Psycho-socio-economic and Health Outcomes of Patients with Work-Related Asthma and Relationships to Different Models of Clinic Organization

By

Joshua Chaim Lipszyc

A thesis submitted in conformity with the requirements for the degree of Master of Science

Institute of Medical Science
University of Toronto

© Copyright by Joshua Lipszyc 2016
Psycho-socio-economic and Health Outcomes of Patients with Work-Related Asthma and Relationships to Different Models of Clinic Organization

Joshua Chaim Lipszyc

Master of Science

Institute of Medical Science
University of Toronto

2016

This thesis explored the impact of clinic structure on psychological, socioeconomic, workplace and quality of life (QoL) outcomes among work-related asthma patients between two tertiary clinics (Toronto Western Hospital [TWH] and St. Michael’s Hospital [SMH]). A cross-sectional comparison was carried out between the two clinics and data was collected through administration of five questionnaires: Beck Anxiety and Depression Inventories, Marks’ Asthma QoL Questionnaire, Work Limitations Questionnaire and Survey of Work and Non-work Related Respiratory Symptoms and their Impact. Forty-seven subjects participated from TWH and 30 from SMH. This study reported a better psychological status for SMH patients compared to TWH patients. SMH patients had better QoL for the ‘mood’ domain, and less workplace limitation for the ‘mental-demands’ domain. However, SMH included a greater number of patients with reduced income compared to TWH. Future research should explore the impact of clinic structure on a more homogenous group with larger sample sizes.
Acknowledgements

First and foremost, I would like to acknowledge my primary supervisor, Dr. Susan Tarlo for her ongoing guidance and unwavering support over these past several years. Her mentorship and expertise has enabled me to think critically, scientifically and independently. I feel fortunate to have been supervised under a kind, selfless, compassionate, and distinguished academic and physician. In the future, I hope to emulate these qualities in my career.

I would also like to thank my co-supervisor, Dr. Frances Silverman, and my Program Advisory Committee (PAC) members, Dr. Linn Holness and Dr. Gary Liss for their insight and advice on my thesis. I feel privileged to have had very compassionate and involved supervisors and committee members with a diversity of perspectives, concerned not only about my thesis, but also about my future career prospects.

I would also like to pay a debt of gratitude to four research students that I had the opportunity to work and interact with: Jack Scarborough, Dale Connor, Simeon Gotzev, and Felix Chan.

I would also like to thank Dr. Tarlo’s administrative assistant, Cidalia Medeiros, for providing me with assistance when needed in the clinic.

Finally, I would like to thank my family for providing me with support and encouragement throughout my degree.
Contributions

The study protocol was developed by the candidate, Joshua C. Lipszyc, and approved by Dr. Susan Tarlo.

The candidate, Joshua C. Lipszyc, was responsible for recruitment of patients, patient interview, data analyses, interpretation of research data, drafting of the thesis and the conduct of the study.

Supervisors, Dr. Susan Tarlo & Dr. Frances Silverman, and PAC members, Dr. Linn Holness and Dr. Gary Liss, assisted with development of the project, drafting of the thesis, and interpretation of data.

This thesis was supported in part by The Centre for Research Expertise in Occupational Disease (Dr. Linn Holness as principal investigator), research grants operated by Dr. Tarlo, an Ontario Graduate Scholarship, and an Institute of Medical Science Graduate Entry Award.
# Table of Contents

Abstract ................................................................................................................................. ii
Acknowledgements ................................................................................................................ iii
Contributions ........................................................................................................................ iv
Table of Contents .................................................................................................................... v
List of Abbreviations ............................................................................................................ viii
List of Tables ......................................................................................................................... x
List of Figures ....................................................................................................................... xi
List of Appendices ................................................................................................................ xiii

Chapter 1: General Introduction .......................................................................................... 1

Chapter 2: Literature Review ............................................................................................... 6

2.1 Asthma Epidemiology ...................................................................................................... 6
2.2 Economic Burden ............................................................................................................. 7
2.3 Etiology and Pathophysiology ......................................................................................... 8
2.3.1 Etiology ...................................................................................................................... 8
2.3.2 Pathophysiology ........................................................................................................ 9
2.4 Clinical Assessment and Diagnosis of Asthma ................................................................. 10
2.5 Work-Related Asthma Introduction and Epidemiology ................................................... 12
2.6 Mechanisms Underlying Work-Related Asthma .............................................................. 15
2.7 Diagnostic Testing of Work-Related Asthma .................................................................. 17
2.7.1 Peak Expiratory Flow Readings (PEFR) .................................................................... 17
2.7.2 Methacholine Challenge (MC) .................................................................................. 18
2.7.3 Specific Inhalation Challenge (SIC) ........................................................................... 19
2.7.4 Clinic Structure .......................................................................................................... 19
2.8 Prevention Hierarchy of Work-Related Asthma ............................................................... 22
2.8.1 Primary Prevention ..................................................................................................... 22
2.8.2 Secondary Prevention ............................................................................................... 23
2.8.3 Tertiary Prevention .................................................................................................... 23
2.8.4 Workplace Safety and Insurance Board (WSIB) and Work-Related Asthma ............. 24
2.9 Socioeconomic, Psychological, and Quality of Life Effects of Work-Related Asthma ................................................................................................................................. 24
2.9.1 Socioeconomic Outcomes among Patients with Work-Related Asthma .................... 24
2.9.2 Relationship between Work-Related Asthma and Specific Occupations ................. 26
2.9.3 Work-Related Asthma and Quality of Life ............................................................... 27
2.9.4 Work-Related Asthma and Mental Health ............................................................... 29
2.9.5 Overall Summary ....................................................................................................... 31

Chapter 3: Research Aim ..................................................................................................... 33
6.1 Overview of Key Findings among TWH and SMH Clinics and How They Relate to the Literature

6.1.1 General Overview

6.1.2 Psychological Status

6.1.3 Asthma Quality of Life (QoL) Status

6.1.4 Work Limitation Status

6.1.5 Socio-demographic and Economic Characteristics

6.2 Limitations of the Present Study

6.3 Strengths of the Present Study

6.4 Conclusions and Future Directions

References

Appendices
**List of Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAI</td>
<td>Beck Anxiety Inventory</td>
</tr>
<tr>
<td>BDI</td>
<td>Beck Depression Inventory</td>
</tr>
<tr>
<td>CFH</td>
<td>Concerns for Health</td>
</tr>
<tr>
<td>ER</td>
<td>Emergency Room</td>
</tr>
<tr>
<td>FROD</td>
<td>Finnish Registry of Occupational Diseases</td>
</tr>
<tr>
<td>HMW</td>
<td>High-molecular-weight</td>
</tr>
<tr>
<td>IGE</td>
<td>Immunoglobulin E</td>
</tr>
<tr>
<td>II-OA</td>
<td>Irritant-Induced Occupational Asthma</td>
</tr>
<tr>
<td>LMW</td>
<td>Low-molecular-weight</td>
</tr>
<tr>
<td>MAQLQ</td>
<td>Marks’ Asthma Quality of Life Questionnaire</td>
</tr>
<tr>
<td>MC</td>
<td>Methacholine Challenge</td>
</tr>
<tr>
<td>OA</td>
<td>Occupational Asthma</td>
</tr>
<tr>
<td>PEF</td>
<td>Peak Expiratory Flow</td>
</tr>
<tr>
<td>PEFR</td>
<td>Peak Expiratory Flow Rate</td>
</tr>
<tr>
<td>PFT</td>
<td>Pulmonary Function Tests</td>
</tr>
<tr>
<td>QOL</td>
<td>Quality of Life</td>
</tr>
<tr>
<td>RTWC</td>
<td>Return-to-work-coordinator</td>
</tr>
<tr>
<td>SIC</td>
<td>Specific Inhalation Challenge</td>
</tr>
<tr>
<td>SI-OA</td>
<td>Sensitizer-Induced Occupational Asthma</td>
</tr>
<tr>
<td>SMH</td>
<td>St. Michael’s Hospital</td>
</tr>
<tr>
<td>TWH</td>
<td>Toronto Western Hospital</td>
</tr>
<tr>
<td>UHN</td>
<td>University Health Network</td>
</tr>
<tr>
<td>WEA</td>
<td>Work-exacerbated Asthma</td>
</tr>
</tbody>
</table>
WLQ  Work Limitation Questionnaire
WRA  Work-related Asthma
WSIB Workplace Safety and Insurance Board
List of Tables

Chapter 1

Table 1.1: Characteristics of the Two Clinics ................................................................. 05

Chapter 5

Table 5.1: Demographic and clinical characteristics; means and standard deviations of the sample at time of study .................................................................................. 53

Table 5.2: Socioeconomic characteristics, employment status and exposure status. 55

Table 5.3: Baseline clinic characteristics (spirometry and methacholine challenge), sociodemographic, and return-to-work characteristics at initial clinic visit(s) ................................................................................................................................. 57

Table 5.4: Correlation Matrix of M-AQLQ Scales and Beck Inventories ............... 70
List of Figures

Chapter 5

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Patients’ Diagnoses</td>
<td>51</td>
</tr>
<tr>
<td>5.2</td>
<td>Comparison of Income Change among OA Patients between Clinics</td>
<td>58</td>
</tr>
<tr>
<td>5.3</td>
<td>Comparison of Income Change among WEA Patients between Clinics</td>
<td>59</td>
</tr>
<tr>
<td>5.4</td>
<td>Comparison of Workers’ Compensation Status among OA Patients between Clinics</td>
<td>60</td>
</tr>
<tr>
<td>5.5</td>
<td>Comparison of Workers’ Compensation Status among WEA Patients between Clinics</td>
<td>60</td>
</tr>
<tr>
<td>5.6</td>
<td>Comparison of Mean Beck Anxiety Raw Scores between TWH and SMH</td>
<td>63</td>
</tr>
<tr>
<td>5.7</td>
<td>Comparison of Mean Beck Anxiety Raw Scores by diagnosis between TWH and SMH</td>
<td>63</td>
</tr>
<tr>
<td>5.8</td>
<td>Comparison of Mean Depression Scores between TWH and SMH</td>
<td>64</td>
</tr>
<tr>
<td>5.9</td>
<td>Comparison of Mean Depression Scores by Diagnosis between TWH and SMH</td>
<td>65</td>
</tr>
<tr>
<td>5.10</td>
<td>Comparison of Mean Marks’ AQLQ Scores between TWH and SMH</td>
<td>67</td>
</tr>
<tr>
<td>5.11</td>
<td>Comparison of Mean Marks’ AQLQ Scores among OA Patients between TWH and SMH</td>
<td>68</td>
</tr>
<tr>
<td>5.12</td>
<td>Comparison of Mean Marks’ AQLQ Scores among WEA Patients between TWH and SMH</td>
<td>69</td>
</tr>
<tr>
<td>5.13</td>
<td>Comparison of Work Limitation Scores between TWH and SMH</td>
<td>72</td>
</tr>
<tr>
<td>5.14</td>
<td>Comparison of Work Limitation Scores between TWH and SMH Excluding Retirees</td>
<td>73</td>
</tr>
<tr>
<td>5.15</td>
<td>Comparison of Work Limitation Scores among OA Patients between TWH and SMH</td>
<td>74</td>
</tr>
</tbody>
</table>
Figure 5.16: Comparison of Work Limitation Scores among WEA Patients between TWH and SMH.
# List of Appendices

<table>
<thead>
<tr>
<th>A) Cover Letters</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B) Informed Consent Form</td>
<td>119</td>
</tr>
<tr>
<td>C) Beck Anxiety and Depression Inventories, Marks’ Asthma Quality of Life Questionnaire, Work Limitation Questionnaire, Survey of Work and Non-work-related Respiratory Symptoms and their Impact</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>134</td>
</tr>
</tbody>
</table>
1. General Introduction

Work-related asthma (WRA) is a preventable respiratory condition that is characterized by two subtypes: occupational asthma (OA) and work-exacerbated asthma (WEA). In general, OA is new-onset and is considered present when respiratory symptoms are caused by workplace exposures, and WEA occurs when concurrent or pre-existing asthma is aggravated, but not caused by workplace exposures (Tarlo et al., 2008; Balmes et al., 2003). Approximately 7% to 51% (with an overall median of 17.6%) of adult asthma cases may be caused by occupational exposures (Toren & Blanc, 2009), and 13% to 58% (with an overall median of 21.5%) of adult asthma cases may be aggravated by workplace exposures (Henneberger et al., 2011).

WRA is associated with worse quality of life, increased disability both inside and outside the workplace (Bahadori et al., 2009), poor socioeconomic outcomes, and increased morbidity and mortality (Stanbury et al., 2008; Jares, Baena-Cagnani, & Gomez, 2012). Individuals with WRA may need to leave their present employment, have modifications and/or respiratory protective equipment introduced into their workplace environment, and/or be relocated to an alternative area under the same employer in order to avoid the presence of occupational triggers and reduce the risk of progression of their illness. This course of action may be facilitated by tertiary centre medical personnel that aim to improve health outcomes of patients by considering the specific workplace exposures (e.g. sensitizers, irritants), severity (based on lung function testing, and extent of occupational impairment) and type of WRA (OA or WEA).
Leaving the workplace containing occupational triggers is often suggested for those with OA, and sometimes for those with WEA. However, there are undesirable consequences that may stem from leaving work, such as poor socioeconomic outcomes through reduced income and loss of accompanied benefits, as well as loss of advancement prospects within the place of employment (Vandenplas, Toren, & Blanc, 2003). In addition, reactive psychological distress and/or psychiatric comorbidities may manifest from employment loss or WRA itself (Lavoie, Joseph & Bacon, 2009; Yacoub et al., 2007). Moreover, psychological symptoms are associated with poor asthma control, and may negatively affect adherence to treatment (Knoeller, Mazurek, & Moorman, 2011).

Medical centres managing patients with WRA in Canada may employ multiple approaches to address patients’ healthcare and workplace needs, including conventional treatments (e.g. asthma medication), education (e.g. educating patients to avoid occupational triggers), workplace interventions (e.g. discussion with WSIB or employer to modify the workplace environment) and other referrals (such as mental health professionals), when appropriate. Management aims to address the multifaceted nature of the illness including psychological and socioeconomic effects. Personnel that may be involved in the management of the patient may include respiratory and occupational physicians, primary care physicians (general practitioners), respiratory therapists, occupational hygienists, return-to-work-coordinators, and mental health professionals (such as psychiatrists and psychologists). Depending on the nature of the patient’s illness, one or several of these personnel may be vital to the patient’s overall healthcare management.
Recognizing that the effect WRA has on a patient may involve many factors, the present study explored the effect WRA has on psychological, socioeconomic, quality of life and work limitation outcomes among patients treated at two tertiary clinics. These clinics have different models of care (please see Table 1.1, page 5). St. Michael’s Hospital runs the Occupational Disease Speciality Program, which is funded by the Ontario Workplace Safety and Insurance Board (WSIB). Patients seen in this program are referred by the WSIB due to the complexity of their diagnosis and potential difficulties associated with returning to work. The program includes an occupational hygienist and a return-to-work-coordinator (RTWC) who assists physicians and their patients diagnosed with work-related asthma by collaborating with those at the workers’ compensation system, the patient, and the patient’s employer. The patient may be advised to use protective equipment to avoid asthma triggers, and medical monitoring may be used. It was anticipated this model of care (e.g. support given from the RTWC and occupational hygienist, and a comprehensive consultation) may lead to more rapid return to work that may improve the financial burden, and ultimately, the mental health and long-term health of the patient.

