RISK FACTORS AND QUALITY OF LIFE IMPACTS ASSOCIATED WITH ADULT ASTHMA IN NEW YORK STATE DEPARTMENT OF HEALTH OCCUPATIONAL HEALTH CLINIC NETWORK POPULATION

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ABSTRACT

Background: Asthma with an occupational etiology contributes to a largely unrecognized burden of preventable disease and disability. In New York State (NYS), estimates of asthma that are associated with work have been reported between 10.6 and 44.5% of all asthma cases. However, studies estimating risk of asthma by industry have not been conducted in NYS. In addition, the quality of life impacts of asthma on NYS workers have not previously been evaluated.

Methods: Odds ratios of asthma by industry as compared with the construction industry and adjusted for age, gender, ethnicity and clinic location were examined through logistic regression in a study of NYS Occupational Health Clinic Network (OHCN) patients from 2000 to 2009 (n=32,902). Four quality of life (QOL) measures were evaluated for asthma patients as compared to medical screening patients in adjusted logistic regression models. QOL was measured by the ability to perform tasks around the house, to provide care for family or children, and to participate in recreational tasks. An additional QOL control measure was used to ascertain if the ability to perform tasks was unaffected.

Results: The risk of asthma was significantly greater than in the construction industry after adjusting for covariates in real estate, retail trade, health care, finance-insurance, other services, manufacturing, and professional services. The real estate industry had the highest estimated risk (OR= 3.56, 95% CI 1.54-8.26) followed by retail trade (OR=3.19, 95% CI 1.89-5.40) and health care (OR= 2.50, 95% CI 1.62-3.85). After adjusting for covariates, a statistically significant elevated risk of greater than 30 was estimated for each negative QOL by asthma.

Conclusion: This study supported and expanded on previous work indicating that real estate, retail trade, health care, finance-insurance, other services, manufacturing, and professional services industries elevate the risk of asthma and that asthma negatively impacts quality of life. Prevention efforts should focus on industries most consistently associated with asthma in the literature. Associations between work-related exposures and asthma warrant further research.

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CHAPTER 1

INTRODUCTION

Asthma is a respiratory disease that creates narrowing of the air passages resulting in difficulty breathing, tightness of the chest, coughing and wheezing. According to the Centers for Disease Control and Prevention (CDC), an estimated 16.4 million adults in the United States have asthma. In the United States and other industrialized countries, asthma with an occupational etiology contributes to a largely unrecognized burden of preventable disease and disability (Friedman-Jimenez et al 2000).

The National Institute for Occupational Safety and Health (NIOSH) defines work-related asthma as asthma that is caused or made worse by exposures in the workplace. Though studies vary, a recent systematic analysis of the literature by Torén and Blanc (2009) estimated that work-related asthma accounts for between 12 and 17% (median 15%) of all asthma cases. Fletcher et al (2006) looked at the distribution of work-related asthma in New York State (NYS) by industry and putative agent from 1988-1999 using a data set of The NYS Department of Health (NYSDOH) Occupational Health Clinic Network (OHCN). Tice et al (2010) also used these data as well as additional population- and case-based registries to evaluate prevalence of work-related asthma in NYS. Tice and colleagues estimated that between 10.6 to 44.5% of asthma in NYS was work-related. The wide estimates were dependent on the data source used to measure prevalence and differences in case definitions. Both Fletcher and Tice described the distribution of asthma by major industry groups including manufacturing, finance, education and construction, among others.

Lowery et al (2007) evaluated asthma's impact on quality of life (QOL). Participants rated the extent to which the symptoms or treatment of asthma had affected their breathlessness, mood distribution, social disruptions and health concerns in the previous four weeks using a four-level rank score. This rank score was attributed to overall QOL but did not directly estimate impacts on daily activities.

The OHCN has been collecting patient data on patients since 1988. The eight regionally-based clinics in the OHCN utilize a public health approach to diagnose and treat occupational diseases with the aim of improving working environments in NYS. The OHCN public health approach employs multidisciplinary teams of physicians, nurses, industrial hygienists, health educators and social workers trained in occupational health to perform a variety of prevention activities as well as clinical services.

Patient data from the OHCN from clinic locations in New York City, Cooperstown, Rochester, Long Island, Albany, Syracuse and Buffalo were utilized for the current study. Each clinic focuses on high-risk industries within its geographic area. The OHCN are located in various institutions including state and private medical schools, a healthcare insurer and a local consortium of unions. The OHCN clinics provide education and training tools to workers, employers and medical care providers. In addition to education, diagnostic and treatment services provided by the OHCN, the staff are experienced in evaluating work conditions of patients to determine whether other co-workers are at risk. These evaluations provide the OHCN information needed to suggest measures and recommendations to improve the workplace environment (Gelberg et al 2003).

The OHCN is open to anyone in NYS with a potential work-related illness. Patients are seen primarily for work-related conditions, but are also seen for environmental exposures. The OHCN also offers group medical screening services for workers specific to job responsibilities or post exposure to known, unknown or suspected putative agent(s).

In summary, the prevalence of work-related asthma in the United States and other countries with similar work environments warrants further investigation into the risk factors for asthma and the QOL impacts associated with this condition. Prevalence of work-related asthma in NYS has been reported by Fletcher et al (2006) for 10 years prior to 1999. Fletcher and colleagues provided descriptive information related to the distribution of work-related disease by putative agent but did not model potential causal relationships or estimate risks (e.g., odds ratios) by industry. The current study examined asthma in the OHCN study population from 2000 to 2009. The study had two primary goals. The first goal was to examine the effect of industry group on the diagnosis of asthma. The construction industry was chosen as a reference for comparison *a priori* based on previous studies reporting the recognized risk and relatively low prevalence of asthma in the construction industry as compared with other industries (McHugh et al 2010). Secondly, the study evaluated the impacts on QOL in those diagnosed with asthma in the OHCN as compared with those visiting for medical screening.

We estimated that medical screening visits were the closest approximation to the working general population available within the existing database. QOL was separately evaluated based on a yes or no response to the following questions provided and recorded by the OHCN:

1. Has the illness affected patient's ability to perform/provide tasks around the house?
2. Has the illness affected patient's ability to perform/provide care to family/children?
3. Has the illness affected patient's ability to perform recreational activity?
4. Has the illness had no affect on the patient's ability to perform/provide tasks?

CHAPTER 2

BACKGROUND

A systematic search of the relevant literature was performed utilizing both PubMed and Google Scholar as search engines. Search terms for the initial literature review included occupational/work-related asthma, spirometry, peak expiratory flow, non-specific inhalation challenge, specific inhalation challenge, construction, schools, health care, police, hotels, restaurants, janitor, metal work, nurse, waiter, waitress, electronics, assemblers, maintenance, dusts, mold, smoke, welding, solvents, indoor air pollutants, oils and isocyanates. The literature search was limited to papers in English published since 1995 with full-text available. Additional papers were also reviewed that may not have been identified using the *a priori* search criteria. These were identified during the normal progression of paper reviews, reference checks and thesis committee recommendations. For the purposes of brevity, only those papers that provided relevant understanding to the current state of research and the current study's goals on asthma by industry and QOL impacts are discussed within this review.

A total of 14 cross-sectional studies were reviewed which examined asthma in the occupational setting. Studies judged to be relevant to the current research are described herein. Two of these studies were specific to NYS. Fletcher et al (2006) characterized the population seen at the NYS OHCN between 1988 and 1999 and determined which industries, occupations and putative agents were associated with work-related asthma in NYS. The study further determined what proportion of cases diagnosed with work-related asthma conformed to the NIOSH's case definition of work-related asthma by

reviewing diagnostic information abstracted from medical charts. They reported that 92% of cases diagnosed as work-related by the OHCN physicians met the NIOSH case definition. The OHCN patients with work-related asthma were most commonly employed in the service (38.8%) and manufacturing (23.1%) industries. Occupations with the highest prevalences included teachers (7.3%), farm operators/managers (6.6%), and construction trades (5.7%). The most frequently reported putative agents associated with work-related asthma were dust (33.5%), indoor air (24%), mold (21.3%) and solvents (19.8%). Fletcher and colleagues provided descriptive information related to the distribution of work-related disease by putative agent but did not model potential causal relationships or estimate risks (e.g., odds ratios) by industry. The current study expands on the understanding of asthma in the OHCN by estimating risk of asthma by industry.

Tice et al (2010) determined the percent of adults with asthma attributable to work (10.6% to 44.5%) and described characteristics of the work-related asthma population in NYS. Data from three population-based surveys and one case-based surveillance system were analyzed for years between 2002 and 2007. Work-relatedness of asthma was determined by self-report for the population-based surveys and by physician report for the case-based system. The most important difference between the questionnaires utilized by Tice and colleagues was the method of determining work-related asthma, which directly accounts for the wide range of asthma estimates attributable to work. Lowery et al (2007) collected demographic, work history, disease information and QOL data from adults with asthma in the general population (n=598) and explored the relationship between workplace exacerbation of asthma and QOL. A QOL impact score of not at all (score=0), mild (score=1), moderate (score=2), severe (score=3) or very severe (score=4)

was constructed based on a self-reported breathlessness, mood disturbance, social disruptions and health concerns. Based on univariate analyses, study participants with work-exacerbated asthma had a statistically significant worse QOL than participants whose asthma was not work-related (OR=2.43 vs. 1.74, p <0.001). The ability to perform familial duties and recreational activities were not directly measured.

In the current study, QOL was measured based on a yes or no response to questions specifically related to the ability to perform tasks around the house, care for family and children and participate in recreational activities. An additional QOL control measure captured a yes or no response to a question ascertaining if the ability to perform tasks was unaffected.

McHugh et al (2010) used data from the National Health and Nutrition Examination Survey (2001–2004) to report prevalence of asthma among workers in mining (17.0%), health-related industries (12.5%), teaching (13.1%), or in health-related occupations (12.6%). Risk estimates were computed using multiple logistic regression models by industry. The construction industry was selected as the comparison group because of the relatively low prevalence of asthma and a large sample size available to enhance the precision (3.9%, n=379). The highest risk of asthma was found in the mining industry (OR=5.2, 95% CI: 1.1–24.2), followed by health-related industries (OR=2.3, 95% CI: 1.1–4.8). Similar to McHugh et al (2010), we elected to use construction as an internal comparison group for estimating risk in the current study.

Henneberger et al (2006) conducted a study of adults between the ages of 18 and 44 with asthma to determine the prevalence of workplace exacerbation of asthma. Members of a health maintenance organization (HMO) were considered candidates for

participation if they fulfilled membership, diagnostic and treatment criteria for asthma based on an automated review of electronic billing, claims and pharmacy records. Diagnosis and treatment were confirmed by manual review of medical records. A telephone questionnaire was administered. A work-related symptom score of low, moderate or high was assigned to each participant based on responses to questions about work-related asthma symptoms, medication use and symptom triggers. Blinded to participants' answers to these questions, two researchers independently reviewed the self-reported work histories and assigned exposure ratings. A final exposure score was then calculated. Participants with sufficient evidence for work-related symptoms and exposure were classified as having workplace-exacerbated asthma (23% of study population). A selection bias was reported because adults without medical coverage were not included in the analysis. At the time of the study, an estimated 17.8% of employed people in the United States did not have health insurance. Henneberger and colleagues postulated that a segment of these unrepresented workers were working in some of the dirtiest jobs in the country. These missing cases could serve to underestimate the risk of work-related asthma in the population.

Sauni et al (2003) looked at the risk of asthma among construction workers (n=7,513) using hospital records of the Tampere University Hospital in Finland. A population of paper mill workers (n=2,686) and the Finnish working age population (n=252,500) served as reference populations. There were 147 new cases of asthma among the construction workers between 1991 and 1995. The annual rate was 37 per 10,000 workers and the odds ratio was 2.1 (95% CI = 1.2–3.6) for women and 1.8 (95% CI = 1.5–2.2) for men when compared with the general working age population. In

general, the risk of asthma among the paper mill workers did not differ from the risk of asthma among the general working age population.

In 2001, Sauni and colleagues studied the effects of asthma on QOL and ability to work in construction workers. The authors sent a questionnaire to all construction workers who had been patients of the Tampere University Hospital between 1991 and 1995 (asthma cases=104, non-asthma cases=206). This study evaluated QOL using dichotomized responses of yes or no to evaluate effects on familial duties and recreation. Workers were asked if chronic asthma had limited the ability to work (90%), engage in sports greatly or totally (52%) and engage in other activities greatly or totally (45%). Respondents' opinions were stratified by severe and moderate asthma. The current study also evaluated QOL impact based on a yes or no response.

Jaakkila et al (2003) assessed the relationship between occupation and risk of developing asthma in adulthood between 1997 and 2000 using a population-based incident case-control study of 521 cases and 932 controls from the general population in south Finland. The authors reported numerous results though many lacked precision and statistical significance. However, asthma risk was elevated for the chemical industry (OR=5.69, 95% CI 1.08-29.8). In occupations that were predominately male, metal working was the strongest determinant of asthma (OR = 4.52, 95% CI 2.35-8.70). For women, asthma risk was increased for waitresses (OR = 3.03, 95% CI 1.10-8.31).

