk to dusts, gases/fumes and vapors for each worker, but this paper does not report specific exposures, nor pair them back to certain occupations[17]. To understand the influence of occupational exposures on COPD, investigators divided the cohort into four groups according exposure and smoking status, and preformed chi-square, and logistic regression analysis. As a cohort, COPD prevalence increased from 9.5% at baseline to 16% at 10 year follow-up, and incidence of COPD increased by 7.3% from baseline to 10 year follow-up[17]. 'Group 4' were both smokers, and occupationally exposed persons, which showed a statistically significant difference in prevalence, and increase of 9.6%, ($P<0.001$), compared to the single exposure groups (smoking exposure only or occupational exposure only)[17]. When comparing occupational exposure group only (group 3) to no the non-exposure group only, at all follow up points this group was statistically different in relation to increased COPD prevalence with p-values of < 0.001, 0.001 and 0.0001, respectively. As a result of logistic regression post 10 year follow-up, a significantly independent role of both cigarette smoking (beta=1.75 $p<0.001$) and occupational exposure (beta=2.62, $p<0.0001$), as well as a statistically significant interaction between smoking and occupational exposure beta was 2.51 ($p<0.0001$)[17]. Therefore, there is a suggested increase of developing COPD in workers that are exposed to occupational hazards like dusts, fumes, and vapors. Workers who are smokers and also experience occupational exposures are considered a high-risk class[17]. This study's strengths were the longitudinal design, large sample size, which allowed for a reliable estimation of occupational exposure on outcome. Although researchers preformed longitudinal analysis, there was no specific analysis identifying a person's longest held job and using that as the time variable. Therefore we do not know if the same job was held by the same subject at every follow-up, which is indicative of potentially over or underinflating the effect.

Role of Length of Time in Longest-held Occupation and Lung Function:

Hzindo and colleges reported in 2002 using NHANES data, the analysis of length of time in longest-held occupation. They estimated an average duration of 15.9 years (SE=0.1) in longest held occupation[10]. Among higher-risk occupations of participants (defined as OR> 1.5) for those with less than 0 years (referent), 1-14 years and greater than or equal to 15 years in occupation, had ORs of 1.0, 1.4 (95% CI= 0.8-2.6) and 1.7 (95% CI= 1.1-2.5), respectively[10]. This indicates that among the defined high-risk occupations, there is a positive dose-response trend, as duration in longest-held occupation increase so do the odds of developing COPD. The most significant trend of the high-risk occupations occurred among the armed forces, with OR's of 1.0, 1.4, and 2.0, respectively for each duration category[10].

Restrictive Lung Impairment Role:

The literature tends to focus on the relationship of lung obstruction and occupational exposures, therefore restrictive impairment should be analyzed as a whole, by occupational exposures. Restrictive diseases are classified by a decreased "Total Lung Capacity", and can consist of intrinsic disease lung scarring, inflammation, or the loss of air space due to debris, and extrinsic conditions that affect the pleura and muscles used in physical ventilation[22]. In recent years research suggested relationships between restrictive lung disease and conditions such as obesity, cardiovascular diseases, diabetes, and natural aging of the lungs[23,24]. Caronia mentions exposures to dusts, metals, organic solvents and employment in agricultural are suggestive of restrictive lung impairment[22]. Restrictive lung diseases consist of pneumoconiosis related to asbestos, silica, and coal, as well as berylliosis, hypersensitivity pneumonitis and organic toxic dust syndrome[25]. Restrictive lung impairment using the GOLD standards for pulmonary function tests of an FEV_1

/$FEV_6 \geq 0.70$ and $FEV_1 < 80\%$ Predicted or FVC <80% Predicted[26]. Reasons for consideration of restrictive lung impairment presence is the potential overlap of test results with obstructive impairment, and in some cases restriction can present as a subtype of COPD, altering associations and interpretations[27].

To understand the burden of restrictive lung conditions prevalence has been examined in multiple studies, pairing spirometry, clinical and survey-type evaluations[26,28,29]. Utilizing the results of the Burden of Lung Disease study (BOLD), 1,382 (14.2%) the subjects were restricted, and 1,890 (19.4%) were obstructed, of 9,762 subjects[28]. Restriction was more common among women (16.4% in women versus 11.7% in men)[28]. These numbers represent participants in Lexington, Kentucky. Using mutually exclusive lung impairment groups in multinomial logistic regression, the Lexington, Kentucky site reported a Risk of Restricted Spirometry as 1.52 (95% C.I. 1.04 to 2.21) which indicted a statistically significant increase in risk of restrictive lung impairment[28].

NHANES data has been useful for understanding prevalence of many diseases and conditions in the United States population. Studies conducted by Ford et al, and Mannino and Diaz-Guzman, both utilize NHANES to evaluate restrictive and obstructive trends, and increased risk of mortality due to restrictive lung impairment present. In the NHANES III (1988-1994) and NHANES data collection from 2007-2010, a reported decrease occurred from 7.6% to 6.5% in the latter of total sample population, restriction prevalence appears to increase with age, increases as educational level decreases, and the most prevalent in minority races[29]. The prevalence estimates by smoking status are intriguing because between the NHANES III and NHANES 2007-2010, current smokers had a prevalence of 8.3% and 7.2%, respectively, and former smokers with prevalence of 6.0% and 6.1%, yet between both survey periods, the prevalence of restriction was 8.2% and 6.5% among never smokers[29]. Misclassification bias could be present, or unaccounted exposures playing a role in the prevalence of restriction in this study population.

Mannino and Diaz-Guzman utilized NHANES III participants and data to estimate Cox Proportional Hazard Ratios after a follow-up time of 18 years with data linkage to vital statistics to understand lung impairments relationship to increased risk of mortality[26]. The hazard ratio (HR) for obstruction was 1.46 with (95% CI=1.21-1.86), and a HR for restriction of 1.94 (95% CI=1.58-2.39) by COPD GOLD standards[26]. Therefore, it appears that subjects with restrictive spirometry, have an increased risk of mortality. Restriction is an important factor to consider in lung impairment studies, but an involvement of occupational and environmental exposure experience should be considered in future publications of similar studies throughout the field.

Role of Exposures on Agricultural Populations:

Agricultural populations in recent decades have gained researcher's attention because of the differential exposures that they experience, in comparison to the general population. Increased risks for respiratory morbidity and mortality are suggested to exist in agricultural populations, despite lower smoking prevalence rates in farmers, compared to the general population[30]. Eduard and colleges determined it was more common for livestock farmers, in comparison to crop-based farmers to have chronic bronchitis and COPD, adjusted odds ratios of 1.9 (95% C.I., 1.4-2.6) $p < 0.05$, and 1.4 (95% C.I. 1.1-1.7), respectivley[31]. COPD prevalence was significantly associated with exposures to organic dusts, endotoxins, mites, ammonia, and hydrogen sulfide[31]. FEV_1 decline was statistically significant in livestock farmers by a -41 mL difference versus referent crop based farmers, which was significantly related to exposures of organic dust, bacteria, endotoxins, glucans, EPS Asp/Pen, ammonia, and hydrogen sulfide[31]. The sample size is considered large (N=4,735) strengthening the reliability and generalizability of the results. Of these 4,735 participants, prevalence of chronic bronchitis (CB) and COPD was lower among plant-based farmers, for CB (4.4%) and COPD (11.9), compared to CB (7.6%) and COPD (14.0%)of those who were animal-based farmers[31]. No statistical significance was found between length of time farming, and prevalence of COPD or Chronic Bronchitis[31]. Crop-based farmers were utilized as the referent group (only 21% of sample size), and there is potential for occupational exposures that could attribute to COPD and chronic bronchitis prevalence, weakening the analysis.

Monso and associates conducted a cross-sectional study to examine if a dose-response relationship between lung function and air contaminants of European never-smoking animal farmers who work in confined buildings existed. In the sample, 45.7% of participants suffered from wheezing and chronic bronchitis, and 17.1% had COPD according to the COPD GOLD standards, at baseline prior to work day[32]. COPD was not statistically significantly related to the characteristics of the building like humidity, temperature, and physical size, but showed a dose-response relationship to the disease to total dust (mg/m^3), and endotoxin ($units/m^3$) exposures[32]. This was only statistically significant for higher levels of dust exposure (OR=6.60, 95% CI=1.10-39.54) after adjustment[32]. Authors note higher concentrations of organic airborne particulate in animal confinement buildings could be related to the development of COPD in never-smoking animal farmers[32]. Some weaknesses were the small sample size of 105 farmers, which created wide confidence intervals. But the statistically significant relationships they discovered could be suggestive of these exposures attributing to COPD and other lung conditions.

Since the burden of lung disease is so prevalent in the state of Kentucky, it is important to consider alternate causes of disease other than smoking. Many researchers have found correlations between occupational exposures and he development or risk of obstructive lung impairment, especially with COPD[9-11]. In the BOLD study Lexington, Kentucky was utilized as the data collection site for the Untied States and the prevalence of obstruction was 19.3% and 14.2% for restriction, giving a potential estimation of the prevalence of lung impairment in Kentucky[28]. Many studies focus on occupational exposures such as vapors, dusts, gases, and fumes, (VGDFs) and vary by occupation and industry[14-17]. There are fewer studies that look into the specific relationship of restrictive lung impairment and occupational exposures, even though there are studies that have looked into specific restrictive diseases like asbestosis and silicosis. This present study hopes to further establish the relationship between obstructive and restrictive lung disease within a population that is at high risk of developing lung impairment.

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METHODS

Data was collected using a cross-sectional, convenience-based sample, study design. The basic methods consisted of pairing a self-reported survey, with a COPD screening test, and using the GOLD diagnosis standards to categorize subjects into normal and abnormal lung function of restricted or obstructed function. The purpose of this study was to identify occupations with abnormal lung function and symptomology. We also evaluated the association with self-reported occupational exposures of the participant's longest-held job.

To conduct the assessment of these research questions, I preformed descriptive, bivariate, and multivariate comparative analyses, consisting of chi-square, linear, and logistic regression in order to determine potential relationships between theses occupational groups, particulate exposure, and outcome of lung impairment characterized by mutually exclusive groups of subjects who had obstructive impairment, restrictive impairment, or neither obstructed or restricted.

Participants, Population, Sample:

Participants were recruited during the 2015 Kentucky State Fair, in Louisville, Kentucky. Our research station was a part of the 'Health Horizons' section, where vendors, focused on health promotion and various health status screenings. It is assumed that Fair attendees were mainly from Kentucky, and the border states of Ohio, Indiana, Tennessee, and Missouri. Participants had to be 18 years or older, and speak English as their primary language. This fair location was used for data collection because of its access to a large amount of people interested in health, specifically in the Health Horizons section. Free baseball caps and beverage insulators were offered as incentives for participation. A convenience-based sample was utilized because it allowed researchers to effectively and quickly obtain a vast amount of participants, without extensive IRB intervention, and approval processes. It gave researchers access to almost 600,000 fair attendees in hopes to have access to a more generalizable study sample.

The University of Kentucky's Institutional Review Board approved of this research to collect data at the Kentucky State Fair (KSF) and we also received approval from the KSF Board.

Survey:

Participants were recruited by verbal consent to preforming a lung function test, and filling out a survey (Appendix A). The survey consisted of a two-page assessment of a participant's basic demographics, occupational history including questions about use of respiratory personal protective equipment (PPE), VGDF exposures, agricultural work, and medical histories. Basic medical history questions focused on respiratory conditions and major health issues such as cardiovascular disease. Lastly, participants answered questions about their smoking habit using the National Health and Nutrition Examination Survey smoking questions in order to best define a dose for smoking.