The other tertiary clinic population is located in an occupational lung clinic as part of the Asthma Airway Centre at the Toronto Western Hospital, part of the University Health Network (UHN). In this clinic, patients are diagnosed and treated by a respiratory physician specializing in WRA in conjunction with a dedicated respiratory therapist. The respiratory physician and respiratory therapist are both responsible for educating patients with appropriate strategies to avoid further exacerbations or progression of WRA. In addition to patient education, the respiratory therapist also carries out minor procedures, including skin-
prick tests. However, the respiratory therapist’s duties do not include return-to-work support, intervention with the patient beyond the clinic, nor communication with those at WSIB.

The two tertiary clinics investigated have a different referral process, which acts as an unavoidable confounding factor. The clinic located at Toronto Western Hospital includes patients referred primarily by respirologists and general practitioners. Conversely, the clinic located at St. Michael’s Hospital receives referrals of compensation claimants from the WSIB to assess a possible work-related association of their diseases (including respiratory disorders, work-related contact dermatitis, and other work-related ailments), and/or to provide recommendations for appropriate future work conditions. In addition, patients at Toronto Western Hospital are often followed over time for several years, while patients at St. Michael’s Hospital often have one in-clinic visit.

I was interested in exploring whether outcomes among patients with WRA were impacted by the different clinic structure. The primary differentiating factor between the two clinics was the inclusion of a RTWC and occupational hygienist at SMH. I hypothesized that this inclusion would be associated with benefit for patients treated at SMH. Five questionnaires were used to evaluate patients’ mental health, quality of life, work limitation, and respiratory health. We were aware that this study could not control for some confounding factors including the variability between patients, the mandate of the two clinics, referral patterns, and other workplace and logistical variables.
Table 1.1: Characteristics of the Two Clinics

<table>
<thead>
<tr>
<th></th>
<th>Toronto Western Hospital: Asthma and Airway Centre</th>
<th>St. Michael’s Hospital: Occupational Disease Specialty Program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medical Focus</strong></td>
<td>● Focus on respiratory disease (asthma, WRA, and other respiratory and allergic diseases).</td>
<td>● Focus on occupational disease.</td>
</tr>
<tr>
<td><strong>Medical Personnel</strong></td>
<td>● Medical personnel include: respirologist and respiratory therapist.</td>
<td>● Medical personnel include: respirologist or allergist, return-to-work-coordinator, and occupational hygienist.</td>
</tr>
<tr>
<td><strong>Patient Follow-up</strong></td>
<td>● Follows patients over an extended period of time.</td>
<td>● Often includes a single clinic visit without further in-clinic follow-up (unless deemed appropriate).</td>
</tr>
<tr>
<td><strong>Referrals</strong></td>
<td>● Typically receives referrals from specialists and general practitioners.</td>
<td>● Receives referrals only from the Workplace Safety and Insurance Board (WSIB).</td>
</tr>
</tbody>
</table>

*Note: The same respirologist assessed patients at both TWH and SMH.*
2. Literature Review

2.1 Asthma Epidemiology

Asthma is the most common chronic respiratory condition in Canada affecting approximately 8.5% of the population in both children and adults (Statistics Canada, 2010), and worldwide prevalence rates are steadily increasing. In the existing literature, there are numerous possible theories that provide explanations for the increased prevalence rates in recent decades, but findings still remain unclear. One article has suggested that increased prevalence rates are associated with urbanization, particularly among teenagers and young children (Lundback et al., 2016). Traditional rural lifestyles are associated with protective factors against asthma and other allergic diseases (e.g. exposure to microbial organisms in farm environments provide immune resistance to the development of allergies and asthma), and residing in modern or urban areas is associated with risk factors for asthma (e.g. environmental pollution, change in diet, fewer infections) and a corresponding increase in asthma prevalence (Hertzen & Haahtela, 2006). An alternative explanation in a recent review has proposed that increased prevalence rates may be associated to differences in how asthma is identified in the general population (either self-reported asthma or doctor-diagnosed asthma) (Sears, 2014). In addition, prevalence rates have substantial variation worldwide, with higher rates among English-speaking countries. For instance, the lifetime prevalence of asthma in the United States is 8.4% compared to a worldwide lifetime prevalence of 4.3% (Zhang et al., 2013).
There are a number of risk factors associated with a disproportionally higher asthma prevalence rate including young children, race (i.e. Blacks and Hispanics), and socioeconomic status. Prevalence of asthma increases consistently from the top to the bottom of the socioeconomic ladder (Keller & Lowenstein, 2002; Loftus & Wise, 2016). Males are more likely to develop asthma prior to puberty. However, higher prevalence and incidence rates are seen in females during adulthood. Females also experience a greater number of hospitalizations and asthma exacerbations (Postma, 2007). In addition, females tend to have longer hospitalizations and readmission is more common (Chen et al., 2003; Trawick, Holm, & Writh, 2001).

The overall cumulative risk of being diagnosed with asthma in a person’s lifetime in Canada is roughly 34% (or 1 in 3; To et al., 2010), and it has been reported that 1 in every 250 deaths worldwide can be attributed to asthma (Follenweider & Lambertino, 2013). The World Health Organization (WHO) forecast that the number of patients diagnosed with asthma will increase by 100 million by 2025 (Masoli et al., 2004) and become the third leading cause of death in 2030 (WHO, 2015).

2.2 Economic Burden

In general, the economic burden of asthma is measured through direct and indirect costs. Direct costs are typically associated with utilization of health care resources by diagnosing, treating and managing those with asthma (i.e. outpatient clinic visits, emergency room visits, hospital admissions, diagnostic tests, medications). Indirect costs typically refer
to productivity loss, days away from work, and physical or functional impairment due to asthma (Boccuzi, 2003).

According to the conference board of Canada, chronic lung illnesses, including asthma, cost the government $12 billion in 2010, comprised of $3.4 billion in direct healthcare costs and $8.6 billion in indirect costs (Theriault et al., 2012). In addition, a recent review reported that the provincial annual population-level cost of asthma is $141 million and $46 million in Ontario and British Columbia respectively, not accounting for indirect costs (Ismaila et al., 2013). Similarly, asthma independently costs approximately $12.7 billion to the annual USA healthcare budget (Weiss & Sullivan, 2001).

The healthcare component that is associated with the greatest healthcare costs is asthma medication, which accounts for 68% of total direct medical costs in Canada and 51% of total direct medical costs in the United States (Barnett & Nurmagambetov, 2011; Bedouch et al., 2012). In addition, poorly controlled asthma is associated with significant increases in expenditure. For instance, one study in Canada reported that an additional $7768 USD per year was lost through indirect costs (primarily through productivity loss) among patients with uncontrolled asthma (Sadatsafavi et al., 2014). These statistics represent a significant economic burden on the economy, society, families, and health care institutions.

2.3 Etiology and Pathophysiology

2.3.1 Etiology

Asthma comprises a range of heterogeneous phenotypes that are variable in etiology, pathophysiology and presentation of symptom profiles. Furthermore, risk factors associated
with asthma phenotypes are broad and varied, including environmental (i.e. allergens, infections, occupational sensitizers), host factors (i.e. gender, obesity, psychological distress) and genetics/epigenetics (Subbarao, Mandhane & Sears, 2009). These risk factors are associated with variable effects on disease pathogenesis, and response to asthma medication. For instance, an environmental factor such as tobacco smoke exposure (even if passively inhaled) is common among patients and associated with increased asthma symptoms and a diminished response to asthma medication. A host factor such as obesity has been associated with poorer asthma control and worse clinical outcomes (Sheehan & Phipatanakul, 2015).

Genetic research aims to identify potential genetic factors associated to asthma and other similar allergic diseases. One study had identified approximately 100 genes associated with asthma (Ober & Hoffjan, 2006). One gene in particular, called ORMDL3 has been demonstrated to be significantly associated with asthma in a number of different populations (Galanter et al., 2008). In general, studies have suggested that asthma is caused by multiple interacting genes, and genetic factors may influence clinical features of asthma. Moreover, some genes that have been identified demonstrate protective effects that prevent development of asthma, and others may be involved in the initiation of the disease process. There are also interacting effects between genes and the patient’s environment (Bijanzadeh, Mahesh & Ramachandra, 2011).

2.3.2 Pathophysiology

Although asthma is considered one of the most prevalent respiratory diseases, there are aspects of its pathophysiology that are not completely understood (Wasche & Schreiber,
2016). The pathophysiology underlying asthma is a chronic inflammation of the airways which is associated with airway hyperresponsiveness and results in recurrent episodes of chest tightness, wheezing, breathlessness, and coughing. The asthmatic episodes that occur in patients are also associated with airflow limitation in the lung. Pharmacological treatments in the form of aerosol inhalers such as bronchodilators and inhaled corticosteroids can help reverse this airflow limitation (Broaddus et al., 2016). There are also numerous types of asthma that are associated with variable levels of severity and provide insight into the pathogenesis of the disease. A common distinction is made between an eosinophilic phenotype to a noneosinophilic (or neutrophilic) phenotype. Those with eosinophilic asthma are likely to be responsive to conventional asthma medication and are associated with a thickening of the basement membrane zone. Conversely, those with noneosinophilic asthma are less likely to be responsive to conventional asthma medication and are associated with an excess of neutrophils and possibly some eosinophils as well. Future research intends on using these cellular markers to develop more tailored treatment programs for patients (Fahy, 2009).

2.4 Clinical Assessment and Diagnosis of Asthma

The first crucial step in diagnosing asthma is a thorough medical history. Hallmark symptoms that patients experience and present with include: shortness of breath, wheezing, cough, and chest tightness. The medical history should include a component to assess precipitating factors that may have played a role in inducing or aggravating symptoms. Identifying common patterns to the timing when symptoms manifest could also be useful and shed light on the primary patient-specific causes of asthma. Occupational history and relationship of symptoms to work should also be documented as a significant proportion of
asthma patients experience symptoms attributed to workplace exposures. A full physical examination should be carried out by the physician to identify any remarkable abnormalities. (Global Initiative for Asthma, 2011; Kaufman, 2011).

Diagnostic tests necessary to confirm an asthma diagnosis are focused on lung function and provide more objective clinical measures of asthma, such as pulmonary function tests (PFTs) and methacholine challenge tests. Spirometry is a first-line PFT tool that evaluates lung function by measuring how much air is inhaled and then exhaled (and the rapidity of exhalation), and is able to confirm the presence of airway obstruction, and whether there is a significant bronchodilator response. Results of this test are then compared with previously established normal values based on demographic characteristics such as age, height, sex, and ethnicity. Values that deviate are suggestive of abnormal lung function. The process is as follows: the patient provides an initial, pre-bronchodilator spirometry (to indicate his/her native respiratory status), the patient is then given a dose of bronchodilator medication (either through an inhaler or nebulizer), and lastly the patient repeats the post-bronchodilator spirometry (an increase in FEV1 [forced expiratory volume in one second] of >200ml and 12% is a positive result) (Barreiro & Perillo, 2004; Miller et al., 2005).

If spirometry findings do not provide concrete evidence of a diagnosis of asthma (on the basis of a significant bronchodilator response) and to provide further validation that asthma is probable, methacholine challenge tests may be carried out. Methacholine is inhaled by the patient, and promotes spasm of the airways. If the airways narrow as a result of a low concentration of methacholine by inhalation, resulting in an FEV1 drop by over 20%, it is
very likely that the patient has asthma. Following the test, a bronchodilator is given to the patient in order to reverse the effects of methacholine (Fetters & Matthews, 1984).

Results of the spirometry test and methacholine challenge test with values that are suggestive of asthma; in conjunction with a thorough medical history, physical examination, and presentation of asthma symptoms (e.g. cough, shortness of breath) is typically indicative of a diagnosis of asthma (Global Initiative for Asthma, 2011; Kaufman, 2011).

2.5 Work-Related Asthma Introduction and Epidemiology

Historically, the notion that workplace agents are associated with asthma began with Hippocrates (460-370 BC), who identified specific occupations in which the condition was more likely to develop which included horsemen, fishermen, and metal workers (Tan & Bernstein, 2014). Work-related asthma (WRA) is seen in most parts of the world, such as agricultural and industrial areas. However, its impact is most evident among industrialized countries. In addition, prevalence of WRA is higher among urbanized areas and developing countries that are engaged in rapid industrialization (Cherry et al., 2000).

There have been mixed findings in determining gender distribution of WRA, and findings tend to reflect the predominance of males or females in certain occupations and industries (Jeebhay & Quirce, 2007). There are also inconsistencies in distributions of age groups that are most associated with WRA. For instance, in the United Kingdom, WRA has been demonstrated to increase with age, while France has a much greater number of WRA cases among those aged 15-29 (Ameille et al., 2003; McDonald et al., 2005).
Work-related asthma accounts for a significant proportion of the asthma population and it has been reported that approximately 15-20% of asthma cases are likely to be attributable to occupational exposures (Toren & Blanc, 2009). The prevalence of WRA in the general population may even exceed reported figures due to it being underdiagnosed in general medical practice (Tarlo & Lemiere, 2014). In addition, patients with WRA are more prone to having poorly controlled asthma compared to those with non-WRA (Knoeller, Mazurek, & Moorman, 2011). The most common causative agents associated to WRA among industrialized countries include isocyanates, cereal flour, welding fumes and wood dust (Latza & Baur, 2005).

*Occupational Asthma*

Estimated prevalence of OA among adult asthmatics range from 7% to 51% (median of 17.6%) (Toren & Blanc, 2009). OA is subdivided based on whether asthma is induced via i) sensitization to a specific agent (sensitizer-induced OA; a majority of cases – roughly 90%) or ii) exposure to respiratory irritant(s) inhaled at work (irritant-induced OA – minority of cases <10%). Irritant-induced OA may consist of acute or delayed onset. The former is termed reactive airway dysfunction syndrome (RADS), which begins within 24 hours following high level exposure to an inhaled irritant, and the latter is a more controversial diagnosis also referred to as low-dose RADS where a patient is exposed to repeated low-level inhaled irritants which may occur over days, weeks or months (Friedman-Jimenez, Harrison, & Luo, 2015; Vandenplas et al., 2014). A common risk factor associated with sensitizer-induced OA is atopy (i.e. history of allergic disorders), particularly among OA patients who are sensitized to a high-molecular-weight agent through an IgE-mediated-
response (Chan-Yeung, Lam & Koerner, 1982). In addition, those that engage in regular cigarette smoking may be at greater risk of developing sensitization to both high-molecular-weight agents and some low-molecular-weight agents (to a lesser extent), also through an IgE-mediated-response (Mapp et al., 2005).

**Work-Exacerbated Asthma**

Estimated prevalence of WEA among adult asthmatics range from 13% to 58% (median of 21.5%) (Henneberger et al., 2011). WEA is established when a person previously (e.g. childhood onset case) or concurrently diagnosed with asthma has asthma symptoms aggravated by workplace exposures (Tarlo et al., 2008; Malo & Chang-Yeung, 2001). Patients diagnosed with WEA are more likely to have been exposed to inhaled irritants including exhaust fumes, and aerosol propellants (Henneberger et al., 2010). In addition, work-related worsening usually occurs multiple years following onset of asthma (Henneberger, Liang & Lemiere, 2013). One tertiary referral centre study in Quebec reported that WEA patients had more severe asthma at initial assessment compared to those with OA (Lemiere et al., 2012).