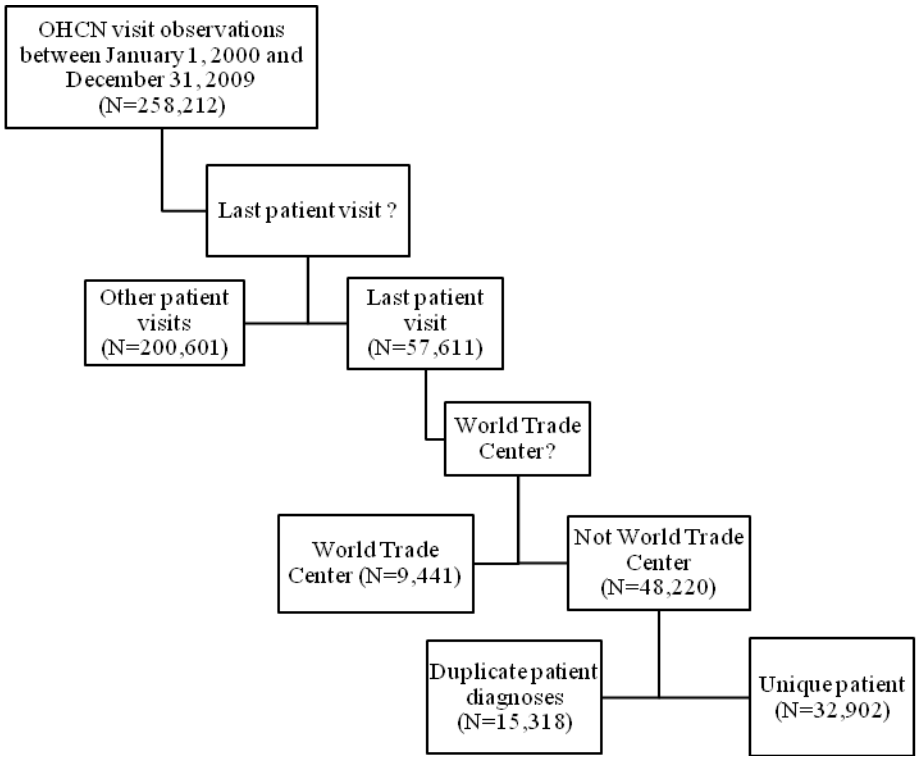
CHAPTER 3

ANALYTICAL METHODS

3.1 Study Subjects

A selection schematic of the NYS OHCN cross-sectional cohort is presented in Figure 1. Data were restricted to patients visits between January 1, 2000 and December 31, 2009 (n = 258,212). Since an individual patient may have had multiple visits and diagnoses within the study time frame, analysis of patient data was then restricted to the last visit (n=57,611). Within these data, cases were further restricted to exclude patients seen due to exposures at the World Trade Center disaster site (n = 9,441) as these cases represented unique exposures that may vary from typical industry environments. Finally, duplicate patient diagnoses (n=15,318) were removed from the data so that each patient represented a unique case (n=32,902).

Figure 1: Selection Schematic of the Cross-sectional Cohort



3.2 Industry Group Definition

For the first study goal, the primary exposure measure was industry groups. Industry groups were recorded for each OHCN patient visit by patient self report. Industry data were collapsed into major economic sectors as defined by the 2002 North American Industry Classification System (NAICS) by using the first two digits of the NAICS variable. For data that predated the NAICS system, the first two digits of the 1987 Standard Industrial Classification (SIC) variable was utilized and collapsed into a major economic sector based on comparability code tables. A summary description of the NAICS major economic sectors and comparability NAICS and SIC codes are provided in Appendix B (NACIS 2002 Manual definitions and 1987 SIC corresponding table

available at: http://www.census.gov/eos/www/naics/, accessed January 9, 2011). In addition, a 'combined industries' variable was created to represent all non-construction industries.

3.3 Asthma Diagnosis Definition

Asthma diagnosis was the health effect of interest for in this study. A diagnosis of asthma was determined by the OHCN health care provider and recorded according to the International Classification of Diseases, 9th revision (ICD-9) as codes of 493-493.9 (ICD-9 definitions available at: http://www.cdc.gov/nchs/icd/icd9.htm, accessed January 9, 2011).

The literature review indicated that studies had different methods of attributing asthma to the workplace. As demonstrated by Fletcher et al (2006), the NYS OHCN determined that 92% of cases between 1989 and 1999 conformed to the NIOSH's case definition of work-related asthma. This result was ascertained by reviewing diagnostic information abstracted from medical charts. The current study did not have the resources to review diagnostic information from medical charts to verify the proportion of asthma cases that met the criteria for work-related asthma within the current study population. Therefore, the authors elected, *a priori*, to use a broader diagnosis of asthma regardless of work-related determination as the health effect under consideration in the current study. Future analysis of these data may consider using NYSDOH's determination of work-relatedness.

3.4 Quality of Life Indicators

QOL was measured based on the self-report and OHCN captured yes or no responses to the four questions administered during to each patient visit. The method of capturing responses may vary based on individual health care provider or clinic location and were not evaluated as part of the current study. A separate analysis was completed for each of the following questions:

1. Has the illness affected patient's ability to perform/provide tasks around the house?
2. Has the illness affected patient's ability to perform/ provide care to family/children?
3. Has the illness affected patient's ability to perform recreational activity?
4. Has the illness had no affect on the patient's ability to perform/provide tasks?

Potential covariates considered as candidates for multivariable modeling included ethnicity, gender, age, current smoking status, ever smoking status and OHCN clinic location. Smoking status for both current and ever smokers were only captured post-2002. Therefore, smoking status was not included in the models due to the large number of missing responses (n=30,427).

3.5 Statistical Methods

Each potential covariate was evaluated first by the chi-square statistic (χ^2) to determine if there was a statistical difference in proportion by asthma diagnosis. If a statistically significant association between the covariate and the diagnosis of asthma was present, a univariate logistic regression between the covariate and a diagnosis of asthma was performed.

For industry associations, univariate logistic regressions models evaluated the association of each separate industry group (n=20) and 'combined industries' with an asthma diagnosis. The construction industry served as the reference group due to the recognized risk, relatively low prevalence within the population and a large sample size in the database (n=5,209). Two models were constructed adjusting for potential confounders. The first multivariable model included industry group, age (dichotomized at the mean), gender (male=0, female=1) and ethnicity (White, Black, Hispanic, other). The second model included industry group, age, gender, ethnicity, and clinic. Interaction terms were assessed for industry group and age, gender, and ethnicity. No signification interaction was found.

For QOL impacts, univariate logistic regression models evaluated the effect of an asthma diagnosis compared to those visiting the clinic for medical screening. The multivariable models for QOL incorporate the covariates of age, gender, and ethnicity.

All data analysis was performed using SAS version 9.2 (SAS Institute, Cary, NC). A p-value of <0.05 was regarded as statistically significant.

CHAPTER 4

RESULTS

4.1 Population Demographics, Asthma Prevalence and Industry Distributions

The population of last patient visits from January 1, 2000 to December 31, 2009 included 32,920 patients that were not related to the World Trade Center (WTC) disaster. An asthma diagnoses was present in 3.2% (n=1,052) of patients. Males represented 69% (n=22,666) of the population while females comprised 31% (n=10,196). An asthma diagnosis was recorded in 2.12% (n=480) of male patients and in 5.58% (n=569) of female patients. Females accounted for 54% (n=569) of those diagnosed with asthma. Gender was a significant predictor of an asthma diagnosis (χ^2 =274.9, p<0.0001).

The population mean age was 43.6 years (±13.8 years standard deviation). Age was dichotomized at the mean, with 50.7% (n=684) patients at or above the mean age of 43.6 years. An asthma diagnosis was recorded in 2.27% (n=368) of patients below the population mean age and in 4.10% (n=684) of patients at or above than the population mean age. Age was a significant predictor of an asthma diagnosis (χ^2 =88.8, p<0.0001).

Seventy-nine percent of patients visiting the clinics were White, and approximately 9% of the population was Black, with smaller percentages of Asians and Hispanics (Table 1). Ethnicity was a significant predictor of an asthma diagnosis (χ^2 =36.2, p<0.0001).

Table 1: Occupational Health Clinic Patients (n=32,902) by Ethnicity				
Ethnicity	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Asian	810	2.46	18	2.22
Black	3074	9.34	121	3.94
Hispanic	2285	6.94	114	4.99
Missing	87	0.26	3	3.45
Native American	169	0.51	4	2.37
Unknown	414	1.26	15	3.62
White	26063	79.21	777	2.98

The largest number of patients were seen at the Mt. Sinai clinic in New York City (19.99%, n=6,576). The Syracuse clinic had the highest number and highest proportion of asthma cases (n=332, 15.76%) (Table 2). Clinic location was significantly associated with an asthma diagnosis (χ^2 =827.7, p<0.0001).

Table 2: Occupational Health Clinic Patients (n=32,902) by Clinic Location				
Clinic Location	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Albany	4283	13.02	93	2.17
Buffalo	3423	10.40	9	0.26
Long Island	4645	14.12	116	2.50
Mt. Sinai (NYC)	6576	19.99	302	4.59
Rochester	4864	14.78	71	1.46
Syracuse	2106	6.40	332	15.76
Cooperstown	5956	18.10	52	0.87
Bellevue (NYC)	1049	3.19	77	7.34

The industries representing the greatest number of patients in this study population were public administration (n=7,661, 23%), construction (n=5,209, 16%) and manufacturing (n=4,805, 15%). The industries with the most reported cases of asthma

were manufacturing (n=196), educational services (n=154) and other services (n=130). A summary of patients by industry for the study period is provided in Table 3.

Table 3: Occupational Health Clinic Patients (n=32,902) by Industry and with Asthma Diagnosis

NAICS Economic Sector	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Agriculture, Forestry, Fishing and Hunting	913	2.77	32	3.50
Mining, Quarrying, and Oil and Gas Extraction	89	0.27	2	2.25
Utilities	1161	3.53	41	3.53
Construction	5209	15.83	82	1.57
Manufacturing	4805	14.60	196	4.08
Wholesale Trade	300	0.91	10	3.33
Retail Trade	720	2.19	36	5.00
Transportation and Warehousing	1612	4.90	45	2.79
Information	1	0.00	1	100.00
Finance and Insurance	691	2.10	29	4.20
Real Estate and Rental and Leasing	98	0.30	9	9.18
Professional, Scientific, and Technical Services	609	1.85	32	5.25
Administrative and Support and Waste Management and Remediation Services	1	0.00	0	0.00
Educational Services	2808	8.53	154	5.48
Health Care and Social Assistance	3525	10.71	124	3.52
Arts, Entertainment, and Recreation	373	1.13	4	1.07
Accommodation and Food Services	278	0.84	8	2.88
Other Services (except Public Administration)	2048	6.22	130	6.35
Public Administration	7661	23.28	117	1.53
Total	32,902	100.00	1052	3.20

Approximately 53% (n=17,462) of patients during the current study period visited clinics for the purpose of group medical screening, while 47% (n=15,440) were symptomatic. Several types of group medical screening visits were provided by the clinics including respirator clearance testing, asbestos screening, lead blood monitoring and pre-placement examinations.

4.2 Univariate Regression Analyses of Covariates and Asthma

Univariate logistic regression of each covariate with odds ratio of an asthma diagnosis are presented in Table 4. An increased risk of an asthma diagnosis was found for patients at or above the population mean age (OR=1.84, 95% CI 1.62-2.09) and in females (OR=2.73, 95% CI 2.41-3.09). Self-reported ethnicities of Black and Hispanic showed an increased risk of an asthma diagnosis when compared to Whites (OR=1.33, 95% CI 1.10-1.62 and OR=1.71, 95% CI 1.40-2.09, respectively). As compared with the Mt. Sinai clinic, Albany, Buffalo, Long Island, Rochester, and Cooperstown had significantly reduced odds ratios, while Syracuse and Bellevue had significantly elevated odds ratios of an asthma diagnosis.