Occupations were self-reported by the subject, in open text form, where they could write the job title of their primary or 'longest-held' occupation. Occupation was categorized by utilizing the job categories defined by Doney et. al., in their investigation of the prevalence of COPD in the US working population[19]. Occupations were classified again into Blue Collar Servicers, Blue Collar Laborers, White Collar Workers (referent), and non-response. Blue Collar Laborers consisted of those in occupations of Agriculture, Construction, and Manufacturing/Production. Blue Collar Servicers consisted of those in the occupations of Military, Protective Services, and Transportation. The White Collar category consisted of those in customer service jobs, educators, office workers and management. There was also a 'non-response/do not know' category that consisted of those occupations people did not list on the survey or which the raters could not define.

Of the occupational exposure variables, types of exposure reported by participant were coded into a comprehensive and inclusive format. Persons reporting specific types of particulate were coded into the following types of particulate: Organic Particulate, Inorganic Particulate, Gases/Vapors/Fumes, Unknown Exposure. Organic particulates were items such as dust, animal dander, plant matter, etc. Inorganic were particulate like metal particles, and Gases/Vapors/Fumes consisted of exposures like 'car exhaust' or 'welding fumes'. Unknown exposures were coded as such when a participant knew they had an exposure but did not know what the particulate was. The number of participants reporting an occupational exposure in their primary occupation, will not equal the amount of exposures reported, because some participants reported more than one type of exposure.

Lung Function Screening Test-Vitalograph COPD-6:

All participants provided a lung function test using the Vitalograph COPD-6 device. The device measures FEV_1, FEV_6/ FVC, and incorporated variables of age, gender, height, and race/ethnicity. These measurements allow researchers to classify participants into obstructed, restricted or normal lung function categories. The intended use of the Vitalograph COPD-6 is as a COPD screening device to help identify patients with pre-symptomatic COPD, and is used by COPD patients to monitor their daily obstructive index. The Vitalograph COPD-6 screening device has been reported to have a sensitivity of 90% and specificity of 80% in detecting persons with obstruction, but no report is available on detecting restriction[33]. This test was repeated three times, accepting the best test as an indication of pulmonary function.

Analysis:

Statistical Analysis & Tests:

All participant data was entered into the surveying system "RedCAP" and subsequently formatted into an Excel file. All data analysis was conducted in SAS 9.4. Power analysis for the final logistic regression model using "Open Epi".

Bivariate chi-square analysis was used to compare individual sample population characteristics, occupational, and exposure variables by lung impairment type. Both simple and multivariable linear regression was used to evaluate the relationship between the outcomes of FEV_1 % Predicted and FEV_1/FEV_6, by amount of time spent in longest-held occupation, total pack years smoked, and age. It is important to note the Vitalograph COPD-6 device automatically adjusts for race, age, height, and gender in the FEV1 % Predicted measurement, and not for FEV1/FEV6 ratio. Separate models were employed to evaluate the regression of the association between FEV1% Predicted and FEV1/FEV6 by both white collar and blue collar type occupations separately.

Lung impairment was stratified into mutually exclusive groups of restricted, obstructed, or neither obstructed or restricted. Bivariate crude logistic regression was used to determine the relationship between both occupational and self-reported exposure type variables by separate obstructive versus no impairment, and restricted versus no impairment models. Final logistic regression models were developed using backwards elimination of all vital variables in the data set. Variables that were included in the final logistic regression models were type of occupation, age category, primary occupational exposure status, type of particulate reported, and total pack years smoked. Selection variables were based on the literatures indication of confounding variables, as well as the established objectives of this study. White collar worker, those aged 18-39, participants without an occupational exposure reported, no particulate type reported, and those with zero total pack years of cigarettes smoked were utilized as referent groups.

There was only one subject excluded from the data set initially due to lack of information for their lung function test. Other missing data from the survey was dealt with by creating a category for missing values or those considered 'non-respondents' for most variables from the survey. Those who are non-respondents were considered in analysis because it is important to be able to look at the potential differences between those who are responding to all questions, and those participants who are not. Proportions of missing values appeared to be at an appropriate level to conduct analyses at the present study. Where missing values were greatest were in those successive questions about exposures. It is expected that if a participant reports not having an occupational exposure, that they will likely not report a level of exposure severity, therefore a significant amount of missing values from this question.

RESULTS

A total of 623 people participated in the study. The characteristics of participants are listed in table 1. Most participants were ages 50-69 (52.3%) with a mean age for 51.9 years (SD=16.2 years). The participants were also predominantly Non-Hispanic Whites (95.2%), and almost two-thirds were female (62.8%). A majority of the population had some college experience or were graduates (68.1%). A majority of subjects were employed (60.8%) but 37.8% were retired/out of work. Mostly, participants categorized themselves in good health (81.4%). Most of the sample were never-smokers, but 40.45% were ever-smokers. Of the total sample, 32 (5.1%) were obstructed, 155 (24.9%) were restricted, and 436 (69.9%) were neither form of respiratory impairment. Comparisons by chi-square analysis between independent variables, and lung impairment (dependent), covariates of age, educational attainment, current employment status, health characterization, and smoking status had statistically significant differences.

Table 2.1 uses the same analytic methods as table 1 for occupational covariates by lung impairment. A majority of participants were categorized into the ‘other’ occupational category (n=315, 50.56%). Restriction had a greater prevalence compared to obstruction in this sample. The following occupations are of concern in relation to lung impairment : Agriculture 11.8% were obstructed and 35.3% were restricted, Construction 0 obstructed, but 46.7% had restriction, Manufacturing and Production1.9% were obstructed, and 36.5% restricted, Transportation had obstructed 3.5% and 31% restricted, Protective Services 11.8% were obstructed and 41.2% were restricted. The proportion of subjects working for 26 years or more in primary occupation had the greatest proportion of restriction at 30.1%. 31.1% of retired/out-of-work subjects showed restrictive impairment. Subject’s reporting never wearing PPE at work, 34.3% had restrictive impairment. There were statistically significant differences present in variables occupation, employment status, agriculture as a primary income, ever lived on a farm, currently living on a farm, and use of PPE ever at work.

Table 2.2 lists the same variables as table 2.1 using crude logistic regression to measure the relationship of lung impairment. Subjects who were ‘refused/not ascertained/do not know’ as an occupational category had 2.11 (95% CI=1.12-6.90) times the odds of obstruction in comparison to the ‘other’ job category. Similarly to chi-square analysis the following occupations had increased crude odds of restriction: Construction at 3.57 (1.66-7.71), Manufacturing and Production at 2.35 (1.25-4.41), and Protective Services at 2.86 (1.05-7.80). Subjects reporting 26 or more years of employment in their longest-held job had an OR of 1.98 (1.09-3.61) for odds of restriction compared to those with neither condition. Retired or out-of-work subjects, had 1.66 (1.15-2.40) the odds of restrictive impairment. Lastly, subjects reporting ever living on a farm had 1.76 (1.19-2.58) times the odds of restriction then those with neither condition. Those currently living on a farm had 2.16 (1.20-3.87) the odds of restrictive impairment. Any form of PPE use for both restrictive and obstructive impairment were not significant.

Table 3.1 assesses self-reported exposure by lung impairment with chi-square analysis. In the sample, 216 (34.67%) subjects reported an occupational exposure. Of those exposed, 30.1% had restrictive impairment. Organic particulate was reported the most among those exposure at 120 times (19.26%) followed by 78 (12.52%) reports of an unknown exposure. Mild exposure levels were the most common (18.78%) followed by moderate exposure levels (12.84%). Occupational exposure to dusts, and type of particulate had significant differences. Table 3.2 shows the crude logistic regression of the same occupational exposure variables and outcome. Those subjects reporting ‘yes’ to occupational exposure had an OR of 4.58 (1.66-12.65) for obstruction, and those reporting exposure to ‘inorganic particulate’ OR of 4.12 (1.1-15.9) for obstruction compared to no lung impairment. Those subjects who also reported ‘yes’ to occupational exposures, and those who ‘refused/did not know’ about occupational exposure to dusts, had significant odds ratios of 1.63 (1.13-2.41) and 2.06 (1.00-4.24) for restriction, respectively. Reported exposure to chemical gases, vapors, and fumes had a significant OR of 3.00 (1.34-6.74) in restricted impairment versus no impairment. There is a suggestive OR of 1.60 (1.00-2.49) for reporting mild exposure levels for restriction.

In table 3.3 occupations are stratified by self-reported primary occupational exposure. The occupations with significant proportions of subjects self-reporting occupational exposures were: 70.59% of Agriculture, 80.00% of Construction, 73.08% of Manufacturing and Production, 65.52% of Transportation, 50.00% of Military, 70.58% of Protective Services. There was a statistically significant difference between occupations, and occupational self-reported exposure.

Multivariate linear regression results are displayed in table 4. Two separate regression models were ran for blue collar works and white collar workers, for both FEV1 % Prediction and FEV1/FEV6 measures of lung function. Covariates included were, years in longest-held occupation, total pack years smoked, and age. Age was not included in the FEV_1% Predicted model because it is automatically adjusted for age, race, gender, and height by the screening device. FEV_1% Predicted results are as follows: blue collar model, beta coefficients were -0.054 (SE 0.116) for years in primary occupation, and -0.18 (SE 0.067) for total pack years. For white collar workers, the beta coefficients were -0.081 (SE 0.06) for years in primary occupation, and -0.20 (SE 0.06) for total pack years. Only total pack years smoked was significant for of FEV_1% Predicted in both blue and white collar workers. Therefore, for every one unit (or year) increase in total pack years smoked there was a 0.18 average decrease in FEV_1 % predicted for blue collar workers, and a 0.20 average decrease in FEV_1% Predicted for white collar workers. For the models ran with outcome of FEV_1/FEV_6 no covariates for both blue or white collar workers produced significance or suggestive beta coefficients. Figures 1 and 2 display simple linear regression of total pack years smoked by FEV1% Predicted.

Table 5.1 (obstructive) and 5.2 (restrictive) represent the adjusted logistic regression results. Covariates in the final models were type of occupation (blue collar laborer, blue collar servicers, white collar, and non-response), age, occupational exposure, type of particulate, and total pack years. These were analyzed by outcomes of obstructed impairment versus no impairment, and restricted impairment versus no impairment. For obstructive impairment, a majority of the covariates corresponding categories were not significant except those ‘non-respondents’ to occupational exposure at 3.84 (CI=1.28-11.47) the odds of obstruction compared to no impairment. For odds of restriction versus no impairment, the following were significant: blue-collar laborers with 2.23 times the odds (CI=1.28-3.91), age categories of 40-59 years at 1.85 times the odds (CI=1.04-3.28) and 60+ years at 2.28 (CI=1.29-4.03). Lastly, subjects with >=10 pack years smoked, had odds of restriction at 2.48 (CI=1.62 to 3.80) compared to those with no impairment.

The final model was ran with backwards elimination (table 5.3) for obstructed lung impairment versus neither condition. Participants reporting "yes" to having an occupational exposure to dusts of those who are non-respondents at 4.58 odds (CI=1.66-12.65) of obstruction. This was the only significant variable. For restricted versus no impairment, after backwards elimination, significant covariates were type of occupation ($p=0.0009$), age ($p=0.013$), and total pack years smoked ($p<0.0001$).