To achieve an optimal prognostic outcome, early diagnosis of WRA and timely identification of the specific sensitizing or irritant agents associated with the patient’s symptoms are important. Full recovery of WRA may be possible in some cases if diagnosis is reached early after onset of symptoms (Wilken et al., 2012). Unfortunately, many patients remain in the same workplace exposed to respiratory triggers for long periods. One study reported that the mean duration of symptoms before an established clinic diagnosis of OA was 4.9 years, and patients waited approximately 7 months before consulting their physician
about possible work-relatedness of their symptoms (Poonai et al., 2005). In order to effectively reduce the morbidity of WRA and improve outcomes, a number of steps are required. Pharmacological treatments are usually necessary to manage the illness (e.g. bronchodilators, inhaled corticosteroids). Workplace preventative measures need to be employed to avoid further exposures for those with sensitizer-induced OA and reduce relevant exposures for those with irritant-induced OA and WEA. Measures may include workplace modifications (e.g. relocation of employee, or control of exposures) and protective equipment (e.g. respirator or mask). In addition, workers’ compensation claims may need to be filed (based on jurisdictional factors).

2.6 Mechanisms Underlying Work-Related Asthma

OA can be caused by a sensitizer in the workplace, which is defined as “an agent that induces asthma through a mechanism that is associated with a specific immunologic response” (Tarlo & Lemiere, 2014). Most often, prolonged exposure (from weeks to years) to a sensitizing agent in the work environment can induce the illness via an IgE-mediated physiological mechanism and subsequent lower exposures can trigger an asthmatic response (Tarlo et al., 2008). There is typically a latency component that can sometimes extend up to multiple years, during which the patient does not demonstrate any asthmatic symptoms, although, the majority of patients develop OA within 1-2 years following initial exposure to workplace agents (Malo et al., 1992). During this period, the immunologic hypersensitivity to the specific workplace sensitizer(s) develops. Following the development of OA, nonspecific airborne triggers that are different from the original respiratory triggers can also elicit an asthmatic response, as with other asthmatics (Pilligian et al., 2006). In general, the
primary factor in determining incidence of OA appears to be the level of exposure of specific workplace agents, and reducing exposure is associated with a reduction of rates of disease and better clinical outcomes (Gautrin et al., 2003).

OA can be caused by over 400 different sensitizing agents (with more agents being classified as potential agents each year; Quirce & Bernstein, 2011), although the majority of cases arise from less than 20 agents (Cullinan & Cannon, 2012). Occupational sensitizers include high and low molecular weight agents, which create a cascade of events that may include the production of IgE antibodies, and an associated allergic response. However, the majority of OA cases reported are associated with high-molecular-weight agents (weighing more than 10 kDa; Dykewicz, 2009). Presently, low-molecular-weight agent sensitization is inadequately understood and requires more investigation (Tarlo & Lemiere, 2014). Detection of specific sensitization to some agents can be validated with serum-specific IgE antibodies or skin prick tests.

Irritant-induced OA which appears to account for less than 10% of OA cases (Labrecque, 2012), occurs from workplace exposures to agents classified as airway irritants (Tarlo & Lemiere, 2014). The concept behind irritant-induced OA is that the condition can be induced by concentrations of airborne chemicals that induce an inflammatory airway response (e.g. cleaning products, spray paint, smoke) (Brooks et al., 1994). Typically, a patient may be exposed to a high potent exposure, which will then induce an inflammatory response, and subsequent low exposures can also lead to respiratory irritation (Tarlo, 2014).

By definition, patients diagnosed with WEA have not been sensitized to specific sensitizing agents in the workplace (Prince et al., 2012). A diagnosis of WEA can be
established on the basis of a negative specific inhalation challenge test (Lemiere et al., 2001). A possible mechanism that may explain the WEA phenotype is sensory nerve activation in the airways from asthma triggers such as chlorine gases (Henneberger et al., 2011).

2.7 Diagnostic Testing for Work-Related Asthma

Generally, the typical approach employed to diagnose WRA requires an objective diagnosis of asthma and establishing an association between changes in lung function and workplace exposures. Patients suspected of having WRA are typically asked if their symptoms improve on days or weeks away from work (information is sometimes elicited from patients via standardized questionnaires; Stenton et al., 1993). There are other important diagnostic tools used in the diagnosis of WRA including: serial peak flow recordings (i.e. PEFR), spirometry, methacholine challenge tests, and specific inhalation challenge tests.

2.7.1 Peak Expiratory Flow Recordings (PEFR)

A diagnostic test that is often used in facilitating a diagnosis of WRA is peak expiratory flow rate monitoring (PEFR). This test measures lung function by assessing the speed at which a person can exhale. A PEFR test can be performed in the convenience of a person’s home or workplace by purchasing a handheld device called a peak flow meter. The PEFR test results are variable depending on the height, age and sex of the patient. If there is significant PEF variability depending on if the patient is at work or not, it may be indicative of WRA. (Burge, 1993).
This PEFR test is recommended to be used in the early phases of patients suspected of having OA. Patients are advised to utilize this tool and compare their performance on days at work to days off work, to shed light on the possible work-relatedness of their symptoms. Although peak expiratory monitoring is primarily used for suspected OA patients, it can also be used for those with WEA. Chiry et al. (2007) reported that variability of PEF was high when comparing work days to non-work days in both OA and WEA patients, with variability most pronounced among OA patients. However, they additionally reported that clinicians could not reliably identify if the patient had OA or WEA based on PEF graphs alone.

The literature exploring the utility of the PEFR test is mixed. The test itself has been reported to be up to 94% sensitive for an OA diagnosis (Gannon et al., 1996). However, the accuracy of reported data is limited by the potential for workers to fabricate data that may not be detected if electronic meters are not used, with some studies reporting that approximately 55% of data is authentic (Quirce et al., 1995; Cullen et al., 1996). In addition, using the test requires good effort by the patient. However, PEFR is a common and suggested tool to use because of its ease of use, portability, and if used appropriately, determination of a possible work-related association (Lindstrom et al., 2011).

2.7.2 Methacholine Challenge (MC)

Methacholine challenge (MC) testing which assesses bronchial hyperresponsiveness is an additional diagnostic tool that is used in the diagnosis of WRA and assists in distinguishing OA from WEA. The tool is sensitive to detecting changes in airway reactivity (worsening during a work period and improvement after a period off work) (Chan-Yeung &
Lam, 1986). A significant advantage of MC testing is that the diagnostic test is relatively brief (often 30-40 min) (Baur et al., 1998) in comparison with SIC testing (defined below: 2.7.3) which can sometimes take multiple hours to several days and PEFR recordings requiring significant time and good effort by the patient. Employing multiple methodologies in the assessment of patients with suspected WRA can lead to a more reliable and accurate diagnosis of the condition (especially OA) (Dewitte, Chang-Yeung & Malo, 1994).

2.7.3 Specific Inhalation Challenge (SIC)

In addition to the conventional diagnostic tools used to establish an asthma diagnosis, there are other methods specifically tailored to assist in acquiring a WRA diagnosis for workplace sensitizer exposures. One such tool is the specific inhalation challenge (SIC) which practitioners primarily use when there is a suspicion that a patient may have OA. SIC testing is carried out under controlled laboratory conditions and transiently exposes the patient to agent(s) that may have been asthmatic triggers in the workplace. This tool is effective for determining which agents are associated with airways reactivity (Vandenplas et al., 2014). The duration of exposure of the specific sensitizer is increased incrementally. Subsequently, a positive or negative response is elicited.

2.7.4 Clinic Structure

In general, patients suspected or diagnosed with asthma that is difficult to control by a primary care health provider are often referred to a specialist (typically a respirologist) who evaluate, diagnose and treat the patient. The specialist may or may not have ancillary support from other healthcare professionals. Those in private practice and not located in academic
centres are more likely to provide care without additional support. In academic tertiary centres such as Toronto Western Hospital and St. Michael’s Hospital, multidisciplinary teams are more likely to be involved in the management of patients’ care. For instance, asthma patients at Toronto Western Hospital are seen by a respirologist in conjunction with a respiratory therapist. The respiratory therapist’s main duties in this particular clinic is to provide asthma education on techniques of how to effectively manage asthma, use asthma medication correctly, and strategies to avoid further exacerbations. St. Michael’s Hospital includes a respirologist or allergist, a return-to-work coordinator and occupational hygienist. The return-to-work coordinator’s primary responsibility is to ensure a more efficient return-to-work process for the patient without further exposure to the implicated causative or exacerbating exposures, by collaborating with the patient, physician, employer, healthcare team, those at the Workers’ Compensation System and other stakeholders if necessary. The primary role of the occupational hygienist is to identify and evaluate possible workplace agents that are associated with the patients’ asthma.

It is often suggested that patients with difficult-to-treat asthma or those with asthma and other comorbid conditions should be followed by a multidisciplinary team in secondary or tertiary centres. This is likely due to the complexity of the patient’s condition, and that these centres have more resources and that the ancillary support can address other aspects of the patient’s condition (Zeiger et al., 1991). There have been a small number of studies exploring how different clinic structure (including multidisciplinary intervention) affect the management and outcomes among patients. This may be due to the difficulty in isolating these variables, as there may be a simultaneous influence of multiple factors on patients.
A recent study that included difficult-to-treat asthma patients (i.e. persistent symptoms despite use of asthma medication and significant morbidity) indicated that tertiary clinics with multidisciplinary expertise were associated with better clinical outcomes and reduction in healthcare utilization costs (Patil et al., 2016). In addition, a multidisciplinary approach to the management and treatment of difficult-to-treat asthma patients was associated with a reduction in: general physician visits, emergency department visits, inpatient days, and intensive care admissions (Patil et al., 2013).

There has been a scarcity of research investigating the benefit of including a return-to-work coordinator in the care of patients. A study (Schandelmaier et al., 2012) compared clinics that included a return-to-work program to clinics without this aspect among patients with musculoskeletal and mental health conditions. They reported that the clinics with this program were more likely to have patients that returned to work, and demonstrated improvements in overall pain and function. A similar study that explored the benefit of a return-to-work intervention among patients with musculoskeletal and pain conditions indicated that patients had lower durations of work disability and costs with intervention (Franche et al., 2005). There has been limited investigation on the possible advantages of return-to-work intervention among patients with asthma, with one article anecdotally suggesting that the RTWC was associated with some benefit in a tertiary clinic (Tarlo & Malo, 2013). The lack of research in this area highlights the importance of evaluating the possible benefit of a return-to-work intervention among asthma patients.

There has been similarly little research in evaluating the benefit of including an occupational hygienist in a multidisciplinary team for patients with suspected work-related
asthma. These healthcare professionals are not as involved in the management of patients’ care, but play an important role in evaluating workplace hazards. For instance, one study (Olim et al., 2015) reported that the occupational hygienist successfully identified the causative agent in 97% of cases with a positive SIC to a workplace agent. In addition, the occupational hygienist identified one or more sensitizing agents in 62% of cases with a negative SIC to a workplace agent. In other words, there is a possibility that some patients were erroneously not diagnosed with sensitizer-induced OA without this information.

2.8 Prevention Hierarchy of Work-Related Asthma

2.8.1 Primary Prevention

In general, prevention of disease is divided into three classifications: primary, secondary and tertiary prevention. In the context of WRA, primary prevention includes moderating or removing the specific respiratory triggers (such as workplace sensitizers) to completely avoid the development of WRA. Although perhaps not as effective as complete removal of the respiratory triggers, reducing the potency of the agent and the use of protective equipment to diminish the likelihood of developing WRA is also helpful (Quint et al., 2008). In addition to removing triggers, important avenues to assist in primary prevention include pre-placement screening (Saric, Vuksic, & Marelja, 1993), identification of asthma-causing agents (Quint et al., 2008), and education to disseminate important information regarding WRA. For instance, Ghajar-Khosravi et al., (2013) developed a web-based work-related asthma educational tool to educate adolescents with asthma, that was validated by asthma educators. It is intended to enhance young asthmatics’ knowledge on effects of WRA, to aid them in making a more informed job choice, and to develop preventive
strategies. The web-based tool was demonstrated to have a positive effect on WRA knowledge among patients at a tertiary clinic population (Lipszyc et al, 2016).

2.8.2 Secondary Prevention

The objective of secondary prevention of WRA is to identify the disease at a pre-clinical or clinical phase when the disease is reversible with management. Early recognition of the condition is pivotal in improving health outcomes. Early screening and medical surveillance is important in preventing WRA from worsening. It is hoped that the patient will take initiative to be assessed as soon as symptoms start to develop to achieve better health outcomes by intervention to effectively slow or stop the disease. A secondary preventative approach may include mass screening of certain workforces that are more prone to developing WRA and inclusion of regular health surveillance (Abramson & Sim, 2006).

2.8.3 Tertiary Prevention

Tertiary prevention of WRA is intended to reduce further medical impairment in those with an established diagnosis (which is the population being assessed in this study). Tertiary preventive measures include pharmacological treatments such as inhaled corticosteroids and bronchodilators, avoidance of further exposures to the agent (specifically for those with sensitizer-induced OA), and ongoing medical monitoring. In addition, worker’s compensation (in Ontario from the Ontario WSIB) can be considered a conjunctive tertiary approach to compensate lost work time, and/or cover costs of certain drug treatments (Tarlo & Liss, 2005).
2.8.4 Workplace Safety and Insurance Board and Work-Related Asthma

Ontario workers diagnosed with WRA may be eligible for compensation from the WSIB, depending on the magnitude of work-related worsening of their condition. Approximately 1,051 claims were accepted in Ontario between 2001 and 2005 for patients diagnosed with WRA (IAPA, 2009). The amount of compensation can vary widely and is influenced by a multitude of factors (e.g., current income, and type of WRA). Potential benefits from the WSIB include, but are not limited to: benefit for loss of earnings, healthcare benefits, healthcare equipment, and benefits for future economic loss.

2.9 Socioeconomic, Psychological, and Quality of Life Effects of Work-Related Asthma

2.9.1 Socioeconomic Outcomes in Work-Related Asthma

The socioeconomic implications of WRA are becoming more significant with an ever-increasing WRA population. Those with WRA may experience significant socioeconomic struggles due to their reduced workplace involvement, changes in duties (which are sometimes accompanied by reduced income), asthma-attributed loss of workdays, and overall diminished work productivity and morale (Vandenplas, Toren, & Blanc, 2003). WRA is associated with significant socioeconomic challenges and has been considered one of the most commonly compensated occupational lung diseases (Vandenplas, 2008), and contributes to the global burden of asthma (Driscoll et al., 2005).
White et al. (2013) reported that unemployment status among 38 American states is significantly higher among those with WRA (41.8%) compared to those with asthma not related to work (27.9%) and healthy controls (14.4%). Similarly, a review carried out by Vandenplas et al. (2003) reported that 25-41% of individuals with OA were unemployed between one and six years following diagnosis. Moullec et al. (2013) also investigated socio-professional outcomes among OA and WEA populations in Montreal and reported that 77% and 42% changed their employment, respectively. Ameille et al. (1997) assessed a cohort of OA patients in France, and demonstrated that more than 40% left their employer, and only a minority found a new job. In this study, 84% of patients who left their initial job for exposure cessation had reduced income and patients who had remained employed without seeking alternative employment were still economically affected as a result of asthma triggers and lack of advancement in the company.

It has been speculated that a significant factor associated with reduced employment rates among the WRA population is overall asthma severity. On average, WRA patients have poorer management of their illness, a greater number of asthma attacks and urgent treatments, more frequent episodes of symptoms and more ER visits in comparison to those with non-WRA (Knoeller, Mazurek, & Moorman, 2011). The higher severity of WRA could partially be explained by the complexity of the condition. In order to recover adequately, cessation of further exposures to the sensitizing agent (in OA cases) is necessary. The trade-off to exposure cessation is a higher likelihood of becoming unemployed and losing income (Legiest & Nemery, 2012). As a result, some patients choose to remain exposed to occupational triggers in order to avoid an economic burden, especially among those that have significant financial commitments. Other factors that play a role in individuals remaining in
the same workplace include: longer tenure with the company, older age, and advanced education (Moscato et al., 1999).