Table 4: Odds Ratios of an Asthma Diagnosis by Selected Covariates (n = 1,052)

Covariate	N (% asthma in group)	OR	95% Confidence Interval	
Age				
<43.6 years	368 (35.0)	1.00	-	-
≥43.6 years	684 (65.0)	1.84	1.62	2.09
Gender				
Male	569 (54.1)	1.00	-	-
Female	480 (45.6)	2.73	2.41	3.09
Ethnicity				
White	777 (73.9)	1.00	-	-
Asian	18 (1.71)	0.74	0.46	1.19
Black	121 (11.5)	1.33	1.10	1.62
Hispanic	114 (10.8)	1.71	1.40	2.09
Missing	3 (0.29)	1.16	0.37	3.69
Native American	4 (0.38)	0.79	0.29	2.13
Unknown	15 (1.43)	1.22	0.73	2.06
Clinic				
Mt. Sinai (NYC)	302 (28.7)	1.00	-	-
Albany	93 (8.84)	0.46	0.36	0.58
Buffalo	9 (0.86)	0.06	0.03	0.11
Long Island	116 (11.0)	0.53	0.43	0.66
Rochester	71 (6.75)	0.31	0.24	0.40
Syracuse	332 (31.6)	3.89	3.30	4.58
Cooperstown	52 (4.94)	0.18	0.14	0.25
Bellevue (NYC)	77 (7.32)	1.65	1.27	2.13

4.3 Univariate Regression Analyses of Industry and Asthma

An increased risk of an asthma diagnosis in 'combined industries' as compared to the construction industry was found in a univariate logistic regression model (OR=2.27, 95% CI = 1.81-2.85). Twelve industries each had elevated and statistically significant odds ratios as compared to the construction industry (Table 5). These estimates of risk ranged from approximately 6-fold in real estate (OR=6.32, 95% CI 3.08-12.98) to 2-fold in transportation and warehousing (OR=1.80, 95% CI 1.24-2.59).

Table 5: Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry

Industry	N =asthma (% asthma in industry)	OR	95% Confidence Limits	
Construction	89 (1.57)	1.00	-	-
Combined Industries (excluding Construction)	963 (3.48)	2.27*	1.81	2.85
Agriculture, Forestry, Fishing and Hunting	32 (3.50)	2.27*	1.50	3.44
Mining, Quarrying, and Oil and Gas Extraction	2 (2.25)	1.44	0.35	5.94
Utilities	41 (3.53)	2.29*	1.57	3.50
Manufacturing	196 (4.08)	2.66*	2.05	3.45
Wholesale Trade	10 (3.33)	2.16*	1.11	4.20
Retail Trade	36 (5.00)	3.29*	2.21	4.91
Transportation and Warehousing	45 (2.79)	1.80*	1.24	2.59
Information	1 (100.00)	NA	NA	NA
Finance and Insurance	29 (4.20)	2.74*	1.78	4.22
Real Estate and Rental and Leasing	9 (9.18)	6.32*	3.08	12.98
Professional, Scientific, and Technical Services	32 (5.25)	3.47*	2.28	5.27
Administrative and Support and Waste Management and Remediation Services	0 (0.00)	NA	NA	NA
Educational Services	154 (5.48)	3.63*	2.77	4.76
Health Care and Social Assistance	124 (3.52)	2.28*	1.72	3.02
Arts, Entertainment, and Recreation	4 (1.07)	0.68	0.25	1.86
Accommodation and Food Services	8 (2.88)	1.85	0.89	3.87
Other Services (except Public Administration)	130 (6.35)	4.24*	3.20	5.62
Public Administration	17 (1.53)	0.97	0.73	1.29

*$p<0.05$

4.4 Multivariate Regression Analyses of Industry and Asthma

Multivariate models are presented in Table 6. Model 1 examined the industry effect adjusting for age, gender and ethnicity. Combined industries were significantly associated asthma after adjusting for confounders (OR= 1.48, 95% CI 1.17-1.87). Ten of the 12 industries examined were significantly associated with asthma after adjusting for confounders. Elevated adjusted risks ranged from approximately 4-fold in real estate to 1.5-fold in education. No significant associations were found for the wholesale trade, transportation (model validity of questionable due to sparse data) and finance-insurance industries.

Model 2 adjusted for clinic location in addition to age, gender and ethnicity. Combined industries were significantly associated asthma after adjusting for confounders (OR= 1.64, 95% CI 1.28-2.08). Seven of the 12 industries examined were significantly associated with asthma after adjusting for confounders. Elevated risks ranged from approximately 2.5-fold in real estate to 2-fold in professional services In addition to insignificant industries identified in model 1, educational services, agriculture and utilities were now not significantly associated with asthma after adding clinic site to the model.

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry																
Model	Variable	Combined Industries (n=27,693)			Agriculture, Forestry, Fishing and Hunting (n=913)			Utilities (n=1,161)			Manufacturing (n=4,805)			Wholesale Trade (n=300)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	1.48	1.17	1.87	2.13	1.35	3.37	1.69	1.12	2.55	2.24	1.70	2.94	1.77	0.88	3.56
	Gender															
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.54	2.23	2.34	1.35	0.73	2.53	3.20	2.00	5.14	1.51	1.13	2.01	1.94	0.96	3.91
	Age															
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.80	1.59	1.58	1.82	1.24	2.67	1.48	1.02	2.13	2.10	1.63	2.72	1.75	1.15	2.66
	Ethnicity															
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.16	0.95	1.41	1.10	0.53	2.29	1.12	0.60	2.08	1.09	0.71	1.66	1.31	0.65	2.65
	Hispanic	1.73	1.41	2.11	0.91	0.48	1.73	1.82	0.98	3.37	1.59	1.06	2.38	2.61	1.45	4.72
	Other	0.73	0.53	1.03	0.33	0.05	2.38	1.27	0.46	3.51	0.41	0.18	0.94	0.69	0.17	2.83
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	1.64	1.29	2.08	0.73	0.37	1.45	1.48	0.94	2.31	2.02	1.49	2.75	1.38	0.65	2.89
	Gender															
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.27	1.99	2.59	1.15	0.61	2.17	2.26	1.36	3.76	1.39	1.03	1.88	1.77	0.87	3.63
	Age															
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.29	1.13	1.47	1.20	0.81	1.80	1.23	0.84	1.79	1.43	1.09	1.88	1.37	0.89	2.10
	Ethnicity															
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.09	0.88	1.34	1.13	0.53	2.43	1.20	0.63	2.27	1.10	0.71	1.70	1.37	0.66	2.85
	Hispanic	1.30	1.03	1.61	1.23	0.62	2.44	1.56	0.79	3.06	1.34	0.84	2.14	2.18	1.13	4.21
	Other	0.55	0.39	0.79	0.30	0.04	2.20	1.05	0.37	2.95	0.31	0.13	0.76	0.64	0.15	2.68
	Clinic															
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.52	0.40	0.66	0.11	0.04	0.38	0.23	0.10	0.56	0.39	0.23	0.69	0.18	0.06	0.52
	Buffalo	0.07	0.04	0.14	0.14	0.04	0.45	0.17	0.07	0.44	0.13	0.06	0.31	0.15	0.05	0.50
	Long Island	0.55	0.44	0.68	0.48	0.24	0.95	0.65	0.36	1.18	0.72	0.45	1.17	0.95	0.51	1.77
	Rochester	0.28	0.22	0.37	0.57	0.24	1.37	0.49	0.21	1.15	0.50	0.31	0.79	0.56	0.23	1.37
	Syracuse	3.56	2.98	4.25	3.35	1.84	6.10	4.49	2.74	7.36	3.71	2.56	5.37	3.95	2.15	7.27
	Cooperstown	0.18	1.13	0.24	4.96	2.32	10.62	1.62	0.65	4.03	0.29	0.15	0.56	1.90	0.62	5.84
	Bellevue	1.64	1.25	2.15	1.81	0.61	5.42	1.78	0.67	4.74	2.01	1.06	3.81	1.52	0.56	4.12

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry (continued 1)													
Model	Variable	Retail Trade (n=720)			Transportation and Warehousing* (n=1612)			Finance and Insurance (n=691)			Real Estate and Rental and Leasing (n=98)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.73	1.72	4.34	1.30	1.29	1.31	1.79	0.92	3.46	4.19	1.87	9.41
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	1.56	0.91	2.68	2.05	2.03	2.07	1.59	0.82	3.09	1.84	0.89	3.80
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.61	1.12	2.34	1.03	1.02	1.03	1.60	1.09	2.35	1.96	1.28	3.01
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.27	0.67	2.42	1.10	1.09	1.11	1.30	0.74	2.30	1.14	0.56	2.31
	Hispanic	2.78	1.62	4.76	2.49	2.46	2.52	1.55	0.83	2.89	2.45	1.33	4.52
	Other	1.42	0.61	3.31	0.89	0.87	0.91	0.45	0.11	1.83	0.76	0.18	3.14
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	3.19	1.89	5.40	1.53	1.52	1.54	2.44	1.25	4.78	3.56	1.54	8.26
	Gender												
	Male	1.00	-	-	1.00	-	-	-	-	-	1.00	-	-
	Female	1.32	0.75	2.32	2.00	1.98	2.02	1.63	0.84	3.16	1.80	0.86	3.77
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.21	0.83	1.78	1.08	1.08	1.08	1.32	0.89	1.96	1.55	1.00	2.41
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.31	0.67	2.54	1.26	1.25	1.27	1.52	0.84	2.75	1.22	0.58	2.53
	Hispanic	1.97	1.08	3.59	2.07	2.05	2.09	1.52	0.77	3.00	1.79	0.90	3.56
	Other	0.90	0.35	2.30	0.84	0.83	0.86	0.44	0.10	1.83	0.62	0.15	2.63
	Clinic												
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.29	0.13	0.62	0.47	0.46	0.48	0.15	0.07	0.32	0.18	0.06	0.52
	Buffalo	0.14	0.04	0.45	0.38	0.38	0.39	0.15	0.04	0.47	0.15	0.05	0.50
	Long Island	0.80	0.45	1.45	0.79	0.78	0.80	0.83	0.45	1.53	0.73	0.38	1.43
	Rochester	0.19	0.08	0.44	0.56	0.55	0.56	0.45	0.18	1.15	0.43	0.17	1.14
	Syracuse	2.45	1.39	4.33	7.32	7.27	7.38	4.01	2.36	6.81	3.78	2.06	6.92
	Cooperstown	2.83	0.96	8.33	0.63	0.62	0.65	2.89	0.98	8.48	3.94	1.45	10.75
	Bellevue	2.06	0.96	4.41	5.63	5.56	5.70	1.61	0.60	4.33	2.48	1.03	6.02

*Model fit questionable due to ridging

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry (continued 2)													
Model	Variable	Professional, Scientific, and Technical Services (n=609)			Educational Services (n=2,808)			Health Care and Social Assistance (n=3525)			Other Services (except Public Administration) (n=2,048)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.64	1.67	4.19	1.44	1.03	2.01	1.88	1.24	2.85	3.11	2.23	4.33
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.36	1.39	4.01	5.87	4.29	8.05	1.21	0.80	1.81	1.78	1.27	2.49
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.64	1.13	2.40	1.47	1.10	1.96	1.88	1.41	2.50	1.47	1.11	1.94
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.12	0.60	2.08	0.96	0.59	1.56	1.34	0.90	1.98	1.17	0.73	1.87
	Hispanic	2.19	1.24	3.85	1.38	0.89	2.13	2.61	1.73	3.92	2.13	1.45	3.14
	Other	0.58	0.18	1.86	0.24	0.06	0.97	0.73	0.36	1.52	0.38	0.15	0.95
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.00	1.24	3.22	1.21	0.85	1.72	2.50	1.62	3.85	2.17	1.53	3.08
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.10	1.22	3.61	5.21	3.72	7.31	1.27	0.84	1.92	1.56	1.10	2.22
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.35	0.92	1.99	1.29	0.96	1.73	1.25	0.93	1.68	1.31	0.98	1.76
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.16	0.61	2.19	1.07	0.64	1.78	0.95	0.62	1.47	1.33	0.81	2.18
	Hispanic	1.75	0.95	3.24	1.49	0.93	2.37	1.42	0.89	2.26	2.30	1.46	3.60
	Other	0.53	0.16	1.72	0.26	0.06	1.05	0.56	0.26	1.18	0.38	0.15	0.99
	Clinic												
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.13	0.04	0.41	0.84	0.52	1.36	0.21	0.10	0.43	0.36	0.17	0.73
	Buffalo	0.15	0.05	0.50	0.16	0.05	0.51	0.12	0.04	0.38	0.16	0.05	0.53
	Long Island	0.76	0.43	1.36	0.91	0.60	1.39	0.72	0.46	1.12	0.90	0.54	1.51
	Rochester	0.63	0.28	1.41	0.50	0.27	0.94	0.14	0.08	0.27	0.55	0.31	0.99
	Syracuse	4.26	2.50	7.28	3.98	2.70	5.86	3.63	2.41	5.45	5.83	3.99	8.51
	Cooperstown	1.76	0.60	5.12	0.88	0.39	1.98	0.08	0.03	0.21	0.91	0.40	2.07
	Bellevue	2.35	1.05	5.27	1.13	0.50	2.52	2.19	1.21	3.98	1.51	0.86	2.65

4.5 Asthma Diagnosis and Quality of Life

The most frequently reported yes response to a negative impact on QOL for patients with an asthma diagnosis was on the ability to participate in recreational activity (n=206) followed by the ability to perform task around the house (n=194) and to provide care for family or children (n=74). Patients indicated there was no affect on the ability to perform tasks based on an asthma diagnosis was reported by 626 patients. As shown in Table 7, statistically significant association was reported for each QOL impact and an asthma diagnosis.