Table 6.1, 6.2, and 6.3 display results of different self-reported agricultural population's exposure experiences. Utilizing chi-square analysis, there was significance between the variable of agriculture as primary income between those responding 'yes', 'no', or 'non-response', for all three exposure variables with $p<0.001$. Those responding 'yes' to agriculture as their primary income and 'yes' to being occupationally exposed, 55.56% reported occupational exposure to dusts, 80% reported organic particulate exposure, followed by an unknown exposure (20.00%) and 66.67% reported mild exposure severity. Of those ever living on a farm (n=184) there was no significance in relation to any exposure variables, but 37.5% reported primary occupational exposure (suggestive p-value=0.06), 71.01% reported exposure of organic particulate, and 33.33% reported an unknown particulate exposure and exposure severity was most commonly 'mild' at 46.38%. Of those currently living on farms 32.75% reported a primary occupational exposure, of those reporting exposure, organic particulate we reported 16 (84.21%) times, followed by unknown exposure 4 times (21.05%), and a majority of participants reported mild exposure severity (73.68%).

DISCUSSION

Most COPD cases are associated with a history of cigarette smoking but it is estimated 10-20% of all cases are linked to occupational exposures [34,35]. In the present screening study, approximately 5% had obstructive impairment while 25% showed restrictive lung impairment. The study intended to focus on obstructive impairment and disease, but produced a drastically different picture from expectations and patterns in other studies. The restrictive impairment models had more statistically significant outcomes for the exposures of interest, when compared to the obstructive impairment models. The results of this study produced points of speculation as to why certain patterns were identified. These main points were the larger prevalence of restrictive impairment, why labor intensive jobs had a greater exposure prevalence and disease burden, why certain exposures were more common, why length of time in occupation was not significant in lung impairment, and the common exposure patterns throughout agricultural populations. To begin, differences in lung impairment prevalence could be related to the influences of cigarette smoking prevalence and effect, role of unaccounted for variables, and use of overall impairment versus disease diagnosis.

Smoking cigarettes is a known cause for developing COPD, and generates significant damage to the pulmonary system. Our sample had approximately 80 current and 172 former smokers, but a larger proportion of those smokers had restrictive impairment versus obstructive impairment. Some of the reason is that former smokers could be older, and had smoked for a greater amount of time. Our Kentucky based study population had 12.8% current smokers, but according to 2014 BRFSS data, approximately 26.2% of adult Kentuckians are current smokers[36]. This could be a reason why our proportion of those with obstruction is lower compared to current available literature. If less people in the study population were smokers, by proxy, less people would have obstruction. Many people may have restricted lung impairment, but not have a disease like silicosis, that directly causes the restrictive impairment. Impairment is not an exact disease diagnosis, it is simply an indication of current lung function. Weight of subject was not accounted for in this sample, therefore overweight or obese subjects could have restrictive lung impairment because the weight on the chest cavity does not allow for the lungs to fully expand. We could not account for restrictive impairment like we could for obstructive impairment on the survey because we did not include restrictive medical diagnoses such as asbestosis. Therefore, restrictive impairment does not mean restrictive lung disease and certainly does not confirm temporality to occupation.

Other than differences in prevalence proportions of impairment and smoking, there were differences in effect measurement between restricted and obstructed lung impairment. There were more significant variables related restrictive impairment over obstructed. Our study compared to similar research studies is fairly small, and an even smaller proportion (n=32) had obstruction, leading to low cell counts for analyses. We could have been drawing a healthier population to our booth, therefore less persons with obstructive impairment. To best avoid a possibility of clinical overlap, mutually exclusive groups were used, in hopes to bar further effect measurement issues.

Occupations of Construction, Manufacturing and Production, Protective Services, and Agriculture not only had the greatest proportion of subjects with restrictive impairment, but also the greatest odds of restrictive impairment compared to the referent group. Agriculture was only slightly suggestive of odds of restriction. Obstruction was not significant in the same occupations potentially due to the small sub-population size of obstructed. If we were to have more participants, then frequencies would have been more reliable to determine the role of occupation on obstructive impairment. In the final logistic regression models, restrictive impairment in blue collar laborers were the only significant category, where this group had 2.23 times the odds of lung restriction versus no lung impairment. This group consisted of occupations of Agriculture, Construction, Manufacturing and Production, and the occupations considered 'blue collar servicers' were Military, Protective Services, and Transportation. Obstruction was not significant in any of the occupation types in the final model.

The occupations with the greatest prevalence of impairment and greatest odds of outcome, all are labor-intensive jobs. People in these fields are generally around airborne particulate matter due to job tasks. Some common tasks that could expose these populations are building demolition, road construction, harvesting crops, cutting or drilling cement, and metalworking. Not only are people in these occupations being exposed, they are potentially breathing in more frequently, thus increasing dose of exposure. Those occupations need to be assessed in the future because of their higher levels of exposures compared to other occupations in order to decrease their risk of lung impairment.

Much of the literature does not focus on individual types of particulate exposure, but utilizes a Job Exposure Matrix (JEM) to combine all exposure variables, to create an algorithm to determine a comprehensive exposure experience. In the sample, 216 (34.67%) subjects, reported occupational exposures to dusts, in longest-held occupation compared to study of COPD patients 123 subjects or 53% reported occupational exposures to vapors, gases, dusts, and fumes[21]. The proportions of exposure reported in the Blanc et. al, study are higher than reported frequencies in the present study, but our counts of exposed participants is higher, potentially due to the larger sample size. The subjects in the Blanc study were diagnosed COPD patients, thus increasing the proportion of recalled occupational exposure. Common exposure trends were organic particulate most frequently reported, followed by unknown particulate exposure, and exposure levels were mainly mild. This would make sense because a majority of persons in higher-risk occupations involves working with materials occurring in the earth that are majority made of carbon. Subjects exposed to inorganic particulate would be working with grinding metal processes, which is a less common job task versus working with concrete. Some participants may not understand to the extent at which they are exposed, and may not consider the exposure 'a big deal'. Therefore, a subject may truly be experiencing a moderate to heavy particulate exposure, but do not see it as a threat and report a mild exposure. It is also hard to quantify a visual exposure, and a majority of subjects were using rough estimates based on what they saw.

It was very interesting the second largest reported type of particulate was 'unknown'. This could be due to inability to recall, or not be informed by employers what materials they are working with and the corresponding health risks. It is important to note when visualizing this data that one participant could report more than one type of exposure, therefore among type of particulates reported, percentages will not equal 100%. Participants appear to answer the occupational exposure question in reference to any particulate exposure they may have experienced. Lastly, another outstanding result was the only significant OR for restriction was that of chemical gases/vapors/ and fumes (GVFs), and for obstruction, inorganic particulate. Though these are smaller groups of subjects, these could be vital results in understanding what types of particulate exposures generate the greatest risk of outcome. Potentially, inorganic particulate could be associated with increasing the odds for developing obstructive diseases, and the GVFs could be related to greater odds of developing restrictive disease. There is the potential for participants to report non-occupationally related exposures. This could have be due to a misunderstanding of the survey questions, or subjects noting a common exposure like ‘house dust’ because it is prevalent in their daily activities. Therefore, a potential exists for reported exposures to be inflating effect of reported exposures on the outcomes of lung impairment.

The structure and content of the questions on the survey could have influenced how participants responded. Subjects could have misinterpreted, did not respond, or record an inaccurate answer. This was important in the exposure experience questions. After collection and analysis it was clear that these questions could have been better designed to elicit the most accurate answers. The first way to execute this would have been to decrease the physical amount of words in the question, and space the questions out on the paper. Numbering the questions would have also lead to participants consistently answering all of the exposure questions, giving participants a logic to follow. It would have been helpful to provide general example answers, so participants knew what acceptable answers were. Lastly, if the survey questions were given in electronic form, such as using RedCAP or Survey Monkey on tablets, it would have allowed us to properly capture the exposure experience of the participants. For example, if a reported job was Administrative Assistant, and the participant reported ‘No’ or occupational exposure, then they would be prompted to the next question not involving occupational exposure descriptions. The current design allowed for subjects to freely fill out individual questions, therefore the same participant in the given example, could have reported no occupational exposure, but when asked about the types of dust reported, they may have reported “house dust”, adding to the amount of ‘occupationally reported” exposures. This can all lead to misclassification, and inflation of the effect of reported exposures on the outcome, and may not be related to occupation.

Retired and out-of-work subjects had a 66% increased odds of restriction, versus those who were currently employed. This is suggestive of retired and out-of-work subjects are more susceptible to develop restrictive impairment. Subjects with obstruction had 6.08 (p=0.031) times the odds for obstruction among non-respondents to current employment status, but this had a very wide 95% confidence interval, ranging from 1.17 to 31.52, indicating a potential product of small cell counts. Retired and out-of-work persons have the potential to be older, and have been in the job field for longer periods of time compared to their counterparts. These results could be indicative of greater levels of exposure and being exposed to particulate for longer durations of time, therefore the increased risk.

For adjusted multivariate linear regression model for length of time in longest-held occupation, there was no significance for either blue-collar (beta=-0.05) or white-collar (beta=-0.08) workers. There was even a smaller average decrease in FEV_1% Predicted when comparing blue-collar workers to the white-collar workers. This could be a product of the smaller sub-population size that the blue-collar workers consisted, versus the majority of white-collar workers. For these outcome variables, one would expect to see more of a decrease, especially in the blue collar workers due to their higher risk for exposure to inhalable particulate they are more likely to experience due to the nature of their job environments. Total pack years smoked appeared to have a stronger relationship for were white-collar workers, and potentially related to sample size and power. The FEV_1/FEV_6 ratio is utilized by healthcare professionals to diagnose COPD by spirometry. For this measurement, there was no statistical significance for any of the variables in the models, even when including covariate of total pack years smoked. These results are interesting because some influence of obstructed lung function was expected from the model. This could potentially be due the small amount of obstructed participants in our sample, and larger proportion of restricted participants.

This study used self-reported data from participants to gain an understanding of participants, their exposure experiences, and medical conditions. This data collection method is common, but introduces multiple forms of bias. As mentioned self-reported data can cause misclassification bias, can be a result of recall bias, and introduces the potential for interviewer bias. Misclassification bias can occur because participants may feel the need to answer questions a certain way, aligning with what they think we want to hear. For example, persons may report they only smoked one pack of cigarettes daily when in reality smoked two packs daily. This causes the participant to potentially be misclassified into the lower dose of cigarettes smoking category. This could happen with any of the questions in the survey, and can cause the data to show researcher an under or over estimation of effect measures.

Recall bias is another glaring issue that could have a negative influence the results. Participants may not remember what type of particulate they had been exposed to in primary occupation for many reasons such as being out of the work force for many years, or not knowing levels of exposures. There are times where participants may not want to report where or for what company they worked, in fear of the results getting back to their employer. Even though there are strict ethical rules in place, and we utilized de-identified data, this is still a realistic fear in the general population. Lastly, with self-report, there is the chance for interviewer bias. Many people would need clarification to understand what a survey question may have been asking. When this occurred the question would be repeated, and occasionally participants would ask for examples. When participants read "Does/did this job require you to work for a year more in a dusty environment?", the question may not have been made clear enough for them to understand, and a research assistant may have said "in you primary job were you around a lot of dust?". This could have potentially lead to and overestimated amount of those reporting exposures in primary occupation, though this was only intended as a point of clarification.

Agricultural jobs have a suggestive relationship for developing lung impairment, by exposure experiences[22]. Table 6.1, 6.2, and 6.3 were completed to describe the exposure experience of agricultural populations. The use of variables like 'ever or currently living on a farm', arose from the nature of farming tasks, and that family members are enlisted to do chores on the farm. For example, children helping during the summers for 10 years, could contribute to exposure experiences similar to those whose primary income method is agriculture. An interesting pattern occurred between all three farming populations. Whether agricultural was a primary income, ever lived on a farm, or currently lived on farm, for all three, the most common type of particulate reported was organic, followed by unknown exposures. A majority of the exposure severity was mild for all three as well. Though these groups are not mutually exclusive, and primary occupational exposure was used to indicate general particulate exposure, results could be skewed. Persons involved with farming tasks or environments at some point in their lives have the potential to have higher exposures to particulate compared to the general population, potentially leading to decreased lung function. It is important to observe the impact the family lifestyle of farming on a persons health, because with family ties being strong in farming communities, persons who have helped their families for years, but do not consider it an occupation, could be at potential increased risk for lung disease, therefore it is important to assess their exposures. Some inconsistency occurred between number of subjects reporting agriculture was their longest held occupation, and the question of "Is agriculture your primary income?". Because of this the results not exactly represent the exposure experiences of occupational agricultural populations, but was the best variable to estimate exposure experience among all participants.