2.9.2 Relationship between Work-Related Asthma and Specific Occupations

WRA has a relatively high prevalence in the asthma population, but the annual incidence rates of OA can sometimes be below 1% in high-risk occupations (Karjalainen et al., 2000). This may explain why there has been a dearth of literature exploring OA incidence rates in the context of specific occupations, industries and sectors. It is important to identify the specific occupations that are at higher risk of developing OA in order to develop appropriate preventive interventions.

A Finish group (Karjalainen et al., 2000) reported incidence of OA by occupation and industry. Their data were extracted from the Finnish Registry of Occupational Diseases (FROD). They indicated that the highest incidence of OA for occupation was highest among bakers for both men and women, which accounted for 218 of the 2602 OA cases. The occupations with the next highest incidence for men and women were painters and lacquerers (58 OA cases), and plywood and fiberwood workers (20 OA cases), respectively. Moreover, the greatest number of cases for industry were in agriculture (1333 OA cases), followed by manufacturing (872 OA cases).

In addition, the number of WRA cases identified among specific occupations and industries may change over time. In a Canadian study at a tertiary care clinic (Gotzev et al., 2016), patients were divided into two periods: 2000-2007 and 2008-2015. They reported that
the most recent period was characterized by fewer cases associated with the manufacturing industry and less frequent isocyanate-induced cases. They also indicated that the number of cases in healthcare and education were higher in the recent period, as well as a greater frequency in dust exposure and cleaning products. They suggest that these differences may relate to preventive measures that have been employed in Ontario in more recent years. This study highlights the importance of re-evaluating occupations and industries to determine where appropriate interventions should be aimed.

2.9.3 Work-Related Asthma and Quality of Life

In general, physicians are typically guided by their perceived sense of the patient’s illness severity, which includes asthma symptoms and PFT findings, but these clinical measures may be inadequate to fully appreciate other aspects of the patient’s illness, such as quality of life (QoL) (Storms et al., 1995; Katz et al., 1999). QoL refers to the overall well-being of the patient and may take into account a number of different life domains including physical and emotional wellbeing, activity and development (Felce & Perry, 1995). QoL and perceived QoL in patients with asthma may impact their overall clinical outcome. The morbidity that accompanies asthma may be due to asthmatic exacerbations, which may result in a greater number of hospitalizations and ER visits, declines in overall lung function, and death (Bahadori et al., 2009). Understandably, patients experiencing a more severe form of asthma are burdened with greater healthcare costs, morbidity, poorer asthma control, and overall reduced QoL, which often characterizes WRA to a greater extent than non-WRA.
Studies have suggested that patients diagnosed with WRA can expect to have permanent impairments in some aspects of their lives and health status, even following exposure cessation and appropriate self-management of their condition. As previously mentioned, those diagnosed with WRA, and especially among those with sensitizer-induced OA, may need to leave their present workplace, and seek out alternative career opportunities, which may require further career training, or, among some patients, resort to a premature retirement. These are risk factors associated with worse QoL among patients with WRA (Malo et al., 1993).

Miedinger et al. (2011) explored quality of life outcomes among patients with OA two years’ post-diagnosis in Montreal and used Juniper’s Asthma Quality of Life Questionnaire that has a scale from 1-7 (1 representing “extreme severity” and 7 representing “not at all”). Juniper’s AQLQ is a common instrument used to assess the extent of QoL impairment among patients with asthma and consists of four domains: symptoms, activity limitations, emotional function, and exposure to environmental stimuli. They reported scores of 4.5, 4.6, 5.0, and 4.8 for the 4 domains, respectively. These scores indicate that patients had moderately impaired QoL.

Lowery et al. (2007) reported that patients with WEA had worse asthma-related quality of life compared to OA patients. In addition, they reported a number of risk factors that are associated with poorer QoL among WRA patients including racial/ethnic minority status, lower educational attainment, and cigarette smoking. These factors are understandable as minority status and lesser education is often linked to menial work positions where the workplace environment may be less favourable for the worker.
2.9.4 Work-Related Asthma and Mental Health

Psychological factors and mental illness are often overlooked in the overall management of the patient’s WRA. Yet, an association between psychological factors and asthma has been evident in medical practice for hundreds of years (Marco, Santus, & Centanni, 2011). Historically, one of the first pieces of modern scientific literature that speculated a strong relationship between asthma and psychological factors was reported by French and Alexander (1941). They hypothesized that asthma manifestations are a result of inner psychological conflicts and could be considered a psychosomatic disorder (Lieshout & MacQueen, 2012). Although it is clear that asthma is a complex illness with diverse etiologies and risk factors, the impact psychological distress and mental illness has on the condition should not be understated. Psychological symptoms that develop in patients have been shown to be associated with significantly more adverse outcomes, poorer symptom control (sometimes due to lack of adherence to treatments), impaired quality of life, and an overall increase in healthcare utilization compared to asthmatics without psychological disorders (Lavoie et al., 2005).

In some epidemiologic studies, WRA has been found to have higher rates of psychiatric comorbidities compared to non-WRA asthma. In one study, non-WRA appeared to have nearly equivalent psychiatric comorbidities to other chronic conditions in the general population, with 14.2% - 31% of asthmatics having a psychiatric disorder (Lu et al., 2013) and a general twofold higher risk of having either an anxiety or depression comorbidity compared with the general population (Kuehn, 2008). In addition, Lavoie et al. (2006) explored the presence of psychiatric conditions among patients with non-WRA, and reported
that 31% met the diagnostic criteria for either depression disorder, anxiety disorder, or both. Yacoub et al. (2007) reported that 35% and 22.5% of OA patients suffer from an anxiety disorder or dysthymia (mild and chronic form of depression), respectively, two years following initial diagnosis. Moreover, Lavoie et al. (2013) reported that among those with OA, rates of psychiatric conditions are two to four times higher compared to the general population, but similar to non-WRA asthma.

Although it is anticipated that leaving work (for those with sensitizer-induced OA) will improve the patient’s clinical outcome (Moscato et al., 1999), the psychological repercussions may interfere with the remedial effect of this approach (Miller & Wood, 1994). Indeed, there are psychological benefits of remaining in the same workplace, which include the avoidance of a financial burden, potential advancement of the patient’s career in the future, and the social network acquired while at work. Removal from this familiar environment may impact the patient’s self-esteem, relationships, and personality identity.

For instance, Lavoie, Joseph and Bacon (2009) indicated that having symptoms suggestive of WRA may provoke anxiety in the patient, and this may delay the patient from seeing a physician. In addition, patients may be reluctant to confide the extent of their symptoms to their physician and refuse to file workers’ compensation claims to avoid the negative socioeconomic consequences, which may further worsen their outcome (Bradshaw et al., 2006; Howse et al., 2006). Therefore, an official diagnosis of WRA is not even necessary to provoke psychological symptoms.

Psychological symptoms that are common among those with WRA include anxiety, depression, and cognitive disturbances (Lavoie, Joseph & Bacon, 2009). Miedinger et al.
(2011) explored psychological outcomes among OA patients two years’ post-diagnosis using the Psychiatric Symptom Index questionnaire. This questionnaire has a scale that ranges from 0 (never) to 3 (very often) and measures four domains: depression, anxiety, anger and cognitive disturbances. Scoring 25 or higher is indicative of clinically significant distress. They reported that 47% of participants had a total score of 25 or more, with 32% and 15% screening positive for mood and anxiety disorders, respectively. In addition, Lavoie et al. (2013) reported that among those with OA, anxiety and depression disorders were present in 29% and 34% of the sample, respectively. Yacoub et al. (2007) reported the presence of anxiety disorders and dysthymia among 35% and 23% of OA participants, respectively. These psychological disorders were present despite patients being investigated for this two years’ post-diagnosis and following exposure cessation. This suggests that psychological symptoms can persist for years, despite patients taking the clinically recommended approach to improve their health outcome.

2.9.5 Overall Summary

In summary, work-related asthma (WRA) is a common respiratory illness that is associated with a range of psycho-socio-economic and health outcomes including worse psychological status, poor quality of life, impairments both inside and outside the workplace (e.g. functional impairment, less workplace productivity), and diminished socioeconomic status. However, these poor outcomes may be ameliorated with appropriate medical and workplace interventions. The inclusion of additional ancillary support, such as the RTW intervention is associated with patients being more likely to return to work, lower durations of work disability, fewer costs among workers, and improvements in overall pain and
function. The benefits of the RTWC has yet to be explored in a clinic population of WRA patients. This is a particularly important population to evaluate the effectiveness of this intervention, as patients with WRA are significantly more likely to be unemployed due to their condition, experience a substantial loss of income, resort to pre-mature retirement, and suffer from psychological distress. In addition, the inclusion of an occupational hygienist plays an important role in accurately identifying workplace hazards associated with patients’ WRA. It is possible that a clinic model that includes a RTWC and occupational hygienist may be associated with better outcomes for psychological status, quality of life, workplace limitation, and socioeconomic status.
3. RESEARCH AIM

The primary objective of the present study is to explore the impact different clinic models (please see Table 1.1 for characterization of the two clinic models) have on the following variables among patients with WRA: psychological status, socioeconomic status, quality of life, and limitations in the workplace. The clinic located at Toronto Western Hospital included the following characteristics: primarily focused on respiratory disease (both general asthma, WRA and other respiratory diseases), included a respirologist and respiratory therapist involved in the management of patients’ care, often follows patients over an extended period of time, and received referrals from specialists and general practitioners. The clinic located at St. Michael’s Hospital included the following characteristics: primarily focused on occupational lung disease (WRA and other work-related respiratory and allergic diseases), included a respirologist or allergist, return-to-work-coordinator, and occupational hygienist involved in patient care, often included a single clinic visit without further in-clinic follow-up, and received referrals from the Workplace Safety and Insurance Board. However, the primary differentiating factor between the two tertiary clinics that has a basis in the literature to demonstrate benefit is the inclusion of the return-to-work-coordinator and occupational hygienist, and these are the central variables we were interested in exploring.

**Primary Research Question:** Is the SMH clinic population associated with better psychological status, quality of life, and socioeconomic status, and less workplace impairment because of the inclusion of the RTWC and occupational hygienist?
**Primary Hypothesis:** I hypothesized that the aforementioned outcomes would be better among patients at SMH compared to TWH.

A secondary objective of the present study was to identify if patient outcomes (i.e. psychological status, quality of life, socioeconomic status and work limitation) were different or similar to other clinic populations among existing literature. Information on these patient outcomes may be of use to specialists managing patients with occupational diseases, and may encourage practitioners to consider other clinic models. It is important for the medical field to continue to evolve in order to accommodate patients with complex diseases that require different kinds of support. This study’s evaluation of two different clinic models will hopefully shed light on possible strengths and best practices.
4. METHODS

4.1 Study Population

Research ethics approval was obtained from Toronto Western Hospital and St. Michael’s Hospital. In addition, administrative research ethics approval was obtained from University of Toronto. The patient samples that were included in the present study were from two tertiary centres: The Asthma and Airway Centre located in Toronto Western Hospital and the Occupational Disease Specialty Program located in St. Michael’s Hospital. All patients included in the study were diagnosed with WRA (either OA or WEA). Diagnoses were established by a single respiratory physician at Toronto Western Hospital and by the same respiratory physician or an allergist at St. Michael’s Hospital. All patients had been previously seen by one of these doctors for both clinics between 1991 and 2014. The SMH clinic was more recently established compared to TWH, so it was expected that on average patients would have been diagnosed more recently at SMH. Medical records contained within each of the clinics from 1991-2014 (1991-2014 for TWH and 2002-2014 for SMH) were reviewed by the graduate student to identify eligible patients and verify diagnoses via medical record review.

4.2 Inclusion and Exclusion Criteria

4.2.1 Inclusion Criteria:

1. Have a confirmed diagnosis of OA or WEA (ascertained from medical charts).

2. Ability to speak and comprehend English.
3. Have been assessed in either the Asthma and Airway Centre or the Occupational Disease Specialty Program.

4. Ability for the participant to be reached via phone and/or mail.

4.2.2 Exclusion Criteria:

1. Diagnosed with a non-psychiatric comorbidity such as cardiovascular disease, chronic obstructive pulmonary disease, or lung cancer, or a psychiatric comorbidity such as major depression or generalized anxiety disorder prior to being diagnosed with WRA. These comorbidities were present at the time of clinical evaluation at their first clinic visit, or in-clinic follow-ups before the present study. This information was gathered through review of medical records.

2. Inability to speak or comprehend English.

4.3 Study Protocol

The graduate student identified prospective patients through retrospective chart review. At the TWH clinic, patients’ charts are divided into ‘occupational’ and ‘non-occupational’ files. Patient charts were identified alphabetically among the occupational files for TWH. In the SMH clinic, the graduate student also identified prospective patients by going through patient files alphabetically. SMH chart systems were divided based on diagnosis (i.e. asthma or allergy, dermatological, toxicological, etc.). For this study, only charts classified with ‘asthma or allergy’ were reviewed. An established diagnosis of occupational asthma or work-exacerbated asthma was made through review of the ‘main findings’ component indicated in the physician consultation letters for both clinics.
A number of strategies were employed to increase patient enrolment in the present study. The TWH and SMH sample received a personal letter (please see Appendix C for the personal letters) signed by the treating physician inviting the patient to participate either on the phone or in the clinic. The option of carrying out the study via the phone was an integral option, as we were aware that many patients lived far distances from the clinic. The recruitment package also included the questionnaires used, a pre-paid return envelope and a consent statement (please see Appendix D for the consent forms and information sheets) describing the study and its research potential. No financial incentive was provided to patients unless they preferred to participate in the study in the clinic (in which case, reimbursement for travel and parking expenses would be provided). The SMH recruitment process was identical to that of the TWH population.

The graduate student waited at least 3 weeks after the recruitment package was sent out before telephoning eligible patients and answering any questions or concerns they had regarding the study. The graduate student called eligible patients at least 4 times (among those with working telephone numbers) before stopping further communication attempts. If the patient agreed to participate in the study, the graduate student then proceeded to complete the questionnaires with the patient by reading the questions aloud and provided clarification if needed (no individual question was difficult to understand across patients). If the call to the patient was at an inconvenient time, the graduate student scheduled a more convenient time to call to better accommodate the patient. The total duration of the patient interview typically took between 40 minutes and 1 hour. Patients indicated during the patient interview if they had an active WSIB claim at the time of the study. All information was entered into an SPSS database. All questionnaires were administered according to the instructions of its
developers. However, for questions related to the patient’s workplace, the graduate student would ask retired patients to retrospectively respond to provide the necessary answers to questions. It had been estimated that each call would take approximately 45 minutes to 1.5 hours per patient.

4.4 Baseline Assessment of Patients

There were a number of demographic and clinical characteristics that were extracted from patient records to establish a baseline for patients and to descriptively analyze the sample. This information was obtained through retrospective chart review. These demographic and clinical characteristics included age, sex, lung function, and working status when seen in the clinic. Relevant medical events were extracted such as if the patient had a previous asthma diagnosis, the year of onset of WRA symptoms and the official year of diagnosis. The specific exposures or causative agents (including HMW or LMW agents) were also noted from the charts.

4.5 Questionnaires

There were five questionnaires employed in the present study to elicit the psychological, quality of life, work limitation and socioeconomic status among patients.

4.5.1 Beck Anxiety Inventory (BAI)

The Beck Anxiety Inventory was formulated by Aaron Beck and fellow colleagues (Beck et al., 1998). It consists of 21 multiple-choice items and assesses the presence and severity of anxiety symptoms in adults or adolescents (please see Appendix C for the
questionnaire). Each item describes a specific symptom of anxiety. The primary domains that are assessed include autonomic, panic-related, neurophysiologic and subjective experiences. The BAI requires only rudimentary reading skills and was typically completed in less than 10 minutes.