Table 7 : Quality of Life Impact by Patients with an Asthma Diagnosis (n=1,052) or Medical Screening (n=17,360)

Quality of Life Impact	Screening N (%) = Yes Response*	Asthma N (%) = Yes Response*	χ^2 (p-value)
Has injury or illness affected patient's ability to perform/provide tasks around the house?	84 (0.44)	194 (1.05)	2178.11 (p<0.0001)
Has injury or illness affected patient's ability to provide care for family/children?	34 (0.18)	74 (0.40)	795.43 (p<0.0001)
Has injury or illness affected patient's ability to perform recreational activities?	108 (0.59)	206 (1.12)	2126.99 (p<0.0001)
Has injury or illness had no affect on the patient's ability to perform/provide tasks?	15,699 (85.27)	626 (3.40)	943.95 (p<0.0001)

*percentage reported yes response out of total asthma and medical screening patients (n=18,412)

As shown in Table 8, an asthma patient had an elevated odds of reporting of an adverse affect on the ability to perform tasks around the house as compared to medical screening patients (OR= 37.84, 95% CI 28.40-50.42) after adjusting for age, gender and ethnicity. An asthma patient also had an elevated odds of reporting of an adverse affect on the ability provide care for family and/or children and a reduced ability perform recreational activities as compared to medical screening patients. Older age was a significant predictor of reduced QOL in all of these analyses. Conversely, there were

decreased odds of an asthma diagnosis having no effect on the ability to perform tasks around the house (OR= 0.23, 95% CI 0.20-0.27).

Table 8: Adjusted Odds Ratio of a Quality of Life Impact by Asthma Diagnosis as Compared to Medical Screening Visit (n=18,412)

Variable	Has injury or illness affected patient's ability to perform/provide tasks around the house?			Has injury or illness affected the patient's ability to provide care for family/children?			Has injury or illness affected patient's ability to perform recreational activities?			Has injury or illness had no affect on the patient's ability to perform/provide tasks?		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Medical Screening	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Asthma Diagnosis	37.84	28.40	50.42	30.77	19.80	47.83	33.02	25.44	42.87	0.23	0.20	0.27
Gender												
Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Female	1.20	0.91	1.57	1.17	0.78	1.77	1.06	0.82	1.37	0.37	0.34	0.41
Age												
≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
>43.6 years	3.01	2.22	4.08	2.37	1.50	3.73	2.75	2.08	3.63	0.56	0.51	0.62
Ethnicity												
White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Black	1.23	0.80	1.88	1.51	0.83	2.74	1.24	0.83	1.85	0.49	0.41	0.58
Hispanic	1.48	0.98	2.24	1.22	0.63	2.35	0.95	0.61	1.47	0.60	0.51	0.72
Other	0.75	0.35	1.57	1.27	0.50	3.21	1.47	0.86	2.51	0.65	0.54	0.79

CHAPTER 5

DISCUSSION

In this study, we found the risk of asthma was significantly greater after adjusting for age, gender, ethnicity and clinic in real estate, retail trade, health care, finance-insurance, other services, manufacturing, professional services and combined industries. The real estate industry had the highest estimated risk followed by retail trade and health care. In addition, a statistically significant elevated risk among asthma patients of greater than 30 was estimated for each negative quality of life (QOL) indicator. Negative QOL indicators were measured by a yes response to a patient's affected ability to perform tasks around the house, provide care for family or children, and participate in recreational activities.

According to Calderia et al (2006), certain occupational groups are known to be at risk of asthma including loggers, chemical industrial workers, bakers, textile workers, animal handlers, woodworkers, and others. Other studies have examined asthma in the health care industry (Delclos et al 2007 and 2009). While these industries were represented within the current study, the outcome measure of the current study reported industry distributions differently. Further, the current study used a large population of traditionally white collar industries that were not represented in the Calderia study. As a result, comparisons to previous results are not straightforward.

Fletcher et al (2006) examined the prevalence of work-related asthma in New York State across industries and found the greatest prevalence of asthma in services and manufacturing, which was consistent with the current study.

Both the current study and McHugh et al (2009) selected the construction industry as a comparison group due to a relatively low prevalence of asthma in that industry, despite the large number of workers in that sector. In the current study, construction workers represented the second largest industry population in the OHCN data with 15.8% (n=5,209) and only had 1.57% (n=82) reported asthma cases within industry. A comparison with the reported odds ratios by McHugh and colleagues and the current study is difficult based on the dissimilar methodology of establishing industry groupings.

In the industry effect models, confounders examined included age, gender and ethnicity. Patients at or above the mean population age generally had an increased risk for asthma as compared to younger workers. This may be serving somewhat as a surrogate for cumulative exposure, perhaps accounting for a chronic sensitization to asthmagens. Unlike in the general population, female patients had an increased risk in most industry models. This may be related to the division of roles between male and female workers in particular industries. Females in this population may also have been more likely to seek care for asthma symptoms than males.

Non-Whites, specifically Hispanics, had a higher risk of asthma diagnosis than Whites in most industry models. Ethnicity in the current study may be indicative of socioeconomic disparities between Whites and non-Whites. Henneberger et al (2006) postulated that a segment of unrepresented workers were working in some of the dirtiest jobs in the country. As postulated by Henneberger, ethnic minorities in NYS may be working in some of these "dirty" jobs. The differences in risk by ethnicity may also be related to the division of labor within some industries. For example, ethnic distributions may be skewed in agricultural migrant workers or among non-skilled laborers in other

blue collar trades. Both of these examples represent workers exposed to higher levels of dust, pesticides and other asthmagens.

The differences between the clinics are possibly an artifact of the Occupational Health Clinic Network (OHCN) outreach focus. Each clinic follows different outreach strategies to attract patients based upon physicians specialties and other factors. Differences may also be influenced by types of industry in the area or environmental factors driven by population density (e.g., industrial pollution, density of automobiles). Fletcher et al (2006) maintained that numerous factors influence clinic utilization including the OHCN's focus on high-risk industries and more frequent use of the clinics among certain unions and industries. This may serve to introduce a patient self-selection bias. Other considerations that may contribute to the clinic effect may be the density of industries within a clinics service area. For example, rural clinics may have a higher proportion of workers in the agriculture industry. Another possibility may be that workers in utilities represent a higher proportion of patient population in areas around water bodies that are used for cooling systems at power generation facilities (e.g., Syracuse's proximity to the Finger Lakes). Each of these examples may serve to represent unadjusted environmental pollution that may be associated with asthma. Environmental pollution may serve to confound the industry effects based on clinic location. Further understanding of the clinic effect is worthy of consideration, and is beyond the scope of the current study.

Sauni et al (2001) examined the prevalence of negative QOL impacts by chronic asthma diagnosis to evaluate effects on familial duties and recreation. Both the Sauni and current studies used a dichotomized yes or no response to measure negative impacts to

QOL. Sauni reported a high prevalence of negative QOL impacts by chronic asthma diagnosis. The current study expanded on this approach to include an estimation of QOL impact risk by asthma diagnosis using odds ratios as determined by multivariate logistic regression models.

A major strength of this study is the large number of patients. Other strengths include the relatively large sample sizes available within each industry of interest. One type of selection bias, the healthy worker effect (also known as survivor bias), may be present. Gautrin et al (2003) indicated survivor bias was the most important bias affecting prevalence estimates in cross-sectional surveys of work-related asthma, due to the possible exclusion of workers who left the workplace before studies were conducted. An analysis of current employment status was not included in the current study design. This concern is somewhat negated since the OHCN treats patients regardless of employment status. Other possible contributing factors to the healthy worker effect may be related to the selection of construction workers as the comparison group. As a predominately male field with a skill set that does not easily translate to other industries, construction workers may be more inclined to remain in the construction industry regardless of asthma diagnosis. We postulate that construction workers may also be less likely to report asthma symptoms when compared to traditionally white collar trades. If this assumption is true, white collar industry effects (i.e., finance, insurance, professional services, educational services, health care) may be over-estimated. Information bias may be present in the diagnosis of asthma. The literature indicates that estimates of the proportion of asthma that is attributable to work vary widely (Calderia et al 2006). Tice et al (2010) estimated that between 10.6 and 44.5% of asthma in New York State

was work-related. This wide variation was attributed to inconsistencies in case definitions. Absent independent verification of work-relatedness by medical chart comparison, the current study utilized any diagnosis of asthma reported within the OHCN's population. Diagnostic specificity could be improved by using the OHCN's work-relatedness determination of asthma. Fletcher et al (2006) reported that 92% of cases diagnosed as work-related by the OHCN physicians met the NIOSH case definition.

Misclassification may be present in the assignment of exposure by industry. For example, a past industry may have triggered the initial onset of asthma. Since current industry was used as a surrogate for exposure, the true exposure industry may have been misclassified as current when the triggering event may have occurred at a past employment. Past industry was missing from most observations which prevented these potential covariates from being evaluated. Duration of employment was also unavailable in the current data set and was not evaluated as a possible risk factor. Further, since work-relatedness was not incorporated in the design and since the OHCN is open to all NYS workers regardless of employment status, exposure to asthmagens outside of the working environment may also contribute to asthma cases.

In addition to the covariates evaluated in the current study (i.e., age, gender, ethnicity and clinic), Lowery et al (2007) identified lower educational levels as a risk factor for asthma and for reduced quality of life. Calderia et al (2006) associated both education and socioeconomic as risk factors in a study completed in Brazil. The study related asthma to low education levels and postulated education level as a surrogate for socioeconomic status. These two studies both point to further limitations with the current

study design as education and socioeconomic status were not examined. In addition, smoking status, a known risk factor for asthma, was not included in the analysis based on the frequency of missing data.

Future studies may benefit from including individuals' level exposure estimates within industry groups. While individual exposure level analysis was not conducted in this study due to lack of physical measurement of, further examination of exposures by including industrial hygiene modeling within particular industries warrants review.

The longitudinal nature of the OHCN data may allow for an examination of incident asthma cases in a case-control design. However, cases would need rigorous verification of new onset asthma through a review of medical charts. Another avenue of future research would be to track changes in QOL through multiple visits to determine efficacy of treatment. The benefit of utilizing these data for a case-control or cohort study design may provide an opportunity to contribute to the understanding of causality for work exacerbated and new onset cases of work-related asthma as well the efficacy of treatment at improving quality of life.

CHAPTER 6

CONCLUSION

Asthma with an occupational etiology contributes to a largely unrecognized burden of preventable disease and disability. In a population of workers seen by the New York State Department of Health Occupational Health Clinic Network, the highest estimated risk was in real estate followed by retail trade and health care. After adjusting for age, gender and ethnicity, a statistically significant elevated risk of greater than 30 was estimated for a patient's ability to perform task around the house, provide care for family or children and participate in recreational activity. The current study supported and expanded on previous work indicating that certain industries are associated with an increased risk of risk of asthma and that asthma negatively impacts quality of life. Prevention efforts should focus on industries most consistently associated with asthma in the literature. A case-control or cohort design in future studies - with additional risk factors including education, socioeconomic status and duration of employment by industry would contribute to the understanding of risk and causality.