Power Analysis of Final Logistic Regression:

To further understand these relationships, a power analysis was conducted. For those exposure of interest categories within covariates with a suggestive relationship or no significance, power was calculated between the exposure of interest and those who were non-exposed (referent category) by obstructive impairment versus no impairment. Obstructive lung impairment appears to have less influence and reliability in relation to exposures of interest and restrictive model power analysis is not presented. When analyzing subjects by type of occupation, the corrected normal approximation of power was 3.6% for Blue Collar Laborers, meaning the ability that these categories had to predict the relationship at hand was extremely weak, and would benefit with a greater sample size. There was an extremely weak power estimate for those reporting 'yes' to occupational exposures to dusts (4.60%), inorganic type particulate exposure (4.44%), and greater than 10 years of pack years smoked (3.01%) for obstructive lung impairment. For restrictive lung impairment, although there were more significant covariates and categories, those who were non-respondents to type of occupation (42.94%), inorganic particulate exposure (4.40%), unknown exposure type (6.88%) and those with a total pack years smoked >10 (2.33%) had weak power estimates. The results of the power analysis could be a contributing factor to the lack of significance witnessed by researchers in present analysis, especially in the obstructed impairment model. The variability within the sample was large, even though the researchers attempted to combat this with the data collection site chosen for data analysis in attempt to capture a vast general population.

STRENGTHS

This research had many strong points for a pilot study. To begin, there was a moderately-sized sample for collecting data only at event, over five days. The sample gave researchers access to a better representation of the general population, therefore providing a variety of participants to analyze. Having a survey paired with a fairly reliable lung function test allowed researchers to best assess lung function, and confirm cases of certain lung conditions, helping support the self-reported data collected. Due to the cross-sectional design, researchers could estimate a current distribution of exposures, occupations, and current lung impairment. The data collected consisted of a fairly-sized proportion of retired/out-of-work participants, allowing for analysis of those who have been in the work force longer, and access to persons who have had time to develop chronic lung diseases. This is a benefit because many occupational studies tend to focus on current employees, partially because this population is easier to access. There is a potential for the healthy worker effect to be not as influential in this sample by the larger proportion of those who are retired and out-of-work, compared to studies who focus just on those currently employed. Lastly, another beneficial function of the design was the low cost and time effectiveness. Compared to studies of similar nature, it was not expensive, and did not take massive amounts of time to conduct the study. It gave us the ability to quickly gather information from participants without consuming much of participant's time, and researcher resources.

LIMITATIONS

This pilot study was in general a success, but there were many limitations. To begin with study design, some of the weaknesses were the cross-sectional nature, therefore researchers to only had data from a specific time, and place, without ability to follow-up with participants. Selection bias was also present. The population was assumed to be majority of Kentucky residents, but unable to confirm. This is an issue because research was conducted with the hopes of understanding Kentucky's occupational risks, when in fact there is no way of knowing if some of the sample was from Ohio or Indiana due to fair location. Using a convenience-based sample, with no formal recruiting process, or randomization adds to influence of selection bias. Participants were potentially drawn to the table because it appeared that we had better free items, compared to other booths.

By our site being in the "Health Horizons' section of the fair, we potentially sampled a different population, compared to the general population of Kentucky. Some of the possibilities of people we could have drawn to the study are 'the worried well', and the other people could be concerned about their health because of a known exposure or heavy smoking history. These limitations could create a potential decreased external validity to the Kentucky population and U.S. population, by misrepresenting the actual general populations exposure or disease burden and relationships. To reduce selection bias, these issues would have been best addressed in the study design phase, as opposed to accounting for them in data analysis. As researchers, we could have included "What state are you a resident of?" or "What was your reason for taking a lung function test today?". This would have diminished some of the selection, and misclassification biases.

Aside from the potential misclassification and selection bias issues, there were minor problems with the screening test administration, and survey dealing with formatting, language, and a typing error. As previously mentioned, there was no question asking a participant to define if they were a Kentucky resident or not, leading to an inability to fully characterize the sample. Another issue was a typing error, where the questions about PPE were included in the agriculture portion of the survey, and was supposed to be in reference to person's longest-held occupation. Therefore, some participants may have skipped the question, especially if they were never in agriculture. Other limitations included the test conduction. The format of the survey was a two-page survey, in attempt to condense many questions one piece of paper, to keep it simple. This created a problem for ensuring participants answers all questions, and with accuracy, because the flow of the survey was not user-friendly. Finally, even after many examples of the proper testing technique, or multiple different explanations to take the test, a proportion of participants could not produce an accurate test. This could potentially be affecting our frequencies of impairment and the corresponding relationships. Some subjects who fell into the restrictive or obstructed lung impairment category may not have produced a valid test. This questions the reliability of the results and further analysis needs to be considered.

Lastly, misclassification bias could be present in both the exposure status and type of particulate exposure, and for lung impairment. Participants could have not accurately report answers to questions on purpose, or on accident. This could shunt them into false categories, potentially skewing relationships. For example, a participant may have written they never smoked cigarettes because they think researchers would judge them, or we want to hear they never smoked. Therefore, we cannot fully account for the influence of smoking history in this case. The study may not have captured persons who have more severe lung impairment due to occupational exposures. Naturally, persons who have severe lung disease would not want to participate in a study of lung impairment, because it could put them at risk of an exacerbation or they already know their disease status. Recall bias is also potentially present. As an example, participants may not know when they started smoking, or duration of time spent in longest-held job, making it difficult to fully rely on the data collected. Researchers simply cannot back up every question a subject answers with solid evidence like a blood test measuring cotinine levels, to determine a subject's current smoking status. Many studies rely on self-reported information, but it comes with a price. In research designs like this one, it is very important to have a large sample size to help minimize the influences we cannot necessarily control, or have the resources to measure all needed variables.

FUTURE DIRECTIONS AND CONCLUSION

As our country's elder population increases, there is a potential for an increase in chronic respiratory diseases, especially as a huge proportion of the U.S. population begins to retire the next 5 to 10 years. Because of this, it is vital to evaluate at-risk occupations for lung impairment because of the burden chronic lung conditions can have on individual's health, and both economic and healthcare system. If these higher at-risk groups can be identified early, then accurate and wide spread preventative interventions can occur to stop future cases of lung impairment, including early detection methods.

To best serve at-risk populations and prevent chronic lung disease in relation to occupational exposures, the field of occupational health must conduct similar studies at a larger scale, and collect and report information of both obstructive and restrictive impairment. They must work on relationship with big industry and collaborate to best understand the disease causation and etiology to foster a healthier national population. For the consideration of time and resources, cross-sectional studies should be conducted, though a longitudinal study would be quite effective in looking into the exposure-outcome temporality, it could potentially not be efficient in regards to resources. Conducting the NHANES study at a greater level, as well as including the involvement of a permanent section on BRFSS data surveys would benefit the detection of this proposed relationship. For future analysis of this dataset, multinomial logistic regression for the outcome variables will be conducted with the outcome of, obstructed versus restricted versus neither condition. A job exposure matrix will be created in order to best classify exposure experiences reported in this sample.

In conclusion, we found that occupations could produce a suggestive relationship in developing respiratory impairment, especially in relation to restrictive impairment. The lack of significant or suggestive results for obstructive lung impairment is most likely a function of sample size, and decreased power, therefore the in the future a larger sample size should be collected. We discovered that participants reporting an occupational exposure, had increased crude odds of developing obstructed and restrictive lung impairment, indicating further exploration is needed. Labor-intensive type jobs such as Construction, Manufacturing and Processing, Agriculture, and Transportation appear to be at a higher risk of exposure and higher odds of developing a form of lung impairment. A positive occupational exposure status and exposure to mild levels of particulate have also been suggested by the results to lead to lung impairment. Overall, the present study was a success, but continued analytic tests in the dataset, and redesign of the study methods, and tools would benefit the outcome measures.

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TABLES

Table 1: Characteristics of Study Participants by Lung Impairment Categories

Type of Lung Impairment					
	Total N (%)	**N (%) Obstructed**	**N (%) Restricted**	**N (%) Neither**	**P-value**
Total Sample	**623 (100)**	**32 (5.1)**	**155 (24.9)**	**436 (69.9)**	-
Age					
18-29	80 (12.8)	3 (3.8)	10 (12.5)	67 (83.7)	
30-39	64 (10.3)	5 (7.8)	10 (15.6)	49 (76.6)	
40-49	80 (12.8)	8 (10)	21 (26.3)	51 (63.8)	
50-59	172 (27.6)	5 (2.9)	44 (25.6)	123 (71.5)	
60-69	154 (24.7)	5 (3.3)	40 (25.9)	109 (70.8)	
>=70	73 (11.7)	6 (8.2)	30 (41.1)	37 (50.7)	p =0.0002
Race					
Non-Hispanic Whites	593 (95.2)	28 (4.7)	147 (24.8)	418 (70.5)	
Hispanic/Black (Minority)	30 (4.8)	4 (13.3)	8 (26.7)	18 (60)	P=0.099
Gender					
Male	232 (37.2)	14 (6)	65 (28)	153 (65.9)	
Female	391 (62.8)	18 (4.6)	90 (23)	283 (72.4)	p=0.234
Education					
No High School	5 (0.8)	2 (40)	1 (20)	2 (40)	
Some High School	23 (3.7)	1 (4.4)	8 (34.8)	14 (60.9)	
High School Graduate or GED	167 (26.8)	13 (7.8)	58 (34.7)	96 (57.5)	
Some College	186 (29.9)	11 (5.9)	50 (26.9)	125 (67.2)	
College Graduate	238 (38.2)	5 (2.1)	37 (15.6)	196 (82.4)	
Non-response	4 (0.6)	0 (0)	1 (25)	3 (75)	p<0.0001
Employment Status					
Employed	379 (60.8)	17 (4.5)	81 (21.4)	281 (74.1)	
Retired/Out-of-Work	235 (37.7)	13 (5.5)	73 (31.1)	149 (64.4)	
Non-Response	9 (1.4)	2 (22.2)	1 (11.1)	6 (66.7)	P=0.007
Characterize Self in good Health?					