In accordance with the suggested administration of the BAI questionnaire, participants were asked to report the extent to which they were bothered by each individual item in the past month. Each item had a four-point Likert-scale: “Not at all” or 0 (symptom does not exist); “Mildly” or 1 (did not bother me much); “Moderately” or 2 (was very unpleasant, but I could stand it); and “Severely” or 3 (I could barely stand it). The values of all 21 individual items were summed yielding a score that can range from 0 to 63 points. Interpretation of scores were as follows: 0-9 represents Minimal anxiety; 10-16 represents Mild anxiety; 17-29 represents Moderate anxiety and 30-63 represents Severe anxiety.

According to the manual (Beck et al., 1993), a score of 16 or higher is designated as the cut-off point for clinically significant anxiety symptoms.

The BAI has sound psychometric properties including strong validity and reliability. The internal consistency of the questionnaire yielded a Cronbach’s alpha from 0.92 to 0.94 for adults. In addition, test-retest reliability (separated by a week) was 0.75. The concurrent validity when comparing the BAI to the *Hamilton Anxiety Rating Scale, Revised* was 0.523 (Osman et al., 1993; Osman et al., 2002).
4.5.2 Beck Depression Inventory (BDI)

The format and structure of the Beck Depression Inventory (BDI) is identical to the BAI, except for the symptoms that are measured. The BDI consists of 21 multiple-choice items that evaluate the presence and severity of depression symptoms among patients in the 2 weeks prior to administration (please see Appendix C for the questionnaire). The questionnaire assesses a number of domains including levels of sleep and appetite, weight loss, concentration difficulties and energy loss (Beck, Rial & Rickets, 1974). The questionnaire was typically completed in less than 10 minutes.

Similar to the BAI, the BDI has a four-point Likert-scale for individual items ranging from 0 to 3. However, there are two items that consist of 7 options to determine increases or decreases of appetite and sleep. The scores of the 21 individual items are summed yielding a score from 0-63. 0-13 represents minimal depression, 14-19 represents mild depression, 20-28 represents moderate depression, and 29-63 represents severe depression (Beck, Streer & Brown, 1996). A recent study has reported that a score of 12 or higher is the optimal cut-off point indicating clinically significant depression (Plourde et al., 2016).

The BDI has been frequently used in many research areas and in many clinical and research populations. The BDI has high construct validity (0.80) and is able to distinguish between non-depressed and depressed patients. The test-retest reliability of the questionnaire (with the group being tested one week apart) had a correlation of 0.93 (Storch, Roberti and Roth, 2004; Beck, Rial & Rickets, 1974).
The BAI and BDI are considered useful tools in the area of WRA as well. The present study utilized the recommendations and methodologies employed by previous studies assessing mental health outcomes in patients with WRA. Both Malo et al. (2009) and Lavoie et al. (2013) effectively employed the Beck Inventories to measure mental health outcomes in a WRA population.

4.5.3 Marks’ Asthma Quality of Life Questionnaire (M-AQLQ)

Marks’ Asthma Quality of Life Questionnaire (M-AQLQ) was developed by Dr. Guy Marks in Sydney Australia (the tool is alternatively known as the ‘Sydney’ Quality of Life Questionnaire) (Marks, Dunn & Woodlock, 1992). It consists of 20 items that are on a Likert scale (please see Appendix C for the questionnaire). The questionnaire assesses symptoms including mood disturbances, breathlessness, and social disruption. The M-AQLQ asks respondents to answer questions based on the preceding four weeks.

Each item on the M-AQLQ has a scale from 0 to 4, with 0 representing “Not at all”, 1 representing “Mildly”, 2 representing “Moderately”, 3 representing “Severely”, and 4 representing “Very Severely”. The primary domains being assessed (with questions from each domain intermittently distributed throughout the questionnaire) include: Breathlessness, Mood, Social and Concerns (Marks, Dunn & Woodlock, 1992). The questionnaire was typically completed in less than 10 minutes.

The psychometric properties of the M-AQLQ have been assessed in a number of studies, and it has been shown to be both a valid and reliable tool. Short term test-retest reliability yielded an intraclass correlation coefficient of 0.80. Internal consistency of the tool
was assessed in an outpatient and community sample, yielding a Cronbach’s alpha of 0.92 and 0.94, respectively (Marks, Dunn & Woodlock, 1992). The Cronbach coefficient values for the different domains of the questionnaires ranged from 0.84 to 0.91 demonstrating its reliability. In addition, Spearman (rank) correlations were carried out between M-AQLQ scores and indicators of severity of asthmatic patients (the indicator was the amount of prescriptions taken to manage asthma in the preceding 3 months). The correlation was statistically significant and positive indicating that asthma severity was associated with QoL, and therefore indicates that the questionnaire has convergent validity (Gupchup, Wolfgang & Thomas, 1997). Studies assessing QoL among WRA patients have chosen to use M-AQLQ particularly for its ease of use via the phone as it contains five Likert-scale items and not 7 Likert-scale items such as in Juniper’s AQLQ (Lowery et al. 2007). In addition, M-AQLQ has sound psychometric properties, and there were no work-related items in the questionnaire that may act as confounding factors. These attributes made the M-AQLQ an appropriate choice for the current study.

4.5.4 Work Limitation Questionnaire (WLQ)

The Work Limitation Questionnaire (WLQ) was developed by Dr. Lerner and colleagues (Lerner, Amick, & Glaxo, 1998). This questionnaire assesses the influence chronic health issues have on job productivity and performance (please see Appendix C for the WLQ). The WLQ consists of 25 items that inquire about the level of difficulty of specific job demands in the preceding two weeks. However, patients that were currently on workers’ compensation and were not currently working or retired, were asked to retrospectively respond for the time when they were most recently still employed (for the present study).
There are four domains or work limitation scales that make up the WLQ: time management, physical demands, mental/interpersonal and output demands. The multiple domains acknowledge the multilayered nature of different job roles. Each individual item on the WLQ has a score between 1 and 5, with a higher score indicating a greater degree of work limitation. Individual scores are summed yielding a total score out between 0 (no limitation) 100 (which indicates limitation during work all the time) (Lemer et al., 2001). This questionnaire typically took less than 10 minutes to complete with the patient.

The WLQ has high construct and criterion validity among many fields including asthma (Munir, 2008; Chen et al., 2008). Inter-rated reliability when carried out by the same chronic population showed a 79% concordance rate. In addition, coefficients of reliability range from 0.88 to 0.91 among items within each of the 4 scales of the WLQ (Munir, 2008; Lerner et al., 2002).

### 4.5.5 Survey of Work and Non-work-related Respiratory Symptoms and their Impact

This questionnaire was developed by researchers in Toronto, and has not been validated. The questionnaire consists of a compilation of questions tailored towards patients diagnosed with WRA (please see Appendix C for the questionnaire). There are three main sections. The first asks about the demographic details of the patient at the time of the study, including level of education, marital status, and income before and after the diagnosis of WRA. The second section assesses a number of respiratory symptoms of the patient in the preceding month. Specifically, it asks how often the symptom occurred: “daily”, “weekly”,
“1-2 times per month”, or “don’t remember”. It also asks if any days off work during the month could be attributed to that specific symptom. These questions were omitted for those who were retired or unemployed. The symptoms assessed included wheezing, shortness of breath, coughing, and waking up with chest tightness. The final section consists of a chart outlining the specific occupations held by the patient (past and present), the duration of employment in that position, and the primary job activities and occupational exposures. This questionnaire has been used in previous pilot studies carried out at the University Health Network.

4.6 Medical Personnel

4.6.1 Respiratory or Allergy Specialist

The specialist physicians are responsible for assessing the patient by obtaining a medical history, and physical examination, prescribing medical imaging (e.g. chest x-ray) and other investigations when necessary, diagnosing, recommending or prescribing treatment (e.g. corticosteroids) and managing the patient’s illness (often over an extended period of time for those at TWH). As part of a multidisciplinary team at both institutions, the specialist physicians receive feedback from the other healthcare personnel and suggest what course of action to take to best help the patient.

4.6.2 Return-to-work-coordinator (RTWC)

The extent of the RTW intervention is variable. The RTWC’s responsibilities can include, but are not limited to (based on the discretion of the Workplace Safety and Insurance
Board [WSIB, RTWC and healthcare team]: in-person discussion with the patient on the type of duties being performed, work environment, and industry the patient works in; ongoing correspondence with the patient over the telephone to track progress and/or changes in the workplace; discussion with the healthcare team (e.g. clinic specialists) and WSIB on the type of workplace exposures and steps taken to ameliorate the patient’s outcome; discussion with the patient’s employer on appropriate steps to improve workplace conditions of the patient. The RTW intervention also requires cooperation by the patient in order to be most effective, as it is suggested that the patient evaluates his/her workplace conditions for the presence of any occupational triggers and health status, and be responsive to phone calls from the RTWC.

The return-to-work-coordinator (RTWC) at St. Michael’s Occupational Disease Specialty Program is registered as an occupational therapist. The RTWC initially consults with the physician to determine if the patient would benefit from RTW services, and then proceeds if deemed appropriate. However, the WSIB also needs to provide approval for a formal RTW intervention in order to proceed. The patients in the clinic are informed of the role of the RTWC and they then can choose to provide consent to have the RTWC contact the WSIB, the employer, and potentially other health care professionals to address the specific issues related to work. As part of a consultation report, the RTWC describes the patient and the specific work industry and/or sector, the work environment, the specific duties, and the number of hours worked by the patient. There is active discussion between the patient, clinic physician, and the RTWC regarding the necessary workplace modifications that may need to be employed. The RTWC then relays this information to the WSIB and specifies the main findings reported from the workplace assessment. If need be, workplace
meetings may be necessary to discuss the work issues in more details. In addition, meetings may be carried out (sometimes via conference call) with all relevant parties including the worker/patient, employer, the RTWC, clinic physician and the union to discuss modified workplace prescriptions. These modified duties are called “Stay at Work” (SAW) recommendations to better manage the patient’s illness (this information is also reviewed by the specialist). Furthermore, the RTWC reports any symptom exacerbations of the patient. The clinic physician and RTWC may advise that the patient utilize a diary to monitor his/her asthma exacerbations or skin conditions to facilitate in tracking the development of the condition.

4.6.3 Occupational Hygienist

The occupational hygienist is also often part of the multidisciplinary team managing patients with WRA in the St. Michael’s Occupational Disease Specialty program. The occupational hygienist has a number of responsibilities. She has to report a thorough workplace description, including the specific type of employment, industry/sector, previous work history and the hourly schedule of the patient. It is also typical for the occupational hygienist to describe the personal protective equipment used by the patient for the various job tasks and determine if the equipment is suitable. Material safety data sheets are reviewed and data summarized by the occupational hygienist with details about the product (e.g. components or properties of the occupational exposure) that may be associated with the patient’s WRA. Finally, a summary of all the occupational exposures that the patient had experienced is noted.
4.6.4 Respiratory Therapist

There are respiratory therapists that assist in managing patients in the Asthma and Airway Centre located at Toronto Western Hospital. They have a number of responsibilities. They are actively involved in respiratory assessments via diagnostic tools such as skin testing and peak flow monitoring. They may educate patients on how to adequately use respiratory medications, encourage treatment compliance among patients, and teach patients self-management techniques to avoid symptom exacerbations (Kallstorm & Myers, 2008). However, they provide no ongoing support to patients outside of the clinic. In addition, they do not monitor patients’ progress in transitioning back to the workplace and do not collaborate with those in the workers’ compensation system.

4.6.5 Data Storage

Patients from both TWH and SMH were assigned a random study identification number. In addition, data was collected using forms without patient-identifying information. Data was stored in a database (powered by SPSS Statistics 20) that was devoid of any personally identifiable information. The names of the participating patients were contained on a separate physical document stored within a locked cabinet located at Toronto Western Hospital. The computer and files were both password protected.

4.7 Data Analysis

All statistical analyses were completed using the Statistical Package for the Social Sciences (SPSS) for Windows, Version 20.0 (IBM Corporation, Armonk, NY). Descriptive
data including: baseline demographics, clinical characteristics, and socioeconomic characteristics were analyzed using independent t-tests for continuous variables, and Chi-square ($\chi^2$) tests for categorical variables. All analyses were set to a significance of $p < 0.05$. All data were expressed as a mean ± standard deviation.

4.7.1 Data Analysis of Questionnaires

The questionnaires (i.e. Beck Anxiety and Depression Inventories, Marks’ Asthma Quality of Life Questionnaire, Work Limitations Questionnaire) were scored and collated based on the scoring instructions of its developers.

Questionnaire data were compared between the two clinics (TWH and SMH) using independent t-tests for variables with normal distributions. Questionnaire data with non-normal distributions were compared between the two clinics using Mann-Whitney U tests. Data normality was assessed using the Kolmogorov-Smirnov test. Levene’s test for homogeneity of variances was carried out for each test to ensure variances among the groups did not significantly differ. Spearman correlation coefficients were used to assess the relationships between selected variables.
5. RESULTS

5.1 Description of Patient Population and Characteristics

5.1.1 Description of Recruitment and Response Rate

There were 293 charts in the TWH clinic for patients that had been initially seen in clinic between 1991 to 2014 and these were reviewed between 2013 and 2015 to determine patient eligibility. Of these, 103 charts included patients that were diagnosed with either occupational asthma or work-exacerbated asthma. Six were excluded and not deemed eligible due to either a non-psychiatric comorbidity, or a psychiatric comorbidity diagnosed prior to their WRA. Ultimately, there were 97 eligible patients diagnosed with WRA for the present study from TWH. There were 271 charts in SMH for patients that had been initially seen in the clinic between 2002 and 2014 and these were reviewed between 2013 and 2015 to determine patient eligibility. Of these, 71 charts included patients that were diagnosed with either occupational asthma or work-exacerbated asthma. Two were excluded and not deemed eligible due to either a non-psychiatric comorbidity, or a psychiatric comorbidity diagnosed prior to their WRA. Sixty-nine were considered eligible patients to participate in the present study.

There were 166 patients identified as being eligible to participate in the study among both clinic sites (n = 97 from TWH and n = 69 from SMH). Recruitment applications were sent out to the homes of these patients between 2014-2015. Forty-seven patients were successfully recruited from TWH, and 30 from SMH – with an overall response rate of 46%. Participants completed the questionnaires either over the phone (n=75) or at the clinic (n=2)
in the presence of the graduate student. The remainder of the non-participants had either refused (n = 19), died (n = 1), had a wrong phone number or a phone number no longer in service (n = 49) or were unsuccessfully contacted (n = 20).