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APPENDIX A

FIGURES AND TABLES

Figure 1: Selection Schematic of the Cross-sectional Cohort

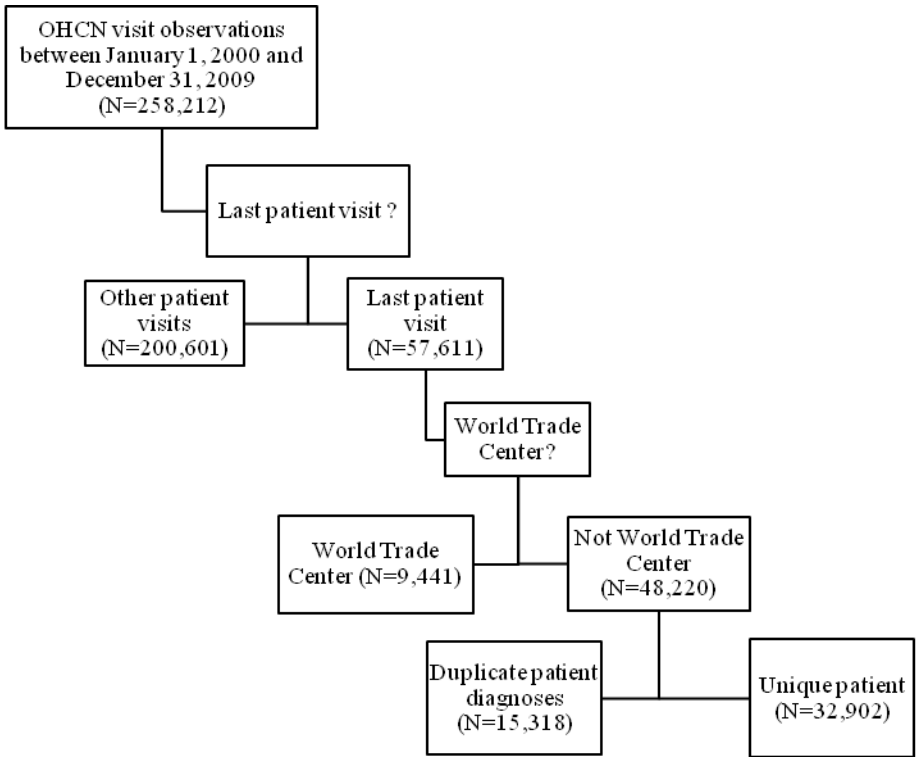

Table 1: Occupational Health Clinic Patients (n=32,902) by Ethnicity				
Ethnicity	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Asian	810	2.46	18	2.22
Black	3074	9.34	121	3.94
Hispanic	2285	6.94	114	4.99
Missing	87	0.26	3	3.45
Native American	169	0.51	4	2.37
Unknown	414	1.26	15	3.62
White	26063	79.21	777	2.98

Table 2: Occupational Health Clinic Patients (n=32,902) by Clinic Location				
Clinic Location	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Albany	4283	13.02	93	2.17
Buffalo	3423	10.40	9	0.26
Long Island	4645	14.12	116	2.50
Mt. Sinai (NYC)	6576	19.99	302	4.59
Rochester	4864	14.78	71	1.46
Syracuse	2106	6.40	332	15.76
Cooperstown	5956	18.10	52	0.87
Bellevue (NYC)	1049	3.19	77	7.34

Table 3: Occupational Health Clinic Patients (n=32,902) by Industry and with Asthma Diagnosis				
NAICS Economic Sector	All patients (n)	% All Patients	Asthma patients (n)	% Asthma Patients
Agriculture, Forestry, Fishing and Hunting	913	2.77	32	3.50
Mining, Quarrying, and Oil and Gas Extraction	89	0.27	2	2.25
Utilities	1161	3.53	41	3.53
Construction	5209	15.83	82	1.57
Manufacturing	4805	14.60	196	4.08
Wholesale Trade	300	0.91	10	3.33
Retail Trade	720	2.19	36	5.00
Transportation and Warehousing	1612	4.90	45	2.79
Information	1	0.00	1	100.00
Finance and Insurance	691	2.10	29	4.20
Real Estate and Rental and Leasing	98	0.30	9	9.18
Professional, Scientific, and Technical Services	609	1.85	32	5.25
Administrative and Support and Waste Management and Remediation Services	1	0.00	0	0.00
Educational Services	2808	8.53	154	5.48
Health Care and Social Assistance	3525	10.71	124	3.52
Arts, Entertainment, and Recreation	373	1.13	4	1.07
Accommodation and Food Services	278	0.84	8	2.88
Other Services (except Public Administration)	2048	6.22	130	6.35
Public Administration	7661	23.28	117	1.53
Total	32,902	100.00	1052	3.20

Table 4: Odds Ratios of an Asthma Diagnosis by Selected Covariates (n = 1,052)				
Covariate	N (% asthma in group)	OR	95% Confidence Interval	
Age				
<43.6 years	368 (35.0)	1.00	-	-
≥43.6 years	684 (65.0)	1.84	1.62	2.09
Gender				
Male	569 (54.1)	1.00	-	-
Female	480 (45.6)	2.73	2.41	3.09
Ethnicity				
White	777 (73.9)	1.00	-	-
Asian	18 (1.71)	0.74	0.46	1.19
Black	121 (11.5)	1.33	1.10	1.62
Hispanic	114 (10.8)	1.71	1.40	2.09
Missing	3 (0.29)	1.16	0.37	3.69
Native American	4 (0.38)	0.79	0.29	2.13
Unknown	15 (1.43)	1.22	0.73	2.06
Clinic				
Mt. Sinai (NYC)	302 (28.7)	1.00	-	-
Albany	93 (8.84)	0.46	0.36	0.58
Buffalo	9 (0.86)	0.06	0.03	0.11
Long Island	116 (11.0)	0.53	0.43	0.66
Rochester	71 (6.75)	0.31	0.24	0.40
Syracuse	332 (31.6)	3.89	3.30	4.58
Cooperstown	52 (4.94)	0.18	0.14	0.25
Bellevue (NYC)	77 (7.32)	1.65	1.27	2.13

Table 5: Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry				
Industry	N =asthma (% asthma in industry)	OR	95% Confidence Limits	
Construction	89 (1.57)	1.00	-	-
Combined Industries (excluding Construction)	963 (3.48)	2.27*	1.81	2.85
Agriculture, Forestry, Fishing and Hunting	32 (3.50)	2.27*	1.50	3.44
Mining, Quarrying, and Oil and Gas Extraction	2 (2.25)	1.44	0.35	5.94
Utilities	41 (3.53)	2.29*	1.57	3.50
Manufacturing	196 (4.08)	2.66*	2.05	3.45
Wholesale Trade	10 (3.33)	2.16*	1.11	4.20
Retail Trade	36 (5.00)	3.29*	2.21	4.91
Transportation and Warehousing	45 (2.79)	1.80*	1.24	2.59
Information	1 (100.00)	NA	NA	NA
Finance and Insurance	29 (4.20)	2.74*	1.78	4.22
Real Estate and Rental and Leasing	9 (9.18)	6.32*	3.08	12.98
Professional, Scientific, and Technical Services	32 (5.25)	3.47*	2.28	5.27
Administrative and Support and Waste Management and Remediation Services	0 (0.00)	NA	NA	NA
Educational Services	154 (5.48)	3.63*	2.77	4.76
Health Care and Social Assistance	124 (3.52)	2.28*	1.72	3.02
Arts, Entertainment, and Recreation	4 (1.07)	0.68	0.25	1.86
Accommodation and Food Services	8 (2.88)	1.85	0.89	3.87
Other Services (except Public Administration)	130 (6.35)	4.24*	3.20	5.62
Public Administration	17 (1.53)	0.97	0.73	1.29

*$p<0.05$

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry																
Model	Variable	Combined Industries (n=27,693)			Agriculture, Forestry, Fishing and Hunting (n=913)			Utilities (n=1,161)			Manufacturing (n=4,805)			Wholesale Trade (n=300)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	1.48	1.17	1.87	2.13	1.35	3.37	1.69	1.12	2.55	2.24	1.70	2.94	1.77	0.88	3.56
	Gender															
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.54	2.23	2.34	1.35	0.73	2.53	3.20	2.00	5.14	1.51	1.13	2.01	1.94	0.96	3.91
	Age															
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.80	1.59	1.58	1.82	1.24	2.67	1.48	1.02	2.13	2.10	1.63	2.72	1.75	1.15	2.66
	Ethnicity															
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.16	0.95	1.41	1.10	0.53	2.29	1.12	0.60	2.08	1.09	0.71	1.66	1.31	0.65	2.65
	Hispanic	1.73	1.41	2.11	0.91	0.48	1.73	1.82	0.98	3.37	1.59	1.06	2.38	2.61	1.45	4.72
	Other	0.73	0.53	1.03	0.33	0.05	2.38	1.27	0.46	3.51	0.41	0.18	0.94	0.69	0.17	2.83
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	1.64	1.29	2.08	0.73	0.37	1.45	1.48	0.94	2.31	2.02	1.49	2.75	1.38	0.65	2.89
	Gender															
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.27	1.99	2.59	1.15	0.61	2.17	2.26	1.36	3.76	1.39	1.03	1.88	1.77	0.87	3.63
	Age															
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.29	1.13	1.47	1.20	0.81	1.80	1.23	0.84	1.79	1.43	1.09	1.88	1.37	0.89	2.10
	Ethnicity															
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.09	0.88	1.34	1.13	0.53	2.43	1.20	0.63	2.27	1.10	0.71	1.70	1.37	0.66	2.85
	Hispanic	1.30	1.03	1.61	1.23	0.62	2.44	1.56	0.79	3.06	1.34	0.84	2.14	2.18	1.13	4.21
	Other	0.55	0.39	0.79	0.30	0.04	2.20	1.05	0.37	2.95	0.31	0.13	0.76	0.64	0.15	2.68
	Clinic															
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.52	0.40	0.66	0.11	0.04	0.38	0.23	0.10	0.56	0.39	0.23	0.69	0.18	0.06	0.52
	Buffalo	0.07	0.04	0.14	0.14	0.04	0.45	0.17	0.07	0.44	0.13	0.06	0.31	0.15	0.05	0.50
	Long Island	0.55	0.44	0.68	0.48	0.24	0.95	0.65	0.36	1.18	0.72	0.45	1.17	0.95	0.51	1.77
	Rochester	0.28	0.22	0.37	0.57	0.24	1.37	0.49	0.21	1.15	0.50	0.31	0.79	0.56	0.23	1.37
	Syracuse	3.56	2.98	4.25	3.35	1.84	6.10	4.49	2.74	7.36	3.71	2.56	5.37	3.95	2.15	7.27
	Cooperstown	0.18	1.13	0.24	4.96	2.32	10.62	1.62	0.65	4.03	0.29	0.15	0.56	1.90	0.62	5.84
	Bellevue	1.64	1.25	2.15	1.81	0.61	5.42	1.78	0.67	4.74	2.01	1.06	3.81	1.52	0.56	4.12

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry (continued 1)													
Model	Variable	Retail Trade (n=720)			Transportation and Warehousing* (n=1612)			Finance and Insurance (n=691)			Real Estate and Rental and Leasing (n=98)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.73	1.72	4.34	1.30	1.29	1.31	1.79	0.92	3.46	4.19	1.87	9.41
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	1.56	0.91	2.68	2.05	2.03	2.07	1.59	0.82	3.09	1.84	0.89	3.80
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.61	1.12	2.34	1.03	1.02	1.03	1.60	1.09	2.35	1.96	1.28	3.01
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.27	0.67	2.42	1.10	1.09	1.11	1.30	0.74	2.30	1.14	0.56	2.31
	Hispanic	2.78	1.62	4.76	2.49	2.46	2.52	1.55	0.83	2.89	2.45	1.33	4.52
	Other	1.42	0.61	3.31	0.89	0.87	0.91	0.45	0.11	1.83	0.76	0.18	3.14
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	3.19	1.89	5.40	1.53	1.52	1.54	2.44	1.25	4.78	3.56	1.54	8.26
	Gender												
	Male	1.00	-	-	1.00	-	-	-	-	-	1.00	-	-
	Female	1.32	0.75	2.32	2.00	1.98	2.02	1.63	0.84	3.16	1.80	0.86	3.77
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.21	0.83	1.78	1.08	1.08	1.08	1.32	0.89	1.96	1.55	1.00	2.41
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.31	0.67	2.54	1.26	1.25	1.27	1.52	0.84	2.75	1.22	0.58	2.53
	Hispanic	1.97	1.08	3.59	2.07	2.05	2.09	1.52	0.77	3.00	1.79	0.90	3.56
	Other	0.90	0.35	2.30	0.84	0.83	0.86	0.44	0.10	1.83	0.62	0.15	2.63
	Clinic												
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.29	0.13	0.62	0.47	0.46	0.48	0.15	0.07	0.32	0.18	0.06	0.52
	Buffalo	0.14	0.04	0.45	0.38	0.38	0.39	0.15	0.04	0.47	0.15	0.05	0.50
	Long Island	0.80	0.45	1.45	0.79	0.78	0.80	0.83	0.45	1.53	0.73	0.38	1.43
	Rochester	0.19	0.08	0.44	0.56	0.55	0.56	0.45	0.18	1.15	0.43	0.17	1.14
	Syracuse	2.45	1.39	4.33	7.32	7.27	7.38	4.01	2.36	6.81	3.78	2.06	6.92
	Cooperstown	2.83	0.96	8.33	0.63	0.62	0.65	2.89	0.98	8.48	3.94	1.45	10.75
	Bellevue	2.06	0.96	4.41	5.63	5.56	5.70	1.61	0.60	4.33	2.48	1.03	6.02