Yes	507 (81.4)	24 (4.7)	112 (22.1)	371 (73.2)	
No	76 (12.2)	5 (6.6)	28 (36.8)	43 (56.6)	
I don’t know/Prefer not to answer	28 (4.5)	3 (10.7)	10 (35.7)	15(53.6)	
Non-response	12 (1.9)	0 (0)	5 (41.7)	7 (58.3)	p=0.017
Smoking Status					
Never	352 (56.5)	16 (4.6)	67 (19)	269 (76.4)	
Former	172 (27.6)	8 (4.7)	56 (32.6)	108 (62.8)	
Current	80 (12.8)	4 (5)	27 (33.8)	49 (61.3)	
Refused	14 (2.3)	3 (21.4)	4 (28.6)	7 (50)	
Non-response	5 (0.8)	1 (20)	1 (20)	3 (60)	P=0.001

Table 2.1: Occupational Categories by Lung Impairment

Occupational Category		Chi square Analysis			
	N (%) Sample	N (%) Obstructed	N (%) Restricted	N (%) Neither	P value
Total Sample	**623 (100)**	**32 (5.1)**	**155 (24.9)**	**436 (69.9)**	-
Agriculture	17 (2.7)	2 (11.8)	6 (35.3)	9 (52.9)	
Construction	30 (4.8)	0 (0)	14 (46.7)	16 (53.3)	
Manufacturing and Production	52 (8.4)	1 (1.9)	19 (36.5)	32 (61.5)	
Transportation	29 (4.7)	1 (3.5)	9 (31)	19 (65.5)	
Military	6 (0.96)	0 (0)	1 (16.7)	5 (83.3)	
Healthcare	87 (13.9)	4 (4.6)	19 (21.8)	64 (73.6)	
Protective Services	17 (2.7)	2 (11.8)	7 (41.2)	8 (47.1)	
Other ^	315 (50.6)	14 (4.4)	62 (19.7)	239 (75.9)	
Refused, Not Ascertained, Do Not Know	70 (11.2)	8 (11.4)	18 (25.7)	44 (62.9)	P=0.007
Length of Employment in Longest-held Occupation					
0-4 years	101 (16.2)	2 (1.9)	18 (17.8)	81 (80.2)	
5-15 years	156 (25)	9 (5.8)	39 (25)	108 (69.2)	
16-25 years	114 (18.3)	8 (7)	27 (23.7)	79 (69.3)	
26+ years	183 (29.4)	6 (3.3)	55 (30.1)	122 (66.7)	
Non-response	69 (11.1)	7 (10.1)	16 (23.2)	46 (66.7)	p=0.095
Employment Status					
Employed	379 (60.8)	17 (4.5)	81 (21.4)	281 (74.1)	
Retired/Out of Work	235 (37.7)	13 (5.5)	73 (31.1)	149 (64.4)	
Non-Response	9 (1.4)	2 (22.2)	1 (11.1)	6 (66.7)	P=0.007
Agriculturally Related Questions					
Is Agriculture Your Primary mode of Income?					
Yes	27 (4.3)	3 (11.1)	10 (37)	14 (51.9)	
No	592 (95)	29 (4.9)	142 (24)	421 (71.1)	
Non-response	4 (0.6)	0 (0)	3 (75)	1 (25)	p=0.033
Have You Ever Lived on a Farm?					
Yes	184 (29.5)	10 (5.4)	59 (32.1)	115 (62.5)	
No	434 (69.7)	22 (5.1)	92 (21.2)	320 (73.7)	
Non-response	5 (0.8)	0 (0)	4 (80)	1 (20)	p=0.002
Do You Currently Live on a farm?					
Yes	53 (8.5)	4 (7.6)	21 (39.6)	28 (52.8)	
No	566 (90.9)	27 (4.8)	132 (23.3)	407 (71.9)	
Non-response	4 (0.6)	1 (25)	2 (50)	1 (25)	p=0.008
PPE Use In Occupation					
Ever wear PPE?					
Yes	86 (13.8)	5 (5.8)	26 (30.2)	55 (64)	
No	382 (61.3)	12 (3.1)	92 (24.1)	278 (72.8)	
I don't know/Prefer not to answer	9 (1.4)	1 (11.1)	1 (11.1)	7 (77.8)	
Non-response	146 (23.4)	14 (9.6)	36 (24.7)	96 (65.8)	p=0.054
How Often PPE?					
Never	67 (10.8)	4 (5.9)	23 (34.3)	40 (59.7)	
Sometimes	68 (10.9)	4 (5.9)	18 (26.5)	46 (67.7)	
Often	14 (2.3)	1 (7.1)	3 (21.4)	10 (71.4)	
Always	13 (2.1)	0 (0)	6 (46.2)	7 (53.9)	
Non-response	461 (74)	23 (4.9)	105 (22.8)	333 (72.2)	p=0.380
^= Management, Customer Services, Community Sevicers, Office, Education, etc…					

Table 2.2: Occupational Categories by Lung Impairment

Occupational Category		Crude Logistic Regression			
		Obstructed	P Value	Restricted	P Value
	N (%) Sample	OR (95% C.I.)		OR (95% C.I.)	
Total Sample	**623 (100)**				
Agriculture	17 (2.7)	2.87 (0.60-13.78)	0.189	2.23 (0.79-6.25)	0.129
Construction	30 (4.8)	NA	0.971	3.57 (1.66-7.71)	0.001
Manufacturing and Production	52 (8.4)	0.42 (0.05-3.28)	0.41	2.35 (1.25-4.41)	0.008
Transportation	29 (4.7)	0.77 (0.10-6.06)	0.802	1.84 (0.80-4.23)	0.153
Military	6 (0.96)	NA	0.987	0.82 (0.10-7.11)	0.854
Healthcare	87 (13.9)	1.04 (0.33-3.23)	0.951	1.14 (0.64 2.04)	0.657
Protective Services	17 (2.7)	2.87 (0.60-13.78)	0.189	2.86 (1.05-7.80)	0.041
Other ^	315 (50.6)	**ref**	-	**ref**	-
Refused, Not Ascertained, Do Not Know	70 (11.2)	2.77 (1.12-6.90)	0.028	1.41 (0.77-2.58)	0.262
Length of Employment in Longest-held Occupation					
0-4 years	101 (16.2)	**ref**	-	**ref**	-
5-15 years	156 (25)	3.03 (0.64-14.33)	0.162	1.54 (0.82-2.87)	0.178
16-25 years	114 (18.3)	3.74 (0.77-18.02)	0.101	1.43 (0.73-2.79)	0.3
26+ years	183 (29.4)	1.68 (0.33-8.47)	0.531	1.98 (1.09- 3.61)	0.025
Non-response	69 (11.1)	5.59 (1.13-27.77)	0.035	1.39 (0.65-2.97)	0.392
Employment Status					
Employed	379 (60.8)	**ref**	-	**ref**	-
Retired/Out of Work	235 (37.7)	1.25 (0.59-2.62)	0.56	1.66 (1.15-2.40)	0.007
Non-Response	9 (1.4)	6.08 (1.17-31.52)	0.031	0.46 (0.06-3.73)	0.467
Agriculturally Related Questions					
Is Agriculture Your Primary mode of Income?					
Yes	27 (4.3)	2.43 (0.69-8.53)	0.167	1.86 (0.84-4.16)	0.129
No	592 (95)	**ref**	-	**ref**	-
Non-response	4 (0.6)	NA	0.99	9.49 (0.98-91.92)	0.052
Have You Ever Lived on a Farm?					
Yes	184 (29.5)	1.08 (0.50-2.32)	0.851	1.76 (1.19-2.58)	0.004
No	434 (69.7)	**ref**	-	**ref**	-
Non-response	5 (0.8)	NA	0.99	14.84 (1.64-134.24)	0.016
Do You Currently Live on a farm?					
Yes	53 (8.5)	1.63 (0.55-4.85)		2.16 (1.20-3.87)	0.01
No	566 (90.9)	**ref**	-	**ref**	-
Non-response	4 (0.6)	6.65 (0.67-66.10)		3.30 (0.46-23.57)	0.236
PPE Use In Occupation					
Ever wear PPE?					
Yes	86 (13.8)	**ref**	-	**ref**	-
No	382 (61.3)	0.53 (0.18-1.53)	0.239	0.73 (0.44-1.23)	0.237
I don't know/Prefer not to answer	9 (1.4)	2.03 (0.21-19.54)	0.541	0.29 (0.03-2.43)	0.253
Non-response	146 (23.4)	1.72 (0.60-4.95)	0.316	0.76 (0.42-1.37)	0.355
How Often PPE?					
Never	67 (10.8)	NA	0.956	0.61 (0.18-2.03)	0.42
Sometimes	68 (10.9)	NA	0.956	0.42 (0.12-1.42)	0.162
Often	14 (2.3)	NA	0.955	0.32 (0.06-1.71)	0.181
Always	13 (2.1)	**ref**	-	**ref**	-
Non-response	461 (74)	NA	0.957	0.34 (0.11-1.05)	0.06

^= Occ Group Consisted of Mangement, Customer Services, Community Sevicers, Office, Education, etc...

NA= <0.001 (<0.001->999.9)

Table 3.1: Chi-square Analysis for Occupational Exposures by Lung Impairment

		Chi Square Analysis		
	N (%) Sample	N (%) Obstructed	N (%) Restricted	P value
Total Sample	**623 (100)**	**32 (5.1)**	**155 (24.9)**	
Primary Occupational Dust Exposure				
Yes	216 (34.7)	11 (5.1)	65 (30.1)	
No	370 (59.4)	15 (4.1)	77 (20.8)	
Refused/Non-Response	37 (5.9)	6 (16.2)	13 (35.1)	p=0.004
Type of Particulate Reported				
No Exposure Reported	383 (61.5)	20 (5.2)	85 (22.2)	
Organic	120 (19.26)	5 (4.2)	34 (28.3)	
Inorganic	16 (2.6)	3 (18.8)	4 (25)	
Chemical gases/fumes/vapors	26 (4.2)	0 (0)	12 (46.2)	
Exposure Reported but Unknown Type	78 (12.5)	4 (5.1)	20 (25.62)	p=0.048
Severity of Exposure				
Mild	117 (18.8)	6 (5.1)	36 (30.8)	
Moderate	80 (12.8)	5 (6.3)	22 (27.5)	
Severe/Heavy	41 (6.6)	2 (4.9)	12 (29.3)	
Refused/Non-Response	385 (61.8)	19 (4.9)	85 (22.1)	p=0.551

Note: Number of Types of exposures reported will be greater than actual number of exposures. More than one type of particulate could be reported by the same participant.

Table 3.2: Logistic Regression for Occupational Exposures by Lung Impairment

	N (%) Sample	Obstructed OR (95% C.I.)	Obstructed P Value	Restricted OR (95% C.I.)	Restricted P Value
Total Sample	**623 (100)**	**32 (5.1)**		**155 (24.9)**	
Primary Occupational Dust Exposure					
Yes	216 (34.7)	4.58 (1.66-12.65)	0.003	1.63 (1.13-2.41)	0.012
No	370 (59.4)	**ref**	-	**ref**	-
Refused/Non-Response	37 (5.9)	1.27 (0.57-2.82)	0.557	2.06 (1.00-4.24)	0.049
Type of Particulate Reported					
No Exposure Reported	383 (61.5)	**ref**	-	**ref**	-
Organic	120 (19.26)	0.79 (0.30-2.15)	0.643	1.39 (0.87-2.21)	0.168
Inorganic	16 (2.6)	4.12 (1.10-15.90)	0.035	1.17 (0.37-3.72)	0.792
Chemical gases/fumes/vapors	26 (4.2)	**NA**	**NA**	3.00 (1.34-6.74)	0.008
Exposure Reported but Unknown Type	78 (12.5)	0.98 (0.32-2.95)	0.973	1.21 (0.69-2.12)	0.509
Severity of Exposure					
Mild	117 (18.8)	1.04 (0.41-2.67)	0.933	1.60 (1.00-2.49)	0.055
Moderate	80 (12.8)	1.28 (0.47-3.55)	0.63	1.34 (0.78-2.31)	0.3
Severe/Heavy	41 (6.6)	0.99 (0.22-4.40)	0.99	1.46 (0.72-2.98)	0.3
Refused/Non-Response	385 (61.8)	**ref**	-	**ref**	-

NA= <0.001 (<0.001->999.9)