5.1.2 Description of Diagnoses of Patients

A total of 77 patients participated in this study from both sites. Their diagnoses are characterized in Figure 5.1. The majority of participants were diagnosed with OA (65%).
Figure 5.1

Patients’ Diagnoses

```
Work-related asthma
77 Cases

Work-related asthma
TWH: 47 Cases

OA
29 Cases

SI-OA
19 Cases

II-OA
10 Cases

Work-related asthma
SMH: 30 Cases

OA
21 Cases

SI-OA
15 Cases

II-OA
6 Cases

WEA
18 Cases

WEA
9 Cases

Legend
TWH - Toronto Western Hospital
SMH - St. Michael’s Hospital
OA - Occupational asthma
WEA - Work-exacerbated asthma
SI - Sensitizer-induced
II - Irritant-induced
```
5.1.3 Description of Demographics of Patients

The clinical and demographic characteristics of patients are found in Table 5.1. Participants had a mean age of 56.8 ± 10.4 years and included more males (62%). In general, males tended to be older than females. The mean age for males and females were 58.3 ± 9.8, and 54.2 ± 10.9, respectively. OA patients tended to be older than WEA patients and were diagnosed earlier. A majority of participants were married (78%). The SMH sample had a slightly older population (along with a greater proportion of 60+ aged patients). The SMH sample also had a trend toward a more recent diagnosis compared to TWH (as expected due to the more recently established clinic at SMH).
### Table 5.1
Demographic and clinical characteristics; means and standard deviations of the sample at time of study

<table>
<thead>
<tr>
<th></th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/Female</td>
<td>48/29 (62%/38%)</td>
<td>27/20 (57%/43%)</td>
<td>21/9 (70%/30%)</td>
<td>0.268</td>
</tr>
<tr>
<td>Mean Age (years)</td>
<td>56.75 ± 10.4</td>
<td>55.26 ± 9.7</td>
<td>59.10 ± 11.1</td>
<td>0.113</td>
</tr>
<tr>
<td>Mean Age for OA Patients</td>
<td>58.70 ± 9.5</td>
<td>56.31 ± 8.2</td>
<td>62.00 ± 10.4</td>
<td>0.036*</td>
</tr>
<tr>
<td>Mean Age for WEA Patients</td>
<td>53.15 ± 11.0</td>
<td>53.56 ± 11.7</td>
<td>52.33 ± 10.1</td>
<td>0.792</td>
</tr>
<tr>
<td>Age Range (years)</td>
<td>34 – 79 (29 aged 60+)</td>
<td>34 – 74 (14 aged 60+)</td>
<td>37-79 (15 aged 60+)</td>
<td>-</td>
</tr>
<tr>
<td>Mean Time Since Symptom Onset</td>
<td>13.03 ± 7.2</td>
<td>14.15 ± 7.4</td>
<td>11.27 ± 6.5</td>
<td>0.087</td>
</tr>
<tr>
<td>Mean Time Since WRA Diagnosis</td>
<td>9.31 ± 5.4</td>
<td>10.23 ± 4.8</td>
<td>7.87 ± 6.0</td>
<td>0.060</td>
</tr>
<tr>
<td>Mean Time Since Symptom Onset for OA Patients (years)</td>
<td>13.82 ± 7.4</td>
<td>15.31 ± 7.0</td>
<td>11.76 ± 7.7</td>
<td>0.097</td>
</tr>
<tr>
<td>Mean Time Since WRA Diagnosis for OA Patients (years)</td>
<td>10.38 ± 5.8</td>
<td>11.45 ± 4.8</td>
<td>8.9 ± 6.7</td>
<td>0.124</td>
</tr>
<tr>
<td>Mean Time Since Symptom Onset for WEA Patients (years)</td>
<td>11.56 ± 6.6</td>
<td>12.28 ± 7.9</td>
<td>10.11 ± 2.6</td>
<td>0.433</td>
</tr>
<tr>
<td>Mean Time Since WRA Diagnosis for WEA Patients (years)</td>
<td>7.33 ± 4.02</td>
<td>8.28 ± 4.1</td>
<td>5.44 ± 3.1</td>
<td>0.085</td>
</tr>
<tr>
<td>Marital Status (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Single</td>
<td>10 (13%)</td>
<td>06 (13%)</td>
<td>04 (13%)</td>
<td>0.485</td>
</tr>
<tr>
<td>2. Married</td>
<td>60 (78%)</td>
<td>37 (79%)</td>
<td>23 (77%)</td>
<td></td>
</tr>
<tr>
<td>3. Widowed</td>
<td>01 (01%)</td>
<td>00 (00%)</td>
<td>00 (00%)</td>
<td></td>
</tr>
<tr>
<td>4. Divorced</td>
<td>03 (04%)</td>
<td>02 (04%)</td>
<td>01 (03%)</td>
<td></td>
</tr>
<tr>
<td>5. Separated</td>
<td>03 (04%)</td>
<td>02 (04%)</td>
<td>02 (07%)</td>
<td></td>
</tr>
<tr>
<td>Education Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Grade 12 or below</td>
<td>34 (44%)</td>
<td>20 (43%)</td>
<td>14 (47%)</td>
<td>0.793</td>
</tr>
<tr>
<td>2. Vocational Training</td>
<td>05 (07%)</td>
<td>03 (06%)</td>
<td>02 (07%)</td>
<td></td>
</tr>
<tr>
<td>3. College or University</td>
<td>38 (49%)</td>
<td>24 (51%)</td>
<td>14 (47%)</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation
Results that are significant at the 0.05 level are marked with an (*)
5.1.4 Description of Socioeconomic Characteristics of Patients

As reported in Table 5.2, roughly half of the participants (53%) were still working when they undertook the study. The majority of the working sample (63%) was working for a different employer and no longer exposed to the WRA respiratory triggers. Those patients still exposed to the same triggers among the TWH sample were diagnosed with either WEA or II-OA. The SMH clinic sample had a greater proportion of patients with a decrease in income compared to TWH and none were presently working in the same workplace under the same employer. Roughly half of all participants (52%) had an active WSIB claim (i.e. partial income, or medication coverages, etc.) at the time of the study. Roughly half of the total clinic population (49%) had gone to college or university (either attended some or completed college or university).
Table 5.2
Socioeconomic Characteristics, employment status and exposure status

<table>
<thead>
<tr>
<th>Present Working Status</th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Working</td>
<td>41 (53%)</td>
<td>25 (53%)</td>
<td>16 (53%)</td>
<td>0.496</td>
</tr>
<tr>
<td>2. Retired</td>
<td>27 (35%)</td>
<td>15 (32%)</td>
<td>12 (40%)</td>
<td></td>
</tr>
<tr>
<td>3. Unemployed</td>
<td>09 (11%)</td>
<td>07 (15%)</td>
<td>02 (07%)</td>
<td></td>
</tr>
</tbody>
</table>

| Mean Age of Retirees   | 65.15 ± 7.7       | 64.07 ± 6.3 | 66.5 ± 9.2 | 0.423   |

<table>
<thead>
<tr>
<th>Employment &amp; Exposure Status among workers</th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Same exposure and employer</td>
<td>07 (17%)</td>
<td>07 (28%)</td>
<td>00 (00%)</td>
<td>0.158</td>
</tr>
<tr>
<td>2. No exposure and same employer</td>
<td>08 (120%)</td>
<td>03 (12%)</td>
<td>05 (31%)</td>
<td></td>
</tr>
<tr>
<td>3. Different employer, no exposure</td>
<td>04 (10%)</td>
<td>02 (8%)</td>
<td>02 (13%)</td>
<td></td>
</tr>
<tr>
<td>4. Different employer, no exposure and</td>
<td>22 (54%)</td>
<td>13 (52%)</td>
<td>09 (56%)</td>
<td></td>
</tr>
<tr>
<td>part time status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supported by WSIB at time of the study (Yes/No)</th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some</td>
<td>40/37 (52%/48%)</td>
<td>24/22 (51%/47%)</td>
<td>16/14 (53%/47%)</td>
<td>0.267</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income Change Following Symptom Onset</th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Increased</td>
<td>07 (09%)</td>
<td>04 (09%)</td>
<td>03 (10%)</td>
<td>0.049*</td>
</tr>
<tr>
<td>2. Unchanged</td>
<td>31 (40%)</td>
<td>24 (52%)</td>
<td>07 (23%)</td>
<td></td>
</tr>
<tr>
<td>3. Decreased</td>
<td>39 (51%)</td>
<td>19 (40%)</td>
<td>20 (67%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income Change Following Symptom Onset Excluding Retirees</th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Increased</td>
<td>05 (10%)</td>
<td>02 (06%)</td>
<td>03 (16%)</td>
<td>.09</td>
</tr>
<tr>
<td>2. Unchanged</td>
<td>24 (48%)</td>
<td>19 (59%)</td>
<td>05 (28%)</td>
<td></td>
</tr>
<tr>
<td>3. Decreased</td>
<td>21 (42%)</td>
<td>11 (34%)</td>
<td>10 (56%)</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation
Results that are significant at the 0.05 level are marked with an (*)
5.1.5 Description of Clinic Baseline Characteristics of Patients

There were no significant differences in spirometry or methacholine data between clinics. In addition, no significant differences in spirometry data or methacholine data were found between tests performed during periods “at work” vs “off work” (Table 5.3).
Table 5.3
Baseline clinic characteristics (spirometry and methacholine challenge), sociodemographic, and return-to-work characteristics at initial clinic visit(s)

<table>
<thead>
<tr>
<th></th>
<th>Both Sites (N=77)</th>
<th>TWH (N=47)</th>
<th>SMH (N=30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/Female</td>
<td>48/29 (62%/38%)</td>
<td>27/20</td>
<td>21/9 (70%/30%)</td>
<td>0.268</td>
</tr>
<tr>
<td>Mean Age at First Appointment</td>
<td>50.2 ± 10.1</td>
<td>48.1 ± 9.8</td>
<td>53.4 ± 9.7</td>
<td>0.03</td>
</tr>
<tr>
<td>Working Status at First Appointment*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Working</td>
<td>55 (72%)</td>
<td>38 (81%)</td>
<td>17 (59%)</td>
<td>0.04*</td>
</tr>
<tr>
<td>2. Not working (1 excluded)</td>
<td>21 (28%)</td>
<td>09 (19%)</td>
<td>12 (41%)</td>
<td></td>
</tr>
<tr>
<td>Return-To-Work Intervention</td>
<td>N/A</td>
<td>N/A</td>
<td>12 (41%)</td>
<td>N/A</td>
</tr>
<tr>
<td>FVC, % predicted, Initial*</td>
<td>91.4 ± 15.9</td>
<td>90.4 ± 14.6</td>
<td>93.9 ± 18.9</td>
<td>0.446</td>
</tr>
<tr>
<td>1. At work</td>
<td>89.3 ± 17.8</td>
<td>86.1 ± 15.5</td>
<td>93.4 ± 20.0</td>
<td>0.192</td>
</tr>
<tr>
<td>2. Off work</td>
<td>76.6 ± 19.2</td>
<td>76.6 ± 16.1</td>
<td>76.5 ± 25.7</td>
<td>0.992</td>
</tr>
<tr>
<td>FEV1/FVC Initial*</td>
<td>78.2 ± 19.9</td>
<td>74.0 ± 18.3</td>
<td>83.8 ± 20.9</td>
<td>0.119</td>
</tr>
<tr>
<td>1. At work</td>
<td>68.3 ± 12.1</td>
<td>69.9 ± 11.1</td>
<td>64.4 ± 13.6</td>
<td>0.112</td>
</tr>
<tr>
<td>2. Off work</td>
<td>71.0 ± 10.2</td>
<td>71.5 ± 11.3</td>
<td>70.5 ± 8.9</td>
<td>0.765</td>
</tr>
<tr>
<td>Methacholine PC20 Initial*</td>
<td>6.0 ± 6.4</td>
<td>6.5 ± 6.9</td>
<td>4.6 ± 4.7</td>
<td>0.447</td>
</tr>
<tr>
<td>1. At work</td>
<td>6.4 ± 6.1</td>
<td>5.0 ± 5.5</td>
<td>8.1 ± 6.61</td>
<td>0.225</td>
</tr>
</tbody>
</table>

*Not all participants included
Values are expressed as mean ± standard deviation
Results that are significant at the 0.05 level are marked with an (*)
As shown in Figures 5.2 and 5.3, OA and WEA patients were more likely to have a decreased income following symptom onset as self-reported at the time of the study. Patients at TWH were more likely to have an unchanged income, and those at SMH were more likely to have a decreased income.

Figure 5.2
Comparison of Income Change among OA Patients between Clinics

Income Change Post Symptom Onset

Participants (%)

Increased
Unchanged
Decreased

TWH (n=29)
SMH (n=21)
At the time of the study, there were a comparable proportion of OA participants receiving some form of compensation from the WSIB between clinics. Those diagnosed with WEA were more likely to be receiving workers’ compensation at SMH compared to TWH. (Figures 5.4-5.5).
Figure 5.4
Comparison of Workers’ Compensation Status among OA Patients between Clinics

Participants Receiving Workers’ Compensation

TWH (n=29)  
SMH (n=21)  
65.5%  
57.1%

Figure 5.5
Comparison of Workers’ Compensation Status among WEA Patients between Clinics

Participants Receiving Workers’ Compensation

TWH (n=18)  
SMH (n=9)  
27.8%  
44.4%
5.1.6 Description of Industries and Occupational Triggers

Manufacturing was the most common industry sector among participants in the two clinics, accounting for 36% of WRA cases. Other less prevalent industry sectors identified among participants included trade (5%), health care (7%), construction (16%), food (10%), education (5%) and automotive (9%). There were no significant differences in the number of cases associated with these industries between the two clinics or the type of WRA.

The most common occupational triggers associated with participants’ WRA were dusts (including airborne dust, dust mites, and wood dust) and isocyanates, which accounted for 18% and 14% of WRA cases, respectively. Other less prevalent occupational triggers identified included cleaning products (4%), oils (3%), moulds (3%), plastics or rubber (3%), food ingredients (e.g. wheat flour) (9%), fragrances (1%), formaldehydes (3%) and other chemicals (13%). The overall distribution of occupational triggers did not differ between the two clinics.

There were some differences reported in the occupational triggers associated with participants’ type of WRA. Among the two clinics, isocyanates, cleaning products, and oils were present primarily among those with OA. In addition, dusts were identified primarily among those with WEA in both clinics.
5.2. Mental Health Status of Patients

5.2.1 Beck Anxiety and Depression Inventory Analyses

Please see Methods for a description of how Beck inventories were scored. For this study, participants were grouped into their respective categories based on severity level (i.e. minimal, mild, moderate, and severe), and then the raw data was averaged to allow for statistical comparisons between samples.

Among both clinics, slightly more than half were identified as having ‘minimal’ levels of anxiety, accounting for 56% of cases. ‘Mild’, ‘moderate’, and ‘severe’ levels accounted for 26%, 11% and 7% of WRA cases, respectively. SMH had a greater proportion of participants with ‘minimal’ levels of anxiety compared to TWH (68% v. 49%, respectively).

There were 13 (28%) participants from TWH and 4 (13%) participants from SMH that scored 16 or higher on the BAI, indicating clinically significant levels of anxiety. A chi-square analysis showed a non-significant trend (0.09).

Participants from TWH had a significantly higher level of anxiety compared to those from SMH (Figure 5.6). The difference arose primarily from OA participants (Figure 5.7).
Figure 5.6
Comparison of Mean Beck Anxiety Scores between TWH and SMH

![Bar chart showing comparison of mean Beck Anxiety Scores between TWH and SMH.]

Figure 5.7
Comparison of Mean Beck Anxiety Scores by diagnosis between TWH and SMH

![Bar chart showing comparison of mean Beck Anxiety Scores by diagnosis between TWH and SMH.]

OA
WEA

Type of Work-related Asthma

TWH
SMH
Beck depression scores also fell within ‘minimal’ range for a majority of participants across both clinics, accounting for 65% of WRA cases. The distribution of severity levels (i.e. minimal, mild, moderate, severe) were comparable between clinics, but SMH had more ‘minimal’ cases (72% for SMH vs. 60% for TWH). Overall, TWH cases had a significantly higher level of severity of depression compared to SMH cases (Figure 5.8). This finding was primarily due to OA participants (Figure 5.9), similar to Beck anxiety scores.