*Model fit questionable due to ridging

Table 6: Adjusted Odds Ratios (95% CI) of Asthma Diagnosis by Industry as compared to the Construction Industry (continued 2)													
Model	Variable	Professional, Scientific, and Technical Services (n=609)			Educational Services (n=2,808)			Health Care and Social Assistance (n=3525)			Other Services (except Public Administration) (n=2,048)		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Model 1	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.64	1.67	4.19	1.44	1.03	2.01	1.88	1.24	2.85	3.11	2.23	4.33
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.36	1.39	4.01	5.87	4.29	8.05	1.21	0.80	1.81	1.78	1.27	2.49
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.64	1.13	2.40	1.47	1.10	1.96	1.88	1.41	2.50	1.47	1.11	1.94
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.12	0.60	2.08	0.96	0.59	1.56	1.34	0.90	1.98	1.17	0.73	1.87
	Hispanic	2.19	1.24	3.85	1.38	0.89	2.13	2.61	1.73	3.92	2.13	1.45	3.14
	Other	0.58	0.18	1.86	0.24	0.06	0.97	0.73	0.36	1.52	0.38	0.15	0.95
Model 2	Construction	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Industry Effect	2.00	1.24	3.22	1.21	0.85	1.72	2.50	1.62	3.85	2.17	1.53	3.08
	Gender												
	Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Female	2.10	1.22	3.61	5.21	3.72	7.31	1.27	0.84	1.92	1.56	1.10	2.22
	Age												
	≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	>43.6 years	1.35	0.92	1.99	1.29	0.96	1.73	1.25	0.93	1.68	1.31	0.98	1.76
	Ethnicity												
	White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Black	1.16	0.61	2.19	1.07	0.64	1.78	0.95	0.62	1.47	1.33	0.81	2.18
	Hispanic	1.75	0.95	3.24	1.49	0.93	2.37	1.42	0.89	2.26	2.30	1.46	3.60
	Other	0.53	0.16	1.72	0.26	0.06	1.05	0.56	0.26	1.18	0.38	0.15	0.99
	Clinic												
	Mt Sinai	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
	Albany	0.13	0.04	0.41	0.84	0.52	1.36	0.21	0.10	0.43	0.36	0.17	0.73
	Buffalo	0.15	0.05	0.50	0.16	0.05	0.51	0.12	0.04	0.38	0.16	0.05	0.53
	Long Island	0.76	0.43	1.36	0.91	0.60	1.39	0.72	0.46	1.12	0.90	0.54	1.51
	Rochester	0.63	0.28	1.41	0.50	0.27	0.94	0.14	0.08	0.27	0.55	0.31	0.99
	Syracuse	4.26	2.50	7.28	3.98	2.70	5.86	3.63	2.41	5.45	5.83	3.99	8.51
	Cooperstown	1.76	0.60	5.12	0.88	0.39	1.98	0.08	0.03	0.21	0.91	0.40	2.07
	Bellevue	2.35	1.05	5.27	1.13	0.50	2.52	2.19	1.21	3.98	1.51	0.86	2.65

Table 7 : Quality of Life Impact by Patients with an Asthma Diagnosis (n=1,052) or Medical Screening (n=17,360)			
Quality of Life Impact	Screening N (%) = Yes Response*	Asthma N (%) = Yes Response*	χ^2 (p-value)
Has injury or illness affected patient's ability to perform/provide tasks around the house?	84 (0.44)	194 (1.05)	2178.11 (p<0.0001)
Has injury or illness affected patient's ability to provide care for family/children?	34 (0.18)	74 (0.40)	795.43 (p<0.0001)
Has injury or illness affected patient's ability to perform recreational activities?	108 (0.59)	206 (1.12)	2126.99 (p<0.0001)
Has injury or illness had no affect on the patient's ability to perform/provide tasks?	15,699 (85.27)	626 (3.40)	943.95 (p<0.0001)

*percentage reported yes response out of total asthma and medical screening patients (n=18,412)

Table 8: Adjusted Odds Ratio of a Quality of Life Impact by Asthma Diagnosis as Compared to Medical Screening Visit (n=18,412)												
Variable	Has injury or illness affected patient's ability to perform/provide tasks around the house?			Has injury or illness affected the patient's ability to provide care for family/children?			Has injury or illness affected patient's ability to perform recreational activities?			Has injury or illness had no affect on the patient's ability to perform/provide tasks?		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Medical Screening	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Asthma Diagnosis	37.84	28.40	50.42	30.77	19.80	47.83	33.02	25.44	42.87	0.23	0.20	0.27
Gender												
Male	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Female	1.20	0.91	1.57	1.17	0.78	1.77	1.06	0.82	1.37	0.37	0.34	0.41
Age												
≤43.6 years	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
>43.6 years	3.01	2.22	4.08	2.37	1.50	3.73	2.75	2.08	3.63	0.56	0.51	0.62
Ethnicity												
White	1.00	-	-	1.00	-	-	1.00	-	-	1.00	-	-
Black	1.23	0.80	1.88	1.51	0.83	2.74	1.24	0.83	1.85	0.49	0.41	0.58
Hispanic	1.48	0.98	2.24	1.22	0.63	2.35	0.95	0.61	1.47	0.60	0.51	0.72
Other	0.75	0.35	1.57	1.27	0.50	3.21	1.47	0.86	2.51	0.65	0.54	0.79

APPENDIX B

NAICS MAJOR ECONOMIC SECTORS

Agriculture, Forestry, Fishing and Hunting	NAICS 2-digit code 11 SIC 2-digit codes 01, 02, 07, 08, 09

Summary:

The Agriculture, Forestry, Fishing and Hunting sector comprises establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.

The establishments in this sector are often described as farms, ranches, dairies, greenhouses, nurseries, orchards, or hatcheries. A farm may consist of a single tract of land or a number of separate tracts which may be held under different tenures. For example, one tract may be owned by the farm operator and another rented. It may be operated by the operator alone or with the assistance of members of the household or hired employees, or it may be operated by a partnership, corporation, or other type of organization. When a landowner has one or more tenants, renters, croppers, or managers, the land operated by each is considered a farm.

The sector distinguishes two basic activities: agricultural production and agricultural support activities. Agricultural production includes establishments performing the complete farm or ranch operation, such as farm owner-operators, tenant farm operators, and sharecroppers. Agricultural support activities include establishments that perform one or more activities associated with farm operation, such as soil preparation, planting, harvesting, and management, on a contract or fee basis.

Excluded from the Agriculture, Forestry, Hunting and Fishing sector are establishments primarily engaged in agricultural research and establishments primarily engaged in administering programs for regulating and conserving land, mineral, wildlife, and forest use. These establishments are classified in Industry 54171, Research and Development in the Physical, Engineering, and Life Sciences; and Industry 92412, Administration of Conservation Programs, respectively.

Mining	NAICS 2-digit code 21 SIC 2-digit codes 10, 12-14

Summary:

The Mining sector comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well

operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity.

The Mining sector distinguishes two basic activities: mine operation and mining support activities. Mine operation includes establishments operating mines, quarries, or oil and gas wells on their own account or for others on a contract or fee basis. Mining support activities include establishments that perform exploration (except geophysical surveying) and/or other mining services on a contract or fee basis (except mine site preparation and construction of oil/gas pipelines).

Establishments in the Mining sector are grouped and classified according to the natural resource mined or to be mined. Industries include establishments that develop the mine site, extract the natural resources, and/or those that beneficiate (i.e., prepare) the mineral mined. Beneficiation is the process whereby the extracted material is reduced to particles that can be separated into mineral and waste, the former suitable for further processing or direct use. The operations that take place in beneficiation are primarily mechanical, such as grinding, washing, magnetic separation, and centrifugal separation. In contrast, manufacturing operations primarily use chemical and electrochemical processes, such as electrolysis and distillation. However, some treatments, such as heat treatments, take place in both the beneficiation and the manufacturing (i.e., smelting/refining) stages. The range of preparation activities varies by mineral and the purity of any given ore deposit. While some minerals, such as petroleum and natural gas, require little or no preparation, others are washed and screened, while yet others, such as gold and silver, can be transformed into bullion before leaving the mine site.

Mining, beneficiating, and manufacturing activities often occur in a single location. Separate receipts will be collected for these activities whenever possible. When receipts cannot be broken out between mining and manufacturing, establishments that mine or quarry nonmetallic minerals, beneficiate the nonmetallic minerals into more finished manufactured products are classified based on the primary activity of the establishment. A mine that manufactures a small amount of finished products will be classified in Sector 21, Mining. An establishment that mines whose primary output is a more finished manufactured product will be classified in Sector 31-33, Manufacturing.

Utilities	NAICS 2-digit code 22 SIC 2-digit codes 46, 48, 49

Summary:

The Utilities sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal. Within this sector, the specific activities associated with the utility services provided vary by utility: electric power includes generation, transmission, and distribution; natural gas includes distribution; steam supply includes provision and/or distribution; water supply includes treatment and distribution; and sewage removal

includes collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities.

Excluded from this sector are establishments primarily engaged in waste management services classified in Subsector 562, Waste Management and Remediation Services. These establishments also collect, treat, and dispose of waste materials; however, they do not use sewer systems or sewage treatment facilities.

Construction	NAICS 2-digit code 23 SIC 2-digit codes 15-17

Summary:

The construction sector comprises establishments primarily engaged in the construction of buildings or engineering projects (e.g., highways and utility systems). Establishments primarily engaged in the preparation of sites for new construction and establishments primarily engaged in subdividing land for sale as building sites also are included in this sector.

Construction work done may include new work, additions, alterations, or maintenance and repairs. Activities of these establishments generally are managed at a fixed place of business, but they usually perform construction activities at multiple project sites. Production responsibilities for establishments in this sector are usually specified in (1) contracts with the owners of construction projects (prime contracts) or (2) contracts with other construction establishments (subcontracts).

Establishments primarily engaged in contracts that include responsibility for all aspects of individual construction projects are commonly known as general contractors, but also may be known as design-builders, construction managers, turnkey contractors, or (in cases where two or more establishments jointly secure a general contract) joint-venture contractors. Construction managers that provide oversight and scheduling only (i.e., agency) as well as construction managers that are responsible for the entire project (i.e., at risk) are included as general contractor type establishments. Establishments of the "general contractor type" frequently arrange construction of separate parts of their projects through subcontracts with other construction establishments.

Establishments primarily engaged in activities to produce a specific component (e.g., masonry, painting, and electrical work) of a construction project are commonly known as specialty trade contractors. Activities of specialty trade contractors are usually subcontracted from other construction establishments but, especially in remodeling and repair construction, the work may be done directly for the owner of the property.

Establishments primarily engaged in activities to construct buildings to be sold on sites that they own are known as operative builders, but also may be known as speculative builders or merchant builders. Operative builders produce buildings in a manner similar to general contractors, but their production processes also include site acquisition and

securing of financial backing. Operative builders are most often associated with the construction of residential buildings. Like general contractors, they may subcontract all or part of the actual construction work on their buildings.

There are substantial differences in the types of equipment, work force skills, and other inputs required by establishments in this sector. To highlight these differences and variations in the underlying production functions, this sector is divided into three subsectors.

Subsector 236, Construction of Buildings, comprises establishments of the general contractor type and operative builders involved in the construction of buildings. Subsector 237, Heavy and Civil Engineering Construction, comprises establishments involved in the construction of engineering projects. Subsector 238, Specialty Trade Contractors, comprises establishments engaged in specialty trade activities generally needed in the construction of all types of buildings.

Force account construction is construction work performed by an enterprise primarily engaged in some business other than construction for its own account and use, using employees of the enterprise. This activity is not included in the construction sector unless the construction work performed is the primary activity of a separate establishment of the enterprise. The installation and the ongoing repair and maintenance of telecommunications and utility networks is excluded from construction when the establishments performing the work are not independent contractors. Although a growing proportion of this work is subcontracted to independent contractors in the Construction Sector, the operating units of telecommunications and utility companies performing this work are included with the telecommunications or utility activities.

Manufacturing	NAICS 2-digit codes 31-33 SIC 2-digit codes 20-39

Summary:

The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, Construction.

Establishments in the Manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector. Manufacturing establishments may process materials or may contract with other establishments to

process their materials for them. Both types of establishments are included in manufacturing.

The materials, substances, or components transformed by manufacturing establishments are raw materials that are products of agriculture, forestry, fishing, mining, or quarrying as well as products of other manufacturing establishments. The materials used may be purchased directly from producers, obtained through customary trade channels, or secured without recourse to the market by transferring the product from one establishment to another, under the same ownership. The new product of a manufacturing establishment may be finished in the sense that it is ready for utilization or consumption, or it may be semi finished to become an input for an establishment engaged in further manufacturing. For example, the product of the alumina refinery is the input used in the primary production of aluminum; primary aluminum is the input to an aluminum wire drawing plant; and aluminum wire is the input for a fabricated wire product manufacturing establishment.

The subsectors in the Manufacturing sector generally reflect distinct production processes related to material inputs, production equipment, and employee skills. In the machinery area, where assembling is a key activity, parts and accessories for manufactured products are classified in the industry of the finished manufactured item when they are made for separate sale. For example, a replacement refrigerator door would be classified with refrigerators and an attachment for a piece of metal working machinery would be classified with metal working machinery. However, components, input from other manufacturing establishments, are classified based on the production function of the component manufacturer. For example, electronic components are classified in Subsector 334, Computer and Electronic Product Manufacturing and stampings are classified in Subsector 332, Fabricated Metal Product Manufacturing.