Table 3.3: Reported Occupational Exposures by Occupation

		Chi-Square Analysis	
Occupational Category	**N (%) Sample**	**Primary Occupational Dust Exposure**	
Total Sample	**623 (100)**	**216 (34.67)**	**P Value**
Agriculture	17 (2.7)	12 (70.59)	
Construction	30 (4.8)	24 (80.00)	
Manufacturing and Production	52 (8.4)	38 (73.08)	
Transportation	29 (4.7)	19 (65.52)	
Military	6 (0.96)	3 (50.00)	
Healthcare	87 (13.9)	13 (14.94)	
Protective Services	17 (2.7)	12 (70.58)	
Other ^	315 (50.6)	81 (25.71)	
Refused, Not Acertained, Do Not Know	70 (11.2)	14 (20.00)	P<0.0001
^= Management, Customer Services, Educators, Office-type work			

Table 4: Multiple Linear Regression for Occupation Type by FEV1% Predicted and by FEV1/FEV6

Occupation Type	Lung Function Measurement							
Blue Collar Laborers & Servicers	**FEV1 % Predicted ^**				**FEV1/FEV6**			
n=144	**Beta Coefficient**	**Std Err**	**P value**	**R2 Adjusted**	**Beta Coefficient**	**Std Err**	**P value**	**R2 Adjusted**
Years in Primary Occupation	-0.054	0.117	0.641		-0.09	0.071	0.204	
Total Pack Years Smoked	-0.181	0.067	0.008	0.041	-0.009	0.033	0.793	
Age	-	-	-	-	0.059	0.065	0.366	-0.009
White Collar Workers	**FEV1 % Predicted ^**				**FEV1/FEV6**			
n=384	**Beta Coefficient**	**Std Err**	**P value**	**R2 Adjusted**	**Beta Coefficient**	**Std Err**	**P value**	**R2 Adjusted**
Years in Primary Occupation	-0.081	0.065	0.212		0.053	0.047	0.259	
Total Pack Years Smoked	-0.196	0.063	0.002	0.026	-0.033	0.034	0.332	
Age	-	-	-	-	-0.039	0.042	0.354	-0.002
^ = Screening Device adjusts this value for Age, Race, Height and Gender								
- = Adjusted for in current model								

Table 5.1: Final Logistic Regression for Obstructed Impairment

	N (%) Sample	N (%) Obstructed	Adjusted OR (95%CI)	P Value
Type of Occupation by Probable Particulate Exposure				
Blue Collar Laborers	99 (15.9)	3 (3)	0.43 (0.10-1.92)	0.269
Blue Collar Servicers	52 (8.4)	3 (5.8)	0.92 (0.22-3.81)	0.912
White Collar	402 (64.5)	18 (4.4)	**ref**	-
Non-Response	70 (11.2)	8 (11.4)	2.11 (0.18-5.43)	0.123
Age				
18-39	144 (23.1)	8 (5.6)	**ref**	-
40-59	252 (40.5)	13 (5.2)	1.15 (0.45-2.96)	0.774
60+	227 (36.4)	11 (4.9)	0.91 (0.34-2.40)	0.845
Primary Occupational Dust Exposure				
Yes	216 (34.7)	11(5.1)	1.84 (0.19-17.59)	0.6
No	370 (59.4)	15 (4.1)	**ref**	-
Non-Response	37 (5.9)	6 (16.2)	3.84 (1.28-11.47)	0.016
Type Particulate Reported				
Organic	120 (19.3)	5 (4.2)	0.75 (0.09-6.31)	0.793
Inorganic	16 (2.6)	3 (18.8)	5.45 (0.39-76.16)	0.207
Chemical Vapors/Fumes/Gases	26 (4.2)	0 (0)	<0.001 (<0.001->999.9)	0.981
Exposure Reported but Type Unknown	78 (12.5)	4 (5.1)	0.75 (0.06-8.82)	0.821
No Exposure Reported	383 (61.5)	20 (23.5)	**ref**	-
Pack Years				
0	385 (61.8)	22 (5.7)	**ref**	-
<1 to 10 years	87 (14)	3 (3.4)	0.68 (0.19-2.42)	0.552
> 10 years	151 (24.2)	7 (4.6)	0.85 (0.34-2.10)	0.718

Table 5.2: Final Logistic Regression for Restricted Impairment

	N (%) Sample	N (%) Restricted	Adjusted OR (95% C.I.)	P values
Type of Occupation by Probable Particulate Exposure				
Blue Collar Laborers	99 (15.9)	39 (39.4)	2.23 (1.28-3.91)	0.005
Blue Collar Servicers	52 (8.4)	17 (32.7)	1.67 (0.84-3.34)	0.143
White Collar	402 (64.5)	81 (20.2)	**ref**	-
Non-Response	70 (11.2)	18 (25.7)	1.16 (0.62-2.20)	0.635
Age				
18-39	144 (23.1)	20 (13.9)	**ref**	-
40-59	252 (40.5)	65 (25.8)	1.85 (1.04-3.28)	0.036
60+	227 (36.4)	70 (30.8)	2.28 (1.29-4.03)	0.005
Primary Occupational Dust Exposure				
Yes	216 (34.7)	65 (30.1)	1.56 (0.51-4.79)	0.437
No	370 (59.4)	77 (20.8)	**ref**	-
Non-Response	37 (5.9)	13 (35.1)	2.12 (0.97-4.65)	0.06
Type Particulate Reported				
Organic	120 (19.3)	34 (28.3)	0.69 (0.23-2.07)	0.512
Inorganic	16 (2.6)	4 (25)	0.41 (0.08-2.03)	0.275
Chemical Vapors/Fumes/Gases	26 (4.2)	12 (46.2)	1.37 (0.36-5.20)	0.641
Exposure Reported but Type Unknown	78 (12.5)	20 (25.6)	0.79 (0.23-2.71)	0.704
No Exposure Reported	383 (61.5)	85 (22.2)	**ref**	-
Pack Years				
0	385 (61.8)	77 (20)	**ref**	-
<1 to 10 years	87 (14)	16 (18.4)	0.90 (0.48-1.67)	0.728
> 10 years	151 (24.2)	62 (41.1)	2.48 (1.62-3.80)	<0.001

Table 5.3: Backwards Elimination of Final Logistic Regression Model

		Restricted vs. Neither Condition		Obstructed vs. Neither Condition	
	N (%)	Adjusted OR (95% C.I.)	P values	Adjusted OR (95% C.I.)	P Values
Type of Occupation by Probable Particulate Exposure					
Blue Collar Laborers	99 (15.9)	2.23 (1.37-3.62)	0.0013		
Blue Collar Servicers	52 (8.4)	1.79 (0.93-3.45)	0.081		
White Collar	402 (64.5)	**ref**	-		
Non-Response	70 (11.2)	1.31 (0.71-2.40)	0.39	**removed by process**	
Age					
18-39	144 (23.1)	**ref**	-		
40-59	252 (40.5)	1.86 (1.06-3.28)	0.032		
60+	227 (36.4)	2.33 (1.33-4.11)	0.003	**removed by process**	
Pack Years					
0	385 (61.8)	**ref**	-		
<1 to 10 years	87 (14)	0.91 (0.49-1.68)	0.763		
> 10 years	151 (24.2)	2.42 (1.59-3.69)	<0.0001	**removed by process**	
Primary Occupational Dust Exposure					
Yes	216 (34.7)			1.27 (0.57-2.82)	0.557
No	370 (59.4)			**ref**	-
Non-Response	37 (5.9)	**removed by process**		4.58 (1.66-12.65)*	0.003

Table 6.1: Agricultural Population's by Occupational Exposure

		Occupational Exposure	
Agriculturally Related Occupations and Tasks	**N (%) Sample**	**N (%) Exposed**	**P Value**
Is Agriculture Your Primary mode of Income?			
Yes	27 (4.3)	15 (55.6)	
No	592 (95)	200 (33.8)	
Non-response	4 (0.6)	1 (25)	P<0.0001
Have You Ever Lived on a Farm?			
Yes	184 (29.5)	69 (37.5)	
No	434 (69.7)	146 (33.6)	
Non-response	5 (0.8)	1 (20)	P=0.0604
Do You Currently Live on a Farm?			
Yes	53 (8.5)	19 (32.8)	
No	566 (90.9)	197 (34.8)	
Non-response	4 (0.6)	0 (0)	P=0.002

Table 6.2: Agricultural Population's by Type of Particulate Reported

			Type of Particulate			
Agriculturally Related Occupations and Tasks	**N (%) Sample**	**Organic**	**Inorganic**	**Chemical Gas/Vapors**	**Unknown Exposure**	**P Value**
Is Agriculture Your Primary mode of Income?						
Yes	27 (4.3)	12 (80.00)	1 (6.7)	1 (6.7)	3 (20)	
No	592 (95)	103 (51.50)	15 (7.5)	25 (12.5)	75 (37.5)	
Non-response	4 (0.6)	1 (25.00)	0 (0)	0 (0)	0 (0)	P=0.0001
Have You Ever Lived on a Farm?						
Yes	184 (29.5)	49 (71.01)	3 (4.4)	6 (8.7)	23 (33.3)	
No	434 (69.7)	70 (47.95)	13 (8.9)	20 (13.7)	55 (37.7)	
Non-response	5 (0.8)	1 (20.00)	0 (0)	0 (0)	0 (0)	P=0.181
Do You Currently Live on a Farm?						
Yes	53 (8.5)	16 (84.21)	0 (0)	1 (5.3)	4 (21.1)	
No	566 (90.9)	100 (50.76)	16 (8.1)	25 (12.7)	74 (37.6)	
Non-response	4 (0.6)	0 (0)	0 (0)	0 (0)	0 (0)	P=0.033

Note: Number of Types of exposures reported will be greater than actual number of exposures. More than one type of particulate could be reported by the same participant.

Table 6.3: Agricultural Population's by Severity of Exposure

		Severity of Exposure			
Agriculturally Related Occupations and Tasks	**N (%) Sample**	**Mild**	**Moderate**	**Severe**	**P-value**
Is Agriculture Your Primary mode of Income?					
Yes	27 (4.3)	10 (66.7)	6 (40)	3 (20)	
No	592 (95)	105 (52.5)	74 (37)	38 (19)	
Non-response	4 (0.6)	1 (25)	0 (0)	0 (0)	P=0.001
Have You Ever Lived on a Farm?					
Yes	184 (29.5)	32 (46.4)	29 (42)	14 (20.3)	
No	434 (69.7)	83 (56.9)	51 (34.9)	27 (18.5)	
Non-response	5 (0.8)	1 (20)	0 (0)	0 (0)	P=0.469
Do You Currently Live on a Farm?					
Yes	53 (8.5)	14 (73.7)	7 (36.8)	3 (15.8)	
No	566 (90.9)	102 (51.8)	73 (37.1)	38 (19.3)	
Non-response	4 (0.6)	0 (0)	0 (0)	0 (0)	P=0.533

Figure 1: Effect of Total Pack Years Smoked on Decreased Lung Function of Blue Collar Workers