There were 19 (40%) participants from TWH and 8 (27%) participants from SMH that scored 12 or higher on the BDI, indicating clinically significant levels of depression.
### 5.2.1 Other Analyses of Beck Inventories

There was a significant positive correlation between the depression and anxiety scores across both sites (\( N = 77, R_s = 0.77, P < 0.0005 \)). In other words, those that scored high or low on one inventory were likely to score similarly on the other. There was no significant relationship found between the inventories and age or time since diagnosis. An independent samples t-test was carried out between males and females for both inventories across the two sites, and there were no significant differences (means for depression were 9.4 and 13.2 for males and females, respectively (\( P = 0.17 \)); means for anxiety were 10.54 and 10.34 for males and females, respectively (\( P = 0.92 \)).
5.3 Quality of Life Status of Patients

5.3.1 Marks Asthma Quality of Life Questionnaire (AQLQ) Analyses

Please see Methods for the instructions used to score Marks’ AQLQ. The allotment was as follows: not at all = 0, mild = 1, moderate = 2, severe = 3, very severe = 4. There were four subscales or domains that grouped questions including: Breathlessness (Questions 1-5), Mood (Questions 6 – 10), Social (Questions 11-17), and Concerns for Health (Questions 9, 11, 14, 17-20). The scores were then averaged.

There were no significant differences between the clinics for AQLQ domains, with the exception of a borderline significant difference for the ‘mood’ domain (Figure 5.10). There was a borderline significant difference between OA patients for the ‘mood’ domain when dividing the clinics based on diagnosis (Figure 5.11). Lastly, there were no significant differences between WEA patients when dividing the clinics based on diagnosis (Figure 5.12).
Figure 5.10
Comparison of Mean Marks’ Asthma Quality of Life Scores between TWH and SMH

Mean M-AQLQ Scores

Mild

Moderate

Total

Breathlessness

Mood

Social

Concerns for Health

Marks’ Asthma Quality of Life Domains

TWH (n=47)

SMH (n=30)

p = 0.06
Figure 5.11
Comparison of Mean Marks’ Asthma Quality of Life Scores among OA Patients between TWH and SMH

Marks’ Asthma Quality of Life Domains

P = 0.08

TWH (n=29)
SMH (n=21)
Figure 5.12
Comparison of Mean Marks' Asthma Quality of Life Scores among WEA Patients between TWH and SMH

Marks' Asthma Quality of Life Domains
5.3.2 Correlational Analyses of Marks’ AQLQ Scores

There was a significant positive correlation (p < 0.01) between all AQLQ subscales (including the sum mean) and the Beck anxiety and depression means (Table 5.4). No significant relationships were found between Marks’ AQLQ scores and age or time since diagnosis.

Table 5.4
Correlation matrix of M-AQLQ Scales and Beck Inventories

<table>
<thead>
<tr>
<th></th>
<th>Beck Anxiety</th>
<th>Beck Depression</th>
<th>AQLQ: Total</th>
<th>AQLQ: Breathlessness</th>
<th>AQLQ: Mood</th>
<th>AQLQ: Social</th>
<th>AQLQ: CFH</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQLQ: Total</td>
<td>0.444**</td>
<td>0.656**</td>
<td>1.00</td>
<td>0.887**</td>
<td>0.798**</td>
<td>0.950**</td>
<td>0.948**</td>
</tr>
<tr>
<td>AQLQ: Breathlessness</td>
<td>0.301**</td>
<td>0.480**</td>
<td>0.887**</td>
<td>1.000</td>
<td>0.612**</td>
<td>0.793**</td>
<td>0.781**</td>
</tr>
<tr>
<td>AQLQ: Mood</td>
<td>0.568**</td>
<td>0.824**</td>
<td>0.798**</td>
<td>0.612**</td>
<td>1.000</td>
<td>0.739**</td>
<td>0.693**</td>
</tr>
<tr>
<td>AQLQ: Social</td>
<td>0.386**</td>
<td>0.605**</td>
<td>0.950**</td>
<td>0.793**</td>
<td>0.739**</td>
<td>1.000</td>
<td>0.910**</td>
</tr>
<tr>
<td>AQLQ: Concerns for Health (CFH)</td>
<td>0.393**</td>
<td>0.580**</td>
<td>0.948**</td>
<td>0.781**</td>
<td>0.693**</td>
<td>0.910**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

** = Correlation is significant at the 0.01 level (2-tailed)
CFH = Concerns for Health
5.4 Work Outcomes

5.4.1 Work Limitations Questionnaire (WLQ) Description

Please see Methods for instructions on how the WLQ was scored. The WLQ is divided into four domains: time demands, physical demands, mental/interpersonal demands and output demands. These domains and the mean of the four domains were calculated. The data is shown in percentages, representing the extent of difficulty the patient had in their respective workplace. Each item was allotted a 4 if it was ‘difficult all of the time’, a 3 if it was ‘difficult most of the time’, a 2 if it was ‘difficult some of the time’, a 1 if it was ‘difficult a slight bit of the time’ and a 0 if it was ‘difficult none of the time’. If the participant responded ‘does not apply’, the item was removed. The mean was calculated of all of the items within each domain. If a participant responded ‘does not apply’, the mean was calculated out of the items that the participant did respond to. Following this, the mean was multiplied by 25 to place it on a scale from 0 – 100%. For further details of the scoring instructions please see Allaire (2003). It is important to note that a large portion of the participating patients were retired. These questionnaires are intended to assess work disability in the previous 2 weeks. For the purposes of this study, the graduate student asked the participants who were retirees to retrospectively provide the degree of their work disability.
5.4.2 Work Limitations Questionnaire (WLQ) Analyses

Participants at TWH had a greater amount of difficulty in the workplace compared to those at SMH, particularly for mental demands (Figure 5.13). This finding remained when excluding retirees from the analysis (Figure 5.14).

Figure 5.13
Comparison of Work Limitation Scores between TWH and SMH
Those with OA at TWH had a greater difficulty at work compared to those with OA at SMH, and this was most evident for time and mental demands. There was a borderline significant relationship for the average of the domains when comparing OA participants between the two clinics (Figure 5.15). There were no significant differences between those with WEA (Figure 5.16).
Figure 5.15
Comparison of Work Limitation Scores among OA Patients between TWH and SMH

![Graph showing comparison of work limitation scores between TWH and SMH patients.](image)

Work Limitation Domains

- Total
- Time Demands
- Physical Demands
- Mental Demands
- Output Demands

Legend:
- TWH (n=29)
- SMH (n=21)

Significance levels:
- p = 0.06
- p = 0.05
- p = 0.005
Figure 5.16
Comparison of Work Limitation Scores among WEA Patients between TWH and SMH

![Chart showing comparison of work limitation scores between TWH and SMH](image)
5.5 Return-to-Work Intervention Analysis

For specific details on the roles and responsibilities the RTWC has please see Methods. Six (20%) of the 30 participants at SMH were seen in the clinic prior to the employment of the RTWC and did not have this support available at the time. Twelve of the remaining 24 participants from SMH (50%) received RTW services. Those who received the RTW service by the RTWC (n = 12) had a better psychological status (p = 0.01 for Beck anxiety and p = 0.02 for Beck depression), comparable quality of life and work limitation status (with exception to mental demands, p = 0.04) compared to patients at TWH. Those who received the RTW service also had comparable scores on all questionnaires compared to SMH patients who did not receive this service (none reached statistical significance). As previously indicated, the type of services provided by the RTWC varied for each patient, depending on the types of needs (e.g. if appropriate exposure reductions would be useful) of the patient.
6. DISCUSSION

6.1. Overview of Key Findings among TWH and SMH Clinics and How They Relate to the Literature

6.1.1. General Overview

Existing literature has demonstrated that the burden WRA imposes on patients is multifactorial, and includes health, psychological, quality of life, personal, and socioeconomic effects. The present study aimed to assess these factors among two clinics and findings suggest that the clinic model adopted by SMH was associated with better mental health outcomes, less limitation in the workplace (for ‘mental demands’), and less impairment in quality of life (for ‘mood’) compared to TWH. However, socioeconomic outcomes were worse at SMH compared to TWH. This study also demonstrated that on average, the clinic samples investigated were characterized by minimal to mild levels of mental health and quality of life impairments. The patterns and differences among the clinics and how they relate to the literature will be systematically addressed.

6.1.2. Psychological Status

First, the overall degree of psychiatric morbidity as revealed by scores on Beck anxiety and depression inventories were skewed towards minimal and mild levels among both clinics (78.7% and 80.9% of TWH patients had either minimal or mild levels of anxiety and depression, respectively; 86.7% and 90% of SMH had either minimal or mild levels of anxiety and depression, respectively). However, there were a greater proportion of
participants at TWH (28% and 40%, respectively) that experienced clinically significant levels of anxiety and depression compared to participants at SMH (13% and 27%, respectively). The average and range of Beck scores reported in the present study are comparable (although slightly higher) to a previous study by Lavoie et al. (2013) that used Beck Inventories and investigated the prevalence of psychiatric disorders among patients with OA. Interestingly, the anxiety and depression scores reported in the present study were milder than a non-WRA clinic population (Ozcan, Dursun, & Cicak, 2015), but patients in that study had moderate-to-severe asthma which may have contributed to the higher levels. This study did not characterize participants by degree of asthma severity, so it would be difficult to make direct comparisons to that particular study.

In comparing mental health status between the two clinics, the level of anxiety (P < 0.001) and depression (P = 0.01) was significantly lower in SMH compared to TWH. These findings may be attributed to the different clinic structure, but it is important to be mindful of other potential contributing factors. Firstly, the SMH clinic sample had a higher mean age (non-significant) compared to TWH, and studies have reported that the prevalence of anxiety and depression may decline with age (Henderson et al., 1998; Jorm, 2000). Secondly, the proportion of retired patients in SMH was greater (non-significant) than TWH, and a systematic review indicated that retirement may have a therapeutic effect on mental health (Burdorf et al., 2013). Although these demographic differences (i.e. age and retirement) were not significantly different between the two clinics and likely did not have a substantial effect on Beck scores, their presence should still be considered in interpreting the findings.
The association between asthma and declines in mental health have been well-established (Ten & Petermann, 2000; Katon et al., 2004; Deshmukh et al., 2007). A longitudinal study reported that there was a 41% increased prevalence of depression and 66% greater lifetime risk of developing depression in asthma patients compared to healthy controls (Trojan et al., 2014). Similarly, a clinic study reported that there was a 43.5% increased risk of anxiety among a sample of predominantly mild asthma patients compared to healthy controls (Gada et al., 2014). Levels of anxiety and depression tend to be particularly high among patients with uncontrolled asthma characterized by nasal and bronchial symptoms (Ciprandi et al., 2015). This study did not include a non-asthma or non-WRA control group of asthmatics, and it would be interesting for future research to see if the prevalence of anxiety or depression is greater in patients with WRA compared to non-WRA patients and healthy controls.

This study reported a significant correlation (P < 0.001) between Beck anxiety and depression scores, and is likely suggestive that there was strong concurrency in the level of severity between the symptoms (i.e. patients experiencing mild anxiety likely experienced mild depression and patients experiencing severe anxiety likely experienced severe depression). This is consistent with Goodwin et al. (2014) who reported that patients diagnosed with a respiratory condition were more likely to have concurrent anxiety and depression compared to controls. Similarly, Marco et al. (2010) reported a high correlation between anxiety, depression and poor asthma control. Our study also reported that approximately 21.3% and 19.1% of TWH patients had either moderate or severe levels of anxiety and depression, respectively. In comparison, 13.3% and 10% of SMH patients had either moderate or severe levels of anxiety and depression, respectively.
In general, there are few studies that have explored the relationship between WRA and mental health. Lavoie, Joseph and Bacon (2009) reported that 35% and 23% of patients with OA have an anxiety or depression disorder, respectively. Moullec at al. (2013) reported that 27% of OA and 32% of WEA workers experienced some form of psychological distress compared to 13% of nonasthmatic workers. In addition, they indicated that 23% and 18% of OA and WEA patients had Beck anxiety scores ≥16, respectively, and 27% and 32% of OA and WEA patients had Beck depression scores ≥13, respectively. The present study reported 16% and 33.3% of OA and WEA patients had Beck anxiety scores ≥16, respectively, and 28% and 37% of OA and WEA patients had Beck depression scores ≥13, respectively.

In general, this study suggests that psychological status among WEA patients may be worse than those with OA, and this was found more consistently among the various questionnaires used compared to the findings of Moullec et al. (2013). Overall, this study reported a very small number of patients experiencing severe or moderate forms of anxiety or depression, and this could be due to several factors. Firstly, the vast majority of patients left their original workplace that contained occupational triggers or else workplace conditions were modified to accommodate patients. As a result, patients may have had a more optimally controlled asthma as they were no longer exposed to asthma triggers, and their better controlled asthma may result in fewer psychological symptoms. Secondly, the mean time since patients had been initially investigated for suspicion of WRA among both clinics was 9+ years, and if they had experienced episodes of psychological distress in reaction to their WRA, these symptoms may have diminished over time. Thirdly, both clinics have a respirologist or clinical allergist specifically trained to treat patients diagnosed with WRA and to provide the necessary educational and behavioural interventions where necessary. In
addition, SMH has a RTWC and TWH has a dedicated respiratory therapist who also educates patients on self-management techniques and the importance of treatment compliance (the RTWC does not fulfill this specific role). These aforementioned characteristics of the clinics and interventions used by medical personnel may have played a role in the absence of more severe psychological status among patients. It is important that these interventions along with a psychological support if deemed necessary be part of a tailored therapy for patients that have chronic respiratory diseases such as WRA.

6.1.3. Asthma Quality of Life (QoL) Status

QoL impairments among patients with WRA can include a greater occurrence of asthma attacks and exacerbations, general lack of energy, poorer self-rated health, and limitations in hobbies and social life (Kneoller et al., 2011; Lemiere et al., 2007; Guilbert et al., 2011). We assessed the QoL of patients with Marks’ AQLQ, which assesses the following domains: breathlessness, mood, social concerns, and concerns for health. Our study reported comparable QoL status among patients at the TWH and SMH clinics, with an average score (across all domains) of 1.1 and 1.0, respectively (1 falls within the mild range). The ‘Mood’ domain was the only one that had a more pronounced difference between the two clinics (non-significant), with an average score of 1.0 and 0.7 for TWH and SMH, respectively. These findings are similar to a study done by Urrutia et al. (2012) that reported an average QoL score (across all domains) of 5.57 among non-WRA patients (they used Juniper’s Asthma Quality of Life Questionnaire [AQLQ], where 7 represents no impairment, and 1 represents severe impairment). In addition, they indicated that QoL of patients was more impaired among those that had poorly controlled asthma (characterized by lower FEV₁,
and asthma symptoms at follow-up). They also reported that patients that had anxiety had a worse QoL in all domains, and that concurrent anxiety and depression were associated with greater impairment in QoL. Consistent with this finding, this study reported significant correlations between Beck anxiety and depression scores and all QoL domains (P < 0.01).

Miedinger et al. (2011) assessed QoL among patients diagnosed with OA also using Juniper’s AQLQ, and reported an average QoL score of 4.6. This score is slightly worse than Urrutia et al. (2012), and likely represents a greater level of severity compared to the present study’s clinic sample, although it is empirically challenging to directly compare the two studies as we used Marks’ (Sydney’s) AQLQ. This study also indicated that the majority of participating patients had left the workplace that caused OA, consistent with this study among OA patients.