Manufacturing establishments often perform one or more activities that are classified outside the Manufacturing sector of NAICS. For instance, almost all manufacturing has some captive research and development or administrative operations, such as accounting, payroll, or management. These captive services are treated the same as captive manufacturing activities. When the services are provided by separate establishments, they are classified to the NAICS sector where such services are primary, not in manufacturing.

The boundaries of manufacturing and the other sectors of the classification system can be somewhat blurry. The establishments in the manufacturing sector are engaged in the transformation of materials into new products. Their output is a new product. However, the definition of what constitutes a new product can be somewhat subjective. As clarification, the following activities are considered manufacturing in NAICS: Milk bottling and pasteurizing; Water bottling and processing; Fresh fish packaging (oyster shucking, fish filleting); Apparel jobbing (assigning of materials to contract factories or shops for fabrication or other contract operations) as well as contracting on materials owned by others; Printing and related activities; Ready-mixed concrete production; Leather converting; Grinding of lenses to prescription; Wood preserving; Electroplating, plating, metal heat treating, and polishing for the trade; Lapidary work for the trade;

Fabricating signs and advertising displays; Rebuilding or remanufacturing machinery (i.e., automotive parts) Ship repair and renovation; Machine shops; and Tire retreading. Conversely, there are activities that are sometimes considered manufacturing, but which for NAICS are classified in another sector (i.e., not classified as manufacturing). They include: 1.

Logging, classified in Sector 11, Agriculture, Forestry, Fishing and Hunting is considered a harvesting operation; 2. The beneficiating of ores and other minerals, classified in Sector 21, Mining, is considered part of the activity of mining; 3. The construction of structures and fabricating operations performed at the site of construction by contractors, is classified in Sector 23, Construction; 4. Establishments engaged in breaking of bulk and redistribution in smaller lots, including packaging, repackaging, or bottling products, such as liquors or chemicals; the customized assembly of computers; sorting of scrap; mixing paints to customer order; and cutting metals to customer order, classified in Sector 42, Wholesale Trade or Sector 44-45, Retail Trade, produce a modified version of the same product, not a new product; and 5.

Publishing and the combined activity of publishing and printing, classified in Sector 51, Information, perform the transformation of information into a product where as the value of the product to the consumer lies in the information content, not in the format in which it is distributed (i.e., the book or software diskette).

Wholesale Trade	NAICS 2-digit code 42 SIC 2-digit codes 50, 51

Summary:

The Wholesale Trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing.

The wholesaling process is an intermediate step in the distribution of merchandise. Wholesalers are organized to sell or arrange the purchase or sale of (a) goods for resale (i.e., goods sold to other wholesalers or retailers), (b) capital or durable nonconsumer goods, and (c) raw and intermediate materials and supplies used in production.

Wholesalers sell merchandise to other businesses and normally operate from a warehouse or office. These warehouses and offices are characterized by having little or no display of merchandise. In addition, neither the design nor the location of the premises is intended to solicit walk-in traffic. Wholesalers do not normally use advertising directed to the general public. Customers are generally reached initially via telephone, in-person marketing, or by specialized advertising that may include Internet and other electronic means. Follow-up orders are either vendor-initiated or client-initiated, generally based on previous sales, and typically exhibit strong ties between sellers and buyers. In fact,

transactions are often conducted between wholesalers and clients that have long-standing business relationships.

This sector comprises two main types of wholesalers: merchant wholesalers that sell goods on their own account and business to business electronic markets, agents, and brokers that arrange sales and purchases for others generally for a commission or fee.

(1) Establishments that sell goods on their own account are known as wholesale merchants, distributors, jobbers, drop shippers, and import/export merchants. Also included as wholesale merchants are sales offices and sales branches (but not retail stores) maintained by manufacturing, refining, or mining enterprises apart from their plants or mines for the purpose of marketing their products. Merchant wholesale establishments typically maintain their own warehouse, where they receive and handle goods for their customers. Goods are generally sold without transformation, but may include integral functions, such as sorting, packaging, labeling, and other marketing services.

(2) Establishments arranging for the purchase or sale of goods owned by others or purchasing goods, generally on a commission basis are known as business to business electronic markets, agents and brokers, commission merchants, import/export agents and brokers, auction companies, and manufacturers' representatives. These establishments operate from offices and generally do not own or handle the goods they sell.

Some wholesale establishments may be connected with a single manufacturer and promote and sell the particular manufacturers' products to a wide range of other wholesalers or retailers. Other wholesalers may be connected to a retail chain, or limited number of retail chains, and only provide a variety of products needed by that particular retail operation(s). These wholesalers may obtain the products from a wide range of manufacturers. Still other wholesalers may not take title to the goods, but act as agents and brokers for a commission.

Although, in general, wholesaling normally denotes sales in large volumes, durable nonconsumer goods may be sold in single units. Sales of capital or durable nonconsumer goods used in the production of goods and services, such as farm machinery, medium and heavy duty trucks, and industrial machinery, are always included in wholesale trade.

Retail Trade	NAICS 2-digit codes 44, 45 SIC 2-digit codes 52-57, 59

Summary:

The Retail Trade sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.

The retailing process is the final step in the distribution of merchandise; retailers are, therefore, organized to sell merchandise in small quantities to the general public. This sector comprises two main types of retailers: store and nonstore retailers.

1. Store retailers operate fixed point-of-sale locations, located and designed to attract a high volume of walk-in customers. In general, retail stores have extensive displays of merchandise and use mass-media advertising to attract customers. They typically sell merchandise to the general public for personal or household consumption, but some also serve business and institutional clients. These include establishments, such as office supply stores, computer and software stores, building materials dealers, plumbing supply stores, and electrical supply stores. Catalog showrooms, gasoline services stations, automotive dealers, and mobile home dealers are treated as store retailers.

In addition to retailing merchandise, some types of store retailers are also engaged in the provision of after-sales services, such as repair and installation. For example, new automobile dealers, electronic and appliance stores, and musical instrument and supply stores often provide repair services. As a general rule, establishments engaged in retailing merchandise and providing after-sales services are classified in this sector.

The first eleven subsectors of retail trade are store retailers. The establishments are grouped into industries and industry groups typically based on one or more of the following criteria:

(a) The merchandise line or lines carried by the store; for example, specialty stores are distinguished from general-line stores.

(b) The usual trade designation of the establishments. This criterion applies in cases where a store type is well recognized by the industry and the public, but difficult to define strictly in terms of commodity lines carried; for example, pharmacies, hardware stores, and department stores.

(c) Capital requirements in terms of display equipment; for example, food stores have equipment requirements not found in other retail industries.

(d) Human resource requirements in terms of expertise; for example, the staff of an automobile dealer requires knowledge in financing, registering, and licensing issues that are not necessary in other retail industries.

2. Nonstore retailers, like store retailers, are organized to serve the general public, but their retailing methods differ. The establishments of this subsector reach customers and market merchandise with methods, such as the broadcasting of "infomercials," the broadcasting and publishing of direct-response advertising, the publishing of paper and electronic catalogs, door-to-door solicitation, in-home demonstration, selling from portable stalls (street vendors, except food), and distribution through vending machines.

Establishments engaged in the direct sale (nonstore) of products, such as home heating oil dealers and home delivery newspaper routes are included here.

The buying of goods for resale is a characteristic of retail trade establishments that particularly distinguishes them from establishments in the agriculture, manufacturing, and construction industries. For example, farms that sell their products at or from the point of production are not classified in retail, but rather in agriculture. Similarly, establishments that both manufacture and sell their products to the general public are not classified in retail, but rather in manufacturing. However, establishments that engage in processing activities incidental to retailing are classified in retail. This includes establishments, such as optical goods stores that do in-store grinding of lenses, and meat and seafood markets.

Wholesalers also engage in the buying of goods for resale, but they are not usually organized to serve the general public. They typically operate from a warehouse or office and neither the design nor the location of these premises is intended to solicit a high volume of walk-in traffic. Wholesalers supply institutional, industrial, wholesale, and retail clients; their operations are, therefore, generally organized to purchase, sell, and deliver merchandise in larger quantities. However, dealers of durable nonconsumer goods, such as farm machinery and heavy duty trucks, are included in wholesale trade even if they often sell these products in single units.

Transportation and Warehousing	NAICS 2-digit codes 48, 49 SIC 2-digit codes 40-45, 47

Summary:

The Transportation and Warehousing sector includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. The type of equipment depends on the mode of transportation. The modes of transportation are air, rail, water, road, and pipeline.

The Transportation and Warehousing sector distinguishes three basic types of activities: subsectors for each mode of transportation, a subsector for warehousing and storage, and a subsector for establishments providing support activities for transportation. In addition, there are subsectors for establishments that provide passenger transportation for scenic and sightseeing purposes, postal services, and courier services.

A separate subsector for support activities is established in the sector because, first, support activities for transportation are inherently multimodal, such as freight transportation arrangement, or have multimodal aspects. Secondly, there are production process similarities among the support activity industries.

One of the support activities identified in the support activity subsector is the routine repair and maintenance of transportation equipment (e.g., aircraft at an airport, railroad rolling stock at a railroad terminal, or ships at a harbor or port facility). Such establishments do not perform complete overhauling or rebuilding of transportation equipment (i.e., periodic restoration of transportation equipment to original design specifications) or transportation equipment conversion (i.e., major modification to systems). An establishment that primarily performs factory (or shipyard) overhauls, rebuilding, or conversions of aircraft, railroad rolling stock, or a ship is classified in Subsector 336, Transportation Equipment Manufacturing according to the type of equipment.

Many of the establishments in this sector often operate on networks, with physical facilities, labor forces, and equipment spread over an extensive geographic area.

Warehousing establishments in this sector are distinguished from merchant wholesaling in that the warehouse establishments do not sell the goods.

Excluded from this sector are establishments primarily engaged in providing travel agent services that support transportation and other establishments, such as hotels, businesses, and government agencies. These establishments are classified in Sector 56, Administrative and Support and Waste Management and Remediation Services. Also, establishments primarily engaged in providing rental and leasing of transportation equipment without operator are classified in Subsector 532, Rental and Leasing Services.

Information	NAICS 2-digit code 51 SIC 2-digit codes NA

Summary:

The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products, (b) providing the means to transmit or distribute these products as well as data or communications, and (c) processing data.

The main components of this sector are the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; the industries known as Internet service providers and web search portals, data processing industries, and the information services industries.

The expressions "information age" and "global information economy" are used with considerable frequency today. The general idea of an "information economy" includes both the notion of industries primarily producing, processing, and distributing information, as well as the idea that every industry is using available information and information technology to reorganize and make themselves more productive.

For the purpose of developing NAICS, it is the transformation of information into a commodity that is produced and distributed by a number of growing industries that is at issue. The Information sector groups three types of establishments: (1) those engaged in producing and distributing information and cultural products; (2) those that provide the means to transmit or distribute these products as well as data or communications; and (3) those that process data. Cultural products are those that directly express attitudes, opinions, ideas, values, and artistic creativity; provide entertainment; or offer information and analysis concerning the past and present. Included in this definition are popular, mass-produced, products as well as cultural products that normally have a more limited audience, such as poetry books, literary magazines, or classical records.

The unique characteristics of information and cultural products, and of the processes involved in their production and distribution, distinguish the Information sector from the goods-producing and service-producing sectors. Some of these characteristics are:

1. Unlike traditional goods, an "information or cultural product," such as a newspaper on-line or television program, does not necessarily have tangible qualities, nor is it necessarily associated with a particular form. A movie can be shown at a movie theater, on a television broadcast, through video-on-demand or rented at a local video store. A sound recording can be aired on radio, embedded in multimedia products, or sold at a record store.

2. Unlike traditional services, the delivery of these products does not require direct contact between the supplier and the consumer.

3. The value of these products to the consumer lies in their informational, educational, cultural, or entertainment content, not in the format in which they are distributed. Most of these products are protected from unlawful reproduction by copyright laws.

4. The intangible property aspect of information and cultural products makes the processes involved in their production and distribution very different from goods and services. Only those possessing the rights to these works are authorized to reproduce, alter, improve, and distribute them. Acquiring and using these rights often involves significant costs. In addition, technology is revolutionizing the distribution of these products. It is possible to distribute them in a physical form, via broadcast, or on-line.

5. Distributors of information and cultural products can easily add value to the products they distribute. For instance, broadcasters add advertising not contained in the original product. This capacity means that unlike traditional distributors, they derive revenue not from sale of the distributed product to the final consumer, but from those who pay for the privilege of adding information to the original product. Similarly, a directory and mailing list publisher can acquire the rights to thousands of previously published newspaper and periodical articles and add new value by providing search and software and organizing the information in a way that facilitates research and retrieval. These products often command a much higher price than the original information.

The distribution modes for information commodities may either eliminate the necessity for traditional manufacture, or reverse the conventional order of manufacture-distribute: A newspaper distributed on-line, for example, can be printed locally or by the final consumer. Similarly, it is anticipated that packaged software, which today is mainly bought through the traditional retail channels, will soon be available mainly on-line. The NAICS Information sector is designed to make such economic changes transparent as they occur, or to facilitate designing surveys that will monitor the new phenomena and provide data to analyze the changes.