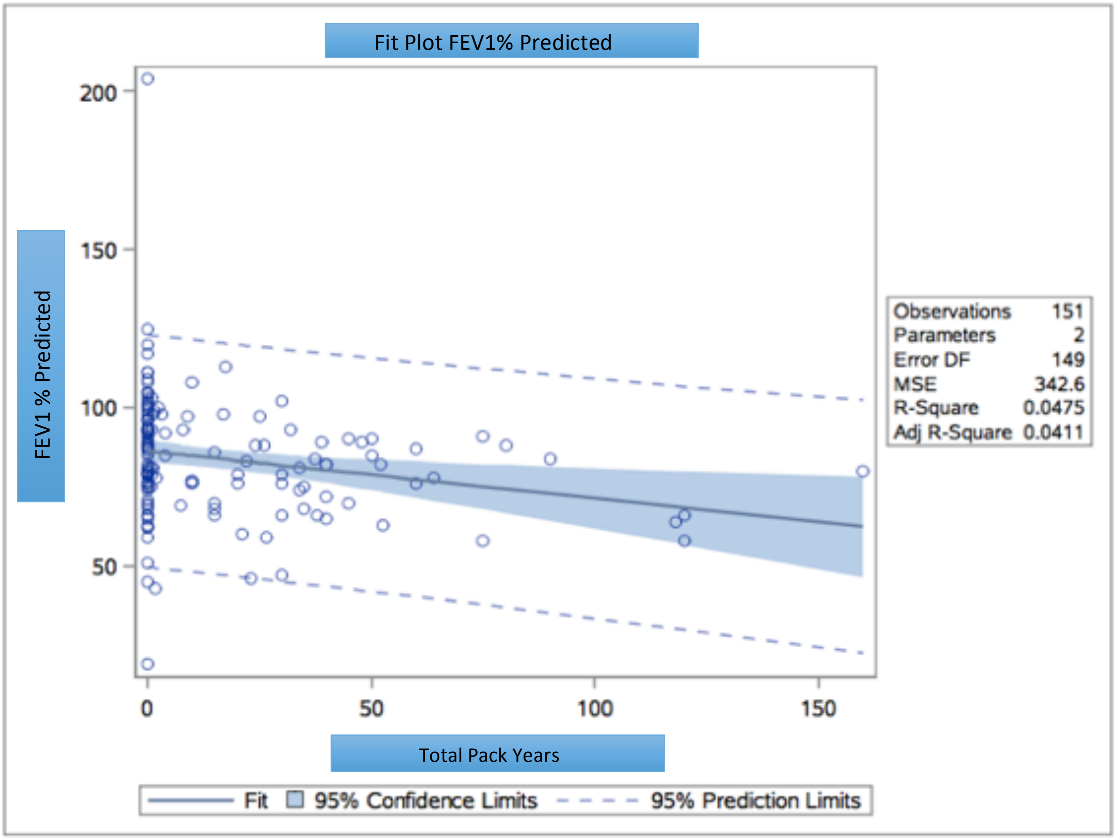
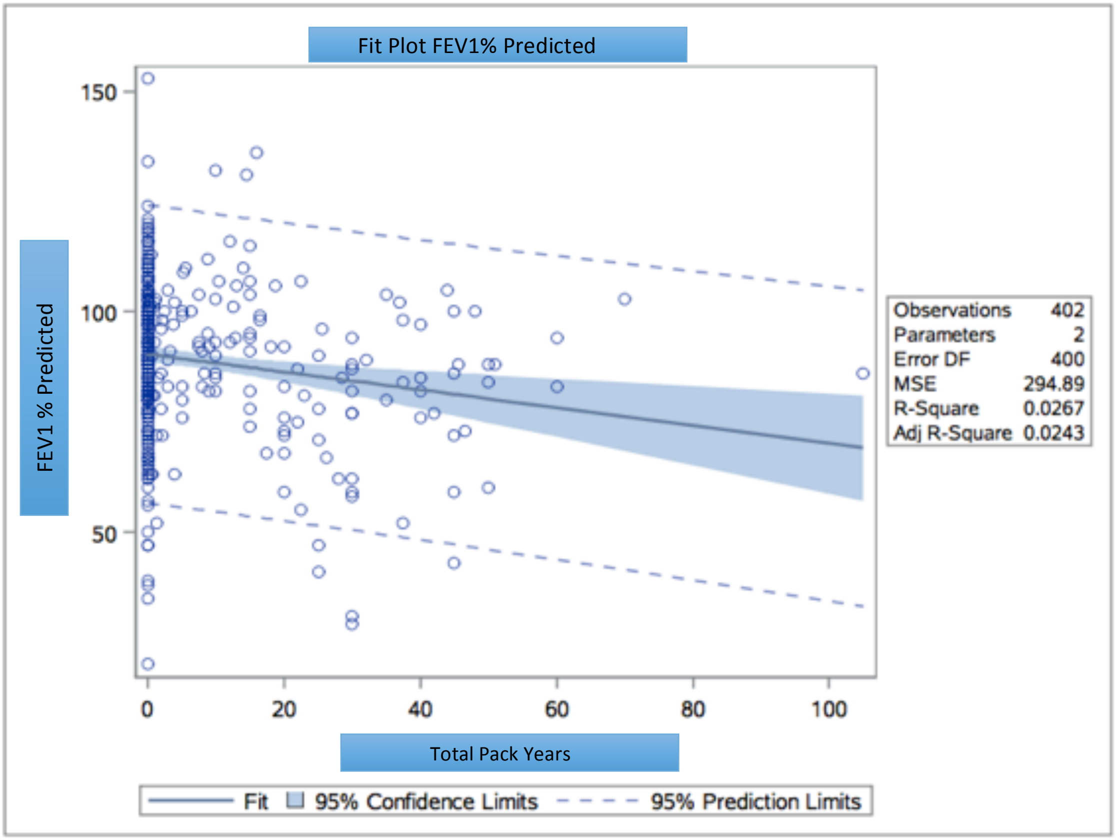


Figure 2: Effect of Total Pack Years Smoked on Decreased Lung Function of White Collar Workers



APPENDIX A

Survey, Kentucky State Fair, August 2015:

Confidential

Demographics

What is your gender?

□ Female □ Male

What is your age? __________ years

What is the highest level completed in school?

□ No High School □ Some High School □ High School Graduate or GED □ Some College □ College Graduate

Is working in the agricultural field your primary mode of income?□Yes □No

Have you EVER lived on a farm at any time for more than 1 year?□Yes □No

Do you CURRENTLY live on a farm? □Yes □No

Job History

Which of the following best describes YOUR CURRENT employment status?

□ Employed □ Self-employed □ Unemployed □ Retired □ Student □ I don't know/Prefer not to answer

What is your primary occupation? *(Please indicate below)*
____

How many years have/had you been in this occupation?________________________________

Does/Did this job require you to work for a year more in a dusty environment?

□ Yes □No □ I don't know/prefer not to answer

If YES, please indicate the level of dust exposure during this job?

□ Mild □ Moderate □ Severe/heavy □ I don't know/Prefer not to answer

What types of dust are you exposed to?

____

How many hours were spent per day/shift completing dusty tasks?□ Less than 1 hour □ 1-2 hours □ 2-4 hours □ 5-6 hours □ 7+ hours □ I don't know/Prefer not to answer

Agriculture Questions

Do/Did you work in the agriculture field?

□Yes □No

If you have answered **NO** to this question, you may proceed to the medical history section.

If YES, how many years did/have you worked in the agricultural field? ____________________

During this time, how would you characterize your dust exposure?

□ Mild □ Moderate □ Severe □ I don't know/Prefer not to answer

What types of dust are you exposed to?

____

How many hours were spent per day/shift doing dusty tasks related to agriculture?□ Less than 1 hour □ 1-2 hours □ 2-4 hours □ 5-6 hours □ 7+ hours □ I don't know/Prefer not to answer

Confidential

Please check all that apply for the next questions:

Do/Did you farm the following field crops?

□ Barley for grain or seed □ Corn for grain or seed □ Corn for silage or greenchop □ Cotton □ Fescue seed □ Rye for grain or seed (exclude ryegrass) □ Sorghum for silage or greenchop □ Soybeans for beans □ Tobacco □ Wheat for grain or seed □ Other : _____________________________

Do/Does your agricultural job require you to cut or harvest any of the following?□ Berries □ Cut trees for sale □ Fruit and nuts □ Hay and forage crops □ Nursery, greenhouse, sod, and vegetable seed □ Vegetables, potatoes, and melons

Do/Does your agricultural occupation require you to work with the following animals? □ Aquaculture □ Cattle and calves □ Colonies of bees □ Equine □ Hogs and pigs □ Poultry □ Sheep and goats

Do/did you wear respiratory protection when working in agriculture?

Was changed by hand to "primary occupation"

□ Yes □ No □ I don't know/Prefer not to answer

If YES, what type of lung/ breathing protection have you used?□ Handkerchief /clothing □ Paper Mask (3M N95 masks) □ Air-Filtering/purifying respirator (canisters, cartridges, filters) □ Air-Supply Respirators (atmosphere-supplying)

How often have you used these during your job?

□ Never □ Sometimes □ Often □ Always

Medical History

Would you characterize yourself in good health?

□Yes □No □ I don't know/refer not to answer

Do you CURRENTLY suffer from any of the following lung/breathing conditions? *(Please check all that apply)* □ Asthma □ Chronic bronchitis □ Chronic cough □ Persistent wheeze

Have you EVER been told by a doctor you have any of the following? *(Please check all that apply)* □ Asthma □ Chronic Obstructive Pulmonary Disease (COPD) □ Emphysema □ Hay fever □ Heart disease □ Pneumonia □ Sleep Apnea

Have you smoked at least 100 cigarettes in your lifetime? □Yes □No

□ I don't know/Prefer not to answer **If YES, how old were you when you first started**

smoking cigarettes daily? _________ years of age

Do you currently smoke cigarettes on a daily basis, less than daily, or not at all?□ Daily □ Less than daily □ Not at all □ Refuse to answer

What is the total number of years you have smoked cigarettes EVERY DAY? _________ years

When you smoked, on the average about how many cigarettes did you smoke each day? _________ cigarettes per day (1 pack = 20 cigarettes)

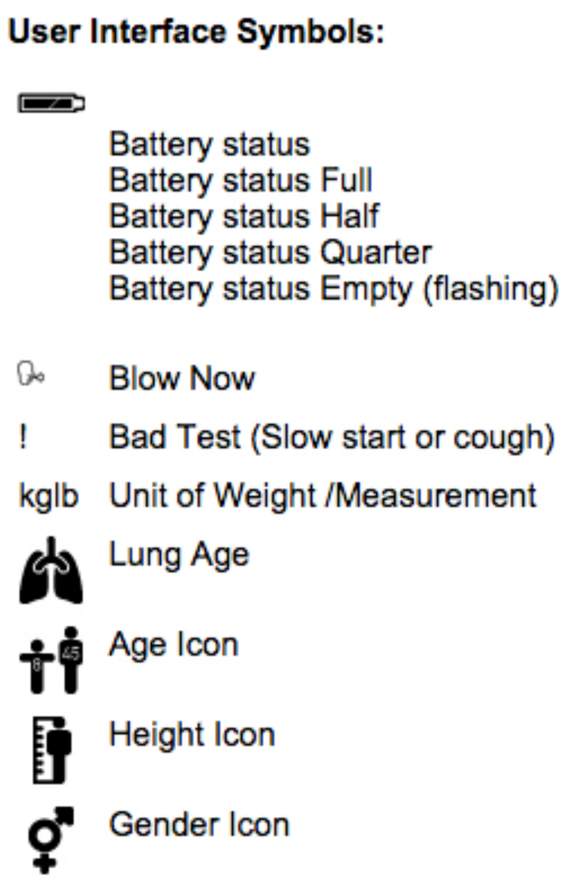
Appendix B

Instructional Reference Packet Utilized at the Kentucky State Fair 2015

Inches to Feet Conversion Chart

Feet	Inches	Feet	Inches	Feet	Inches
5’0”	60”	5’7”	67	6’2”	74
5’1”	61	5’8”	68	6’3”	75
5’2”	62	5’9”	69	6’4”	76
5’3”	63	5’10”	70	6’5”	77
5’4”	64	5’11”	71	6’6”	78
5’5”	65	6’0”	72	6’7”	79
5’6”	66	6’1”	73	6’8”	80

Key Symbols from Vitalograph



User Interface Symbols:

Battery status
Battery status Full
Battery status Half
Battery status Quarter
Battery status Empty (flashing)

Blow Now

! Bad Test (Slow start or cough)

kglb Unit of Weight /Measurement

Lung Age

Age Icon

Height Icon

Gender Icon

Lung Function and COPD Basics

Study Purpose:

Most COPD, roughly 80% is caused from smoking, but there is 20% that is said to be caused by occupational/environmental determinants. Therefore we are collecting data by a short survey on basic information, occupational, and other medical information to see is there is a correlation between different occupations and the lower lung function based on exposure to different dusts (Organic and inorganic). This stemmed from a project just focused on agricultural dust exposure but this is now attempting to look at the bigger picture of undiagnosed COPD and lower lung function based on occupation. Early identification of the disease can be beneficial before significant amounts of lung function are lost.