Similarly, Malo et al. (1993) compared QoL outcomes between OA and non-OA patients who were matched on clinical and functional indices (i.e. medication reliance, FEV$_1$, level of bronchial responsiveness). Among those with OA, participants were no longer exposed to the causative agents during re-evaluation for the study. They used Juniper’s AQLQ (currently considered an out-dated version with a reversed scale) where 1 represented no impairment and 7 represented maximum impairment. Those diagnosed with OA had an average score (across all domains) of 2.8, compared to 2.3 for those with non-OA. Future studies should research this area and determine if there have been any changes in QoL status between WRA patients and non-WRA patients in the modern work environment.
6.1.4 Work Limitation Status

WRA is associated with greater limitations in the workplace, loss of income, and higher rates of unemployment (Vandenplas & Henneberger, 2007; Vandenplas et al., 2008). I assessed the extent to which patients’ WRA interfered with their ability to work in their respective jobs for several domains: time demands, physical demands, mental-interpersonal demands, and output demands. Among the two clinics, TWH’s participants performed slightly worse on all domains compared to SMH, but with only ‘mental demands’ reaching statistical significance. Since SMH had a greater number of retirees, I removed retirees from both clinics to avoid this possible confounding factor, and this relationship remained, but with ‘mental demands’ now becoming more pronounced. However, the RTWC might have potentially played a role as hypothesized in providing select patients with the necessary support systems and preventive strategies to avoid further limitation in the workplace, which may account for this difference. However, it is difficult to establish a strong link, given the small sample size of patients receiving the RTW intervention by the RTWC and the low statistical power. A previous study (Franche et al., 2005) that evaluated return-to-work intervention among patients with pain and musculoskeletal conditions reported lower durations of work disability and costs among workers, but inconclusive findings on quality of life.

6.1.5 Socio-Demographic and Economic Characteristics

This study included patients diagnosed with WRA at an average of 10.2 and 7.9 years post-diagnosis for TWH and SMH, respectively. The time since diagnosis was borderline
significant between the two clinics. However, the SMH occupational disease clinic had been established more recently compared to the TWH clinic, and this likely accounted for the difference. Among the two clinic samples combined, the time since diagnosis for OA patients (11.6 years) was greater than those with WEA (7.3 years), and this reached statistical significance. This finding was also accompanied by an older OA patient population (58.7 years) compared to the WEA patient population (53.1 years), and this difference also reached statistical significance. The age difference may largely be due to the time difference since diagnosis.

There were no significant differences in current working status between TWH and SMH. Fifty-three percent were working at the time of the study, 35% were retired and 12% were unemployed. Of those that were retired, information was not collected to determine if this was a voluntary retirement or a necessary retirement related to WRA. Indeed, patients with WRA may experience significant occupational impairments that may lead to patients resorting to a premature retirement. White et al. (2015) reported that those with WRA, non-WRA, and healthy controls had unemployment rates of 41.8%, 27.9% and 14.4%, respectively. It has been suggested that workplace exposures are associated with greater asthma severity, asthma exacerbations, and a higher burden of healthcare costs, and this may contribute to the higher unemployment rates (Henneberger et al., 2010).

Only 9% of participants in the present study were still working in the same workplace exposures as when they were initially assessed and diagnosed. This is similar to a study previously mentioned by Moullec at al. (2013), who reported that 84% and 65% of OA and WEA workers were removed from their workplace that was associated with their WRA,
respectively. These findings are consistent with a recent article (Malo et al., 2015). They indicated that persistent exposure to workplace agents may lead to declines in FEV\textsubscript{1} and is associated with the age of patients and duration of asthma. Complete avoidance of workplace agents allows for the most favourable outcome among patients with WRA (Lange et al., 1998).

Interestingly, participants at SMH had a greater reduction in income compared to those at TWH post-symptom-onset. It is possible that the greater number of retirees in SMH may have contributed to this income decline. In addition, workers’ compensation tends to amount to less than workers’ typical income for those who are not retired. For instance, the Workplace Safety and Insurance Board in Ontario provide an annual wage ceiling of 85% of take home pay (WSIB, 2016). Overall, the financial burden was substantial in these clinic groups, with approximately half of the total participants having a reduced income following symptom-onset. This finding is similar to Cannon et al., (1995), Ameille et al. (1997), Larbanois et al. (2002), Leira, Bratt and Slastad (2005) and Moullec et al. (2013) who reported a reduction in income for 55%, 46%, 62%, 51% and 50% of WRA patients, respectively.

There were no significant differences between the clinics among those who were provided workers’ compensation through the WSIB. Roughly, half were provided workers’ compensation at the time of the study when combining the two clinic samples. It is difficult to compare this finding to other studies, as different jurisdictions hold different regulations, and cover varying aspects (i.e. work disability, physiological impairment, loss of income, healthcare costs, etc.). In Quebec, Moullec et al. (2013) reported that among those WRA
patients that had lost earning power, all were offered financial compensation. In Europe, 17% to 87% patients diagnosed with OA received financial compensation due to their work-related condition (Larbanois et al., 2002; Gannon et al., 1993; Marabini et al., 1993).

The industrial sectors in which participants worked were not different between TWH and SMH. Manufacturing (36%) was the most frequently reported industry among the two clinics. This is consistent with Jajosky et al. (1999) who reported 41.5% of WRA cases were associated with the manufacturing industry in Michigan and New Jersey.

6.2 Limitations of the Present Study

There are a number of limitations that need to be acknowledged in the present study. Firstly, the sample sizes of the clinics were small, particularly for SMH, and larger samples would allow for a more representative WRA population, greater statistical power and confidence in outcomes. Secondly, the referral patterns of the two clinics differed which was an unavoidable confounding factor. TWH mainly received referrals from respirologists or family doctors, and SMH received referrals from the WSIB. The difference in referrals may have affected the type of patient populations being assessed in these two clinics. Moreover, this study was only available to those who were fluent in English comprehension and writing, and investigation of these variables on a more culturally diverse population would account for this subset of the population. In addition, SMH was characterized by a greater number of retirees, an older sample and a more recent diagnosis, which may have affected the findings. Finally, although the severity of participants’ asthma was described (i.e. lung function data), it was not considered when exploring the variables. In addition, the low response rate of participants (46%) indicates that there may be a response bias. Future
research should consider these limitations to ensure a more empirically appropriate study when assessing clinic differences.

6.3 Strengths of the Present Study

The present study assessed variables among patients at a mean of 9+ years post-diagnosis when combining the clinics. This represents a unique characteristic and a strength of the present study and better elucidates long-term outcomes in areas of psychological status, QoL, socioeconomic status, and work limitation. For instance, in a review by Vandenplas (2008), of the 10 studies assessed to explore employment and income loss among patients with OA, only one study had included patients with a mean of 10 years’ post-diagnosis (Piirila et al., 2005), the remaining studies ranged from 1.5-6 years. Similarly, in studies exploring QoL and mental health status, patients were seen up to 6 years’ post-diagnosis (Mazurek, Knoeller & Moorman, 2012; Coban and Aydemir, 2014; Knoeller, Mazurek, & Moorman, 2013). A systematic review on the available literature exploring QoL, mental health and work limitation status among patients with WRA may be useful to determine if there are concrete conclusions in these areas.

There has been a paucity of literature exploring how clinic models affect the variables evaluated (i.e. psychological, socioeconomic, quality of life and workplace limitation), and this study tried to addresses this gap, and represents a strength of the current study. It has been reported that outcomes among those with WRA may be influenced by many factors, and considering these other aspects are important in the management of patients’ care. It is difficult to tease out other confounding factors that may have influenced the variables
assessed in this study when looking at differences in clinic models and how it affects outcomes. Future research should explore this possible relationship in a more empirically controlled study, with a more homogenous population that have similar levels of severity, and similar amount of time elapsed from diagnosis to being assessed in a study such as this one.

Patients were mainly seen by a single respiratory physician among both clinic samples. All patients in the TWH sample were seen by this physician, and a majority in the SMH sample were also seen by her. This represents a strength of the study, as diagnostic, treatment, and management practices were likely comparable between the two clinics.

Another strength of the current study is that comparisons of the two clinic models were between two tertiary centres in Toronto (in the same jurisdiction) where the operational definition of WRA and the clinical steps and strategies employed are the same. Clinical steps include the approach in diagnosing, evaluating, managing, and treating the patient. These characteristics may differ in other jurisdictions compared to Ontario, and this may render it more challenging to make appropriate interpretations of the results.

6.4 Conclusions and Future Directions

In summary, the present study compared psychological status, quality of life, workplace limitation, socioeconomic status, and other sociodemographic and clinical variables (i.e. time since symptom onset and diagnosis, working status, retirement status, etc.) among patients seen at two tertiary clinics in Toronto. The clinic model of the two tertiary clinics differed (see Table 1.1). We had hypothesized that the variables explored in
this study may be affected by the different clinic structure. In general, a better psychological status (i.e. anxiety and depression), quality of life (for ‘mood’), and workplace limitation (for ‘mental demands’) among participants in SMH was reported, and a better socioeconomic status among participants in TWH. These differences, however, should be interpreted cautiously because of the aforementioned limitations.

This study was an important one to undertake for several reasons. First and foremost, the existing literature has demonstrated that WRA has broad effects on the lives of patients, and evaluating their condition from multiple angles is important to ensure that all aspects of their health are being adequately managed. This study reported that a substantial proportion of patients among both tertiary clinics experienced clinically significant levels of anxiety (21%) and depression (36%). These rates are significantly higher than prevalence rates of anxiety and depression found in the general population. A recent Canadian epidemiologic survey reported the presence of generalized anxiety disorder in the general population and indicated a lifetime prevalence rate of 8.7% and a 12-month prevalence rate of 2.6% (Watterson et al., 2016). Similarly, lifetime prevalence was 11.3% and 12-month prevalence was 4.7% for major depression among the general Canadian population (Patten et al., 2015). This suggests that psychological support should be provided to patients if considered appropriate, and may prevent a worse psychological outcome, and would likely be beneficial to a WRA population where psychological disorders are more prevalent.

Secondly, appraisal of healthcare delivery is essential to ensure quality care is being provided to patients. In addition, different clinic models may be more appropriate depending on how the patients’ condition impacts their health, lifestyles, and other personal factors. A
very small number of studies have evaluated the impact clinic structure (including multidisciplinary care) has on outcomes among patients with asthma. Studies that do explore this topic primarily assess clinical measures such as asthma severity, and healthcare utilization. To my knowledge, there has been no exploration in the existing literature of the affect clinic structure has on psychological, quality of life, work limitation and socioeconomic status among patients diagnosed with WRA. This study tried to address this gap, and future research should further examine this area. It is often suggested that patients with severe or difficult-to-treat asthma may benefit from tertiary centres that include multidisciplinary teams.

This study only collected limited information on socioeconomic status from participants. For instance, the proportion of patients that had a self-reported reduced income is included, but it would be insightful to know the extent to which income decreased among participants. Although there were a greater number of participants with reduced income at SMH, it is not known if participants had more or less of an income decline compared to those at TWH. Certainly, future studies should explore the amount of income reduced among WRA patients, as this may provide a more valid measure of the extent to which socioeconomic status is influenced.

This study carried out a cross-sectional comparison between the two clinic samples for a single time-point. This only provides limited information on the status of selected variables among participants. Future studies should utilize a methodology similar to this, but evaluate patients initially diagnosed with WRA, and then repeat the process several times post-diagnosis. A study such as that one would provide a greater depth of information for
each participant. Speculatively, those initially diagnosed may potentially have a more severe symptom profile and psychological status compared to when they are evaluated at a later time-point (assuming they are able to adequately manage their condition and have good asthma control). If appropriate psychological and workplace intervention are incorporated early on, the methodology employed by this study should be able to better identify if these services are beneficial for participants.

As previously mentioned, this study did not consider asthma severity among participants, and this is an aspect that should be considered in future studies. There have been a small number of studies that have indicated that psychological factors account for a portion of poor asthma control. This would enable us to have more definitive conclusions on the extent clinic structure can affect psychological status. The clinic samples were located at tertiary centres, which are generally associated with a greater number of patients with more severe or complex lung conditions, but there is still enough variability between patients to warrant this control measure. Future research should also further investigate and consider the extent to which asthma severity or exacerbations are related to psychological factors.

There were fewer participants with WEA compared to those with OA that received some form of financial compensation from the WSIB at the time of the study. Previous literature has suggested that among certain jurisdictions, those that have asthma caused by workplace exposures (i.e. OA) are more likely to have their compensation claims accepted compared to those with WEA (Vandenplas et al., 2003). Those with WEA should be considered with the same weight, as there has also been evidence that patients with WEA
among a tertiary clinic population have more severe asthma compared to those with OA (Lemiere et al., 2013). Future clinic studies should identify if this pattern is observed as well.

Although not addressed in this study, future studies should also evaluate WRA preventive and surveillance strategies that are presently being employed in Ontario. An abundance of literature has demonstrated that WRA is under-recognized and potentially under-diagnosed. One important strategy is to educate the population on potential work-related effects in the workplace. For instance, as previously mentioned, a web-based educational tool has been recently developed (Ghajar-Khosravi et al., 2013) to educate adolescents on WRA, and its efficacy was demonstrated in a recent study among a sample of patients at a tertiary care clinic (Lipszyc et al., 2016). Further studies are planned to explore the effectiveness of this web-based tool in schools in Toronto. Educating adolescents may enable them to make more informed decisions when navigating the workforce and pursuing career paths.

Another important preventive strategy would be to further identify other possible occupational triggers associated with WRA, and to replace provocative agents with safer substitutes. An occupational hygienist who is knowledgeable on workplace hazards may best to carry out this strategy. For instance, quaternary ammonium compounds are often used in cleaning products (e.g. antiseptics, disinfectants, detergents), but very little research has explored this possible association with OA. Identifying a greater number of occupational triggers and preventing their exposure may lead to higher rates of prevention.

This study mainly included WRA patients who were diagnosed multiple years before undertaking the study, and provides useful information on patients being followed for several
years. However, it would be equally important for future research to explore short-term outcomes among patients with a more recent diagnosis as impairments in mental health, quality of life, or the workplace may be greatest soon after diagnosis, and this information can be useful in determining appropriate interventions. In the future, research should also include a healthy control group to compare short-term and long-term outcomes of WRA with non-WRA.
References


IAPA. (2009). Work-related asthma: Preventing work-related asthma in higher risk industries. Retrieved from


Labrecque, M. (2012). Irritant-Induced Asthma. *Current Opinion in Allergy and Clinical Immunology,* 2(12), 140-144.


Workplace Safety and Insurance Board, 2016. http://www.wsib.on.ca/WSIBPortal/faces/WSIBArticlePage?fGUID=835502100635000226&_afrLoop=883055121725000&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D883055121725000%26_afrWindowMode%3D0%26fGUID%3D835502100635000226%26_adf.ctrl-state%3D768hkkkzv_4 Accessed October, 2016.

Appendix A

Susan M. Tarlo, MB, BS, FRCP (C)
Division of Respirology
Toronto Western Hospital
7th Floor, East Wing, Rm 449

February 24th, 2014

Dear Patient,

We are conducting a graduate student research study to investigate the health and psycho-socio-economic outcomes of patients with work-related asthma. We enclosed information and a consent form as well as a copy of the questionnaires that we will use. Your participation is completely voluntary and would not affect any medical care you would receive in our clinic.

You will be contacted by telephone by a graduate student (Joshua Lipszyc) within the next 2 weeks to ask you whether or not you would like to participate. If you wish to participate, the questionnaire will be completed by the graduate student with you, over the phone or in the clinic, whichever is more convenient for you. It will take approximately 45 minutes to complete. In addition, we ask you to please return the signed consent form indicating whether you agree to the study. We enclose a stamped, self-addressed envelope so that you may return this to us after any questions you may have are answered by the graduate student.

To find out more information about the study, please read the enclosed study description, and please feel free to ask any questions about this study to Joshua Lipszyc when he phones you, or you may call me at 416 603 5177.
January 22, 2015

Dear Ms. Patient