Many of the industries in the NAICS Information sector are engaged in producing products protected by copyright law, or in distributing them (other than distribution by traditional wholesale and retail methods). Examples are traditional publishing industries, software and directory and mailing list publishing industries, and film and sound industries. Broadcasting and telecommunications industries and information providers and processors are also included in the Information sector, because their technologies are so closely linked to other industries in the Information sector.

Finance and Insurance	NAICS 2-digit code 52 SIC 2-digit codes 60-64, 67

Summary:

The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Three principal types of activities are identified:

1. Raising funds by taking deposits and/or issuing securities and, in the process, incurring liabilities. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or purchasing securities. Putting themselves at risk, they channel funds from lenders to borrowers and transform or repackage the funds with respect to maturity, scale, and risk. This activity is known as financial intermediation.

2. Pooling of risk by underwriting insurance and annuities. Establishments engaged in this activity collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments. Fees are based on the expected incidence of the insured risk and the expected return on investment.

3. Providing specialized services facilitating or supporting financial intermediation, insurance, and employee benefit programs.

In addition, monetary authorities charged with monetary control are included in this sector.

The subsectors, industry groups, and industries within the NAICS Finance and Insurance sector are defined on the basis of their unique production processes. As with all industries, the production processes are distinguished by their use of specialized human resources and specialized physical capital. In addition, the way in which these establishments acquire and allocate financial capital, their source of funds, and the use of those funds provides a third basis for distinguishing characteristics of the production process. For instance, the production process in raising funds through deposit-taking is different from the process of raising funds in bond or money markets. The process of making loans to individuals also requires different production processes than does the creation of investment pools or the underwriting of securities.

Most of the Finance and Insurance subsectors contain one or more industry groups of (1) intermediaries with similar patterns of raising and using funds and (2) establishments engaged in activities that facilitate, or are otherwise related to, that type of financial or insurance intermediation. Industries within this sector are defined in terms of activities for which a production process can be specified, and many of these activities are not exclusive to a particular type of financial institution. To deal with the varied activities taking place within existing financial institutions, the approach is to split these institutions into components performing specialized services. This requires defining the units engaged in providing those services and developing procedures that allow for their delineation. These units are the equivalents for finance and insurance of the establishments defined for other industries.

The output of many financial services, as well as the inputs and the processes by which they are combined, cannot be observed at a single location and can only be defined at a higher level of the organizational structure of the enterprise. Additionally, a number of independent activities that represent separate and distinct production processes may take place at a single location belonging to a multilocation financial firm. Activities are more likely to be homogeneous with respect to production characteristics than are locations, at least in financial services. The classification defines activities broadly enough that it can be used both by those classifying by location and by those employing a more top-down approach to the delineation of the establishment.

Establishments engaged in activities that facilitate, or are otherwise related to, the various types of intermediation have been included in individual subsectors, rather than in a separate subsector dedicated to services alone because these services are performed by intermediaries, as well as by specialist establishments, the extent to which the activity of the intermediaries can be separately identified is not clear.

The Finance and Insurance sector has been defined to encompass establishments primarily engaged in financial transactions; that is, transactions involving the creation, liquidation, change in ownership of financial assets; or in facilitating financial transactions. Financial industries are extensive users of electronic means for facilitating the verification of financial balances, authorizing transactions, transferring funds to and from transactors' accounts, notifying banks (or credit card issuers) of the individual transactions, and providing daily summaries. Since these transaction processing activities

are integral to the production of finance and insurance services, establishments that principally provide a financial transaction processing service are classified to this sector, rather than to the data processing industry in the Information sector.

Legal entities that hold portfolios of assets on behalf of others are significant and data on them are required for a variety of purposes. Thus for NAICS, these funds, trusts, and other financial vehicles are the fifth subsector of the Finance and Insurance sector. These entities earn interest, dividends, and other property income, but have little or no employment and no revenue from the sale of services. Separate establishments and employees devoted to the management of funds are classified in Industry Group 5239, Other Financial Investment Activities.

Real Estate and Rental and Leasing	NAICS 2-digit code 53 SIC 2-digit code 65

Summary:

The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.

This sector also includes establishments primarily engaged in managing real estate for others, selling, renting and/or buying real estate for others, and appraising real estate. These activities are closely related to this sector's main activity, and it was felt that from a production basis they would best be included here. In addition, a substantial proportion of property management is self-performed by lessors.

The main components of this sector are the real estate lessors industries; equipment lessors industries (including motor vehicles, computers, and consumer goods); and lessors of nonfinancial intangible assets (except copyrighted works).

Excluded from this sector are real estate investment trusts (REITS) and establishments primarily engaged in renting or leasing equipment with operators. REITS are classified in Subsector 525, Funds, Trusts, and Other Financial Vehicles, because they are considered investment vehicles. Establishments renting or leasing equipment with operators are classified in various subsectors of NAICS depending on the nature of the services provided (e.g., transportation, construction, agriculture). These activities are excluded from this sector because the client is paying for the expertise and knowledge of the equipment operator, in addition to the rental of the equipment. In many cases, such as the rental of heavy construction equipment, the operator is essential to operate the equipment.

Professional, Scientific, and Technical Services	NAICS 2-digit code 54 SIC 2-digit code 8

Summary:

The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

This sector excludes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and recordkeeping, personnel, and physical distribution and logistics. These establishments are classified in Sector 56, Administrative and Support and Waste Management and Remediation Services.

Management of Companies and Enterprises	NAICS 2-digit code 55 SIC 2-digit code NA

Summary:

The Management of Companies and Enterprises sector comprises (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decisionmaking role of the company or enterprise. Establishments that administer, oversee, and manage may hold the securities of the company or enterprise.

Establishments in this sector perform essential activities that are often undertaken, in-house, by establishments in many sectors of the economy. By consolidating the performance of these activities of the enterprise at one establishment, economies of scale are achieved.

Government establishments primarily engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration. Establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and recordkeeping, personnel,

and physical distribution and logistics are classified in Industry 56111, Office Administrative Services.

Administrative and Support and Waste Management and Remediation Services	NAICS 2-digit code 56 SIC 2-digit code NA

Summary:

The Administrative and Support and Waste Management and Remediation Services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. These essential activities are often undertaken in-house by establishments in many sectors of the economy. The establishments in this sector specialize in one or more of these support activities and provide these services to clients in a variety of industries and, in some cases, to households. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.

The administrative and management activities performed by establishments in this sector are typically on a contract or fee basis. These activities may also be performed by establishments that are part of the company or enterprise. However, establishments involved in administering, overseeing, and managing other establishments of the company or enterprise, are classified in Sector 55, Management of Companies and Enterprises. These establishments normally undertake the strategic and organizational planning and decision making role of the company or enterprise. Government establishments engaged in administering, overseeing, and managing governmental programs are classified in Sector 92, Public Administration.

Educational Services	NAICS 2-digit code 61 SIC 2-digit code 82

Summary:

The Educational Services sector comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated. They may also offer food and accommodation services to their students.

Educational services are usually delivered by teachers or instructors that explain, tell, demonstrate, supervise, and direct learning. Instruction is imparted in diverse settings, such as educational institutions, the workplace, or the home through correspondence, television, or other means. It can be adapted to the particular needs of the students, for example sign language can replace verbal language for teaching students with hearing

impairments. All industries in the sector share this commonality of process, namely, labor inputs of instructors with the requisite subject matter expertise and teaching ability.

Health Care and Social Assistance	NAICS 2-digit code 62 SIC 2-digit codes 80, 83

Summary:

The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities. The industries in this sector are arranged on a continuum starting with those establishments providing medical care exclusively, continuing with those providing health care and social assistance, and finally finishing with those providing only social assistance. The services provided by establishments in this sector are delivered by trained professionals. All industries in the sector share this commonality of process, namely, labor inputs of health practitioners or social workers with the requisite expertise. Many of the industries in the sector are defined based on the educational degree held by the practitioners included in the industry.

Excluded from this sector are aerobic classes in Subsector 713, Amusement, Gambling and Recreation Industries and nonmedical diet and weight reducing centers in Subsector 812, Personal and Laundry Services. Although these can be viewed as health services, these services are not typically delivered by health practitioners.

Arts, Entertainment, and Recreation	NAICS 2-digit code 71 SIC 2-digit codes 78, 84

Summary:

The Arts, Entertainment, and Recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure-time interests.

Some establishments that provide cultural, entertainment, or recreational facilities and services are classified in other sectors. Excluded from this sector are: (1) establishments that provide both accommodations and recreational facilities, such as hunting and fishing camps and resort and casino hotels are classified in Subsector 721, Accommodation; (2) restaurants and night clubs that provide live entertainment in addition to the sale of food and beverages are classified in Subsector 722, Food Services and Drinking Places; (3) motion picture theaters, libraries and archives, and publishers of newspapers, magazines,

books, periodicals, and computer software are classified in Sector 51, Information; and (4) establishments using transportation equipment to provide recreational and entertainment services, such as those operating sightseeing buses, dinner cruises, or helicopter rides are classified in Subsector 487, Scenic and Sightseeing Transportation.

Accommodation and Food Services	NAICS 2-digit code 72 SIC 2-digit codes 70

Summary:

The Accommodation and Food Services sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services establishments because the two activities are often combined at the same establishment.

Excluded from this sector are civic and social organizations; amusement and recreation parks; theaters; and other recreation or entertainment facilities providing food and beverage services.

Other Services (except Public Administration)	NAICS 2-digit code 81 SIC 2-digit codes 72-76, 81, 86, 88, 89, 'unidentified'

Summary:

The Other Services (except Public Administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.

Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector.

Excluded from this sector are establishments primarily engaged in retailing new equipment and also performing repairs and general maintenance on equipment. These establishments are classified in Sector 44-45, Retail Trade.

Public Administration	NAICS 2-digit code 92 SIC 2-digit codes 91-99

Summary:

The Public Administration sector consists of establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area. These agencies also set policy, create laws, adjudicate civil and criminal legal cases, provide for public safety and for national defense. In general, government establishments in the Public Administration sector oversee governmental programs and activities that are not performed by private establishments. Establishments in this sector typically are engaged in the organization and financing of the production of public goods and services, most of which are provided for free or at prices that are not economically significant.

Government establishments also engage in a wide range of productive activities covering not only public goods and services but also individual goods and services similar to those produced in sectors typically identified with private-sector establishments. In general, ownership is not a criterion for classification in NAICS. Therefore, government establishments engaged in the production of private-sector-like goods and services should be classified in the same industry as private-sector establishments engaged in similar activities.

As a practical matter, it is difficult to identify separate establishment detail for many government agencies. To the extent that separate establishment records are available, the administration of governmental programs is classified in Sector 92, Public Administration, while the operation of that same governmental program is classified elsewhere in NAICS based on the activities performed. For example, the governmental administrative authority for an airport is classified in Industry 92612, Regulation and Administration of Transportation Programs, while operating the airport is classified in Industry 48811, Airport Operations. When separate records are not available to distinguish between the administration of a governmental program and the operation of it, the establishment is classified in Sector 92, Public Administration.

Examples of government-provided goods and services that are classified in sectors other than Public Administration include: schools, classified in Sector 61, Educational Services; hospitals, classified in Subsector 622, Hospitals; establishments operating transportation facilities, classified in Sector 48-49, Transportation and Warehousing; the operation of utilities, classified in Sector 22, Utilities; and the Government Printing Office, classified in Subsector 323, Printing and Related Support Activities.

Appendix C

INSTITUTIONAL REVIEW BOARD DOCUMENTATION

(Content attached on the following pages)

TEMPLE UNIVERSITY®

Office for Human Subjects Protections
Institutional Review Board
Medical Intervention Committees A1 & A2
Social and Behavioral Committee B

3400 North Broad Street
Philadelphia, Pennsylvania 19140
Phone:215.707.3390
Fax:215.707.8387
e-mail: richard.throm@temple.edu

MEMORANDUM

To: **GOLD, JUDITH E**
CHP-PUBLIC HEALTH (0910)

From: Richard C. Throm
Director, Office for Human Subjects Protection
Institutional Review Board Coordinator

Date: 08-Jun-2010

Re: Exempt Request Status for IRB Protocol:
13197: Risk Factors for Adult-Onset Occupational Asthma in New York State

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It has been determined by Expedited Review that this study qualifies for exemption status as follows:

45 CFR 46 Protection of Human Subjects

Section 101 (b): Unless otherwise required by department or agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:

Exemption 4: Collection or Study of Existing Data. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subject.

Nothing further is required from you at this time; however, if anything in your research design should change, you must notify the Institutional Review Board immediately.

If you should have any questions, please feel free to contact me at 215-707-8757.

Thank you for keeping the IRB informed of your clinical research.