COPD- Chronic Obstructive Pulmonary Disease

Characterized usually by one or both Chronic Bronchitis and Emphysema

Symptoms: Cough (productive and non-productive), Wheeze, Fatigue, Tight Chest, Shortness of breath, short and long term exacerbations (periods of time with attacks and severe shortness of breath)

Currently 9.3% of Kentucky Residents have COPD *HIGHEST RATE IN USA*

IN: 7.9%

TN: 8.7%

OH: 7.1%

IL: 5.9%

WV: 8.0%

http://www.copdfoundation.org/What-is-COPD/COPD-Facts/Statistics.aspx

- COPD is an obstructive lung disease which means that the airways are obstructed, usually with constant mucus and inflammation, therefore less air is getting out of the lungs, and bad de-oxygenated air is getting trapped in the lungs, leaving no room for the good air
- FEV means forced expiratory volume and the numbers 1 and 6 represent seconds
- Level of Lung Obstruction is determined by FEV1 % Predicted- if this is greater then 80% then there is no obstruction, anything less than that indicates obstruction

- COPD is determined by taking FEV1/FEV6 ratio of less then .70 and if FEV1 % predicted is less that 80%

This is shown on the chart below and what we will be measuring, <u>this is why it is important for all subjects to keep holding the device to their mouth and blowing for the FULL 6 seconds</u> until the device has 2 definitive beeps.

The colour systems for each zone type are pre-set as follows:

FEV1% Pred.	Obstructive Index		COPD Classification	FEV1/FEV6 Ratio and FEV% Pred.
≥ 80%	0		Not COPD	FEV1/FEV6 > 0.7
		Top Boundary	Stage I	FEV1/FEV6 < 0.70 and FEV1 ≥ 80% Pred.
< 80%	1	Middle Boundary	Stage II	FEV1/FEV6 < 0.70 and FEV1 < 80% Pred.
< 50%	2	Bottom Boundary	Stage III	FEV1/FEV6 < 0.70 and FEV1 < 50% Pred.
< 30%	3		Stage IV	FEV1/FEV6 < 0.70 and FEV1 < 30% Pred.

<u>Procedure to complete survey with a participant & entering test info into computer</u>

1. **<u>Eligibility Criteria:</u>** Subject must be 18 years or older and English must be their Frist /Primary Language
2. After you talk to a subject and get them to agree to the survey and breathing test hand them a survey attached to a clipboard and pen
    a. Try to give the survey out in order of subject ID # at the top of the survey
3. Tell them that there is one page and front and back, and to make sure they answer all the questions & to let you know if they have any questions about the survey or lung test
4. After they are finished quickly skim all pages of survey and make sure they answered all questions
    a. If not complete hand it back and get them to answer ALL the questions

<u>5. ENTERING SUBJECT DATA INTO VITALOGRAPH:</u>

b. Turn Device on if not already on (circle button top right hand of screen)

c. Enter subject's age by using the up and down arrow keys
d. Enter subject's height with the up and down arrow keys (use provided feet to inches chart provided)
e. Enter subject's gender (By Symbol) with the up and down arrow keys (first symbol is a female symbol)
f. Enter subjects race/ethnicity

C= Caucasian

AA=African American

HA=Hispanic

g. Make sure that the face blowing out air is showing on the screen before handing the device to the subject

Breathing Test Steps TO DO & SAY this as showing subject:

h. take as deep of a breathe as possible
i. put mouth piece up to mouth & slightly bite the mouth piece (lips must be around the mouth piece or results could be inaccurate –this is VERY IMPORTANT!)
j. breathe out as fast and hard as possible for 6 Seconds until there is a definitive beep (its going to feel like no air is coming out after the first 2 seconds but it is and the subjects need to keep the mouth piece in their mouth the whole 6 seconds)
k. If an exclamation symbol pops up on the screen **'!'** this indicates a bad test/blow and should be repeated
l. subjects must complete this test 3 times to get the best of 3
m. tell them they will be taking 3 , 6 second tests and they can take as much time to break in between tests
n. if a participant feels dizzy, sick, or anything do not proceed

5. Take device from participant & remove & immediately throw out mouthpiece in trash
6. Instruct participant to use the hand sanitizer & you use sanitizer after you remove the mouth piece from the device

7. Get the study letter with the test result section on back & look at the arrows on the device screen & circle the corresponding COPD GOLD stage and Obstruction level *(if they have a normal reading you do not have to do this step)*
8. Hook up the device to the USB cord and hit the left side 'UP' arrow, until a symbol that looks like a folder/piece of paper pops up on the device screen,

   <u>On the computer:</u>

   a. A window should be pulled up that has an empty load bar
   b. Click the top left had button that says start (only has to be clicked 1 time for continuous data submission, not every time you up load data)
      i. When it is working it should say "stop" in this corner now instead of 'start'
   c. Connect the vitalograph to the computer with the white USB cord, and the word 'connected' should appear at the bottom left of the window
   d. On the device, click the up arrow until the paper icon appears on the device screen then hit the center button on the device that is the arrow pointing left and the icon should start blinking – you should also hear beeps during this process
   e. Then the window should say 'receiving data' if it is working and the load bar should load green
   f. A second window should pop up and you only need to do 2 things in this window
      i. Type in the subject ID number listed at the top of the survey that is paired with that vitalograph data upload
      ii. Select Imperial & US at the top left hand corner then hit next and a pdf should pop up
      iii. Change the title from the random numbers and letters and change it to that subject's ID number and hit **<u>SAVE AS and not SAVE</u>**
      iv. It should already be connected to the KSF Data Folder
      v. Just complete the save and continue collection
      vi. Once the test result is saved put the survey immediately into the provided folder

**Always double check the study ID on the survey before saving it to the computer and keep the completed survey with you*

<u>9. IF ABNORMAL TEST:</u>

a. After the person completes all 3 lung tests look at the screen on the device and the arrows on each side of the screen

b. The left hand side is "Obstruction level" – indicated by the colors

c. The right hand side of the screen is COPD GOLD stage

d. If either of these arrows are not in the green for the obstruction level side, or the green/very top section for the right COPD GOLD side, then you must indicate this abnormality to the subject.

e. We are providing each subject with a letter in case they have questions about the study, on the back of this letter you can circle the 2 different measurements for the subject so they can take this to their medical provider

https://vitalograph.com/downloads/view/07381

Other tips:

Reviewing the Last Session Test Results

The Vitalograph copd-6 will always store the last test session, even after the device has powered itself down or has been switched OFF. In order to view the last test session, follow these steps:

1. Turn the device on,
2. When the device is ready for age entry , press the button for approximately 3 seconds. The last test session (best results) data will now show again.
3. When you have finished reviewing the data, press the OFF button for 3s. OR
4. Press The device will return to the age entry screen ready for entering the next test subject's data.

APPENDIX C

Letter To Participants

UNIVERSITY OF
KENTUCKY

To Participants:

Thank you for agreeing to participate in the research project entitled, "Assessment of dust exposure and lung function in agricultural workers". The purpose of this research is to identify agricultural workers with dust exposure related to farming practices. By quantifying dust exposure among agricultural workers, the research team will be able to screen participants for early, undiagnosed respiratory disease. By obtaining the level of disease burden among our target population, future research efforts can expand to other vulnerable populations at risk for respiratory disease.

The survey questionnaire will ask basic demographic information in order to characterize the sample population. Occupational history will be required in order to characterize whether or not participants are in an agricultural field and to determine the amount of dust exposure. Furthermore, occupational questions will identify the different agricultural commodities among the sample population. A brief medical history will be acquired to determine what pre-existing conditions as well as pertinent information, which may skew results from the study. Information will be collected on tobacco habits, which may affect respiratory outcomes. Lastly, we will ask that participants expel a full breath of air into a Vitalograph device. The Vitalograph device identifies those at risk of COPD at the pre-symptomatic stage to allow early medical intervention and facilitate better clinical outcomes. Possible risk associated with Vitalograph device involves risk of transmission of bodily fluids. Safety hygienic trays will be used for each participant to eliminate the risk of transmission of bodily fluids.

Although you will not get personal benefit from taking part in this research study, your responses may help us understand more about how dust exposure in an agricultural setting impacts respiratory function. Specifically, your responses will aid in identifying chronic obstructive pulmonary disease (COPD) in its early stages of development.

We hope to receive completed questionnaires from 400 people, so your answers are important to us. Of course, you have a choice about whether or not to complete the survey/questionnaire, but if you do participate, you are free to skip any questions or discontinue at any time.

The survey/questionnaire will take about 10 minutes to complete.

You will receive a small incentive (hat, maglite, pen, etc.) for completing the questionnaire and screening test.

There are no known risks to participating in this study.

Your response to the survey is anonymous which means no names will appear or be used on research documents or be used in presentations or publications. The research team will not know that any information you provided came from you or whether you participated in the study.

Please be aware, while we make every effort to safeguard your data once received on our servers via REDCap, given the nature of online surveys, as with anything involving the Internet, we can never guarantee the confidentiality of the data while still en route to us.

UNIVERSITY OF KENTUCKY

If you have questions about the study, please feel free to ask; my contact information is given below. If you have complaints, suggestions, or questions about your rights as a research volunteer, contact the staff in the University of Kentucky Office of Research Integrity at 859-257-9428 or toll-free at 1-866-400-9428.

Thank you in advance for your assistance with this important project.

Sincerely,

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Vitalograph COPD-6 Results

Lung Age: _______

Obstructive Index: _____

Obstructive Index:

FEV1 Meas./FEV1 Pred. ≥ 80%	Normal
FEV1 Meas./FEV1 Pred. < 80%	Mild
FEV1 Meas./FEV1 Pred. < 50%	Moderate
FEV1 Meas./FEV1 Pred. < 80%	Severe

COPD (GOLD) Classification:

FEV1/FEV6 ≥ 0.70	Normal
FEV1/FEV6 < 0.70 & FEV1 ≥ 80%	Stage I
FEV1/FEV6 < 0.70 & FEV1 < 80%	Stage II
FEV1/FEV6 < 0.70 & FEV1 < 50%	Stage III
FEV1/FEV6 < 0.70 & FEV1 < 30%	Stage IV

AKNOWLEDGEMENTS

I would like to thank all of my professors that have helped me become a knowledgeable public health professional in the areas of Environmental and Occupational Health, as well as Epidemiology.

A special thanks to my committee, and those on the research team who directly worked with me to complete data collection this past summer at the Kentucky state fair.

Thank you Dr. Sanderson, Dr. Mannino, and Caroline Holsinger for keeping me on track, providing me with materials, suggestions, and mental support through out this entire process. I would have not had the experience and knowledge without the wonderful support I have received the past two years. I would not be the hardworking and knowledgeable student today without the guidance of Dr. Sanderson and Dr. Mannino. A further special thanks to Dr. Holsinger for being my main research partner and guiding me into the field on top of helping me navigate graduate school.

I also want to thank Dr. Browning for the encouragement and support as a committee member and his detail to attention. This will help me as I continue to pursue both my career and educational goals.

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To all my friends and professors, and staff members at the University of Kentucky, who listened to my concerns and panicked moments throughout data collection and data analysis, I thank you for being there for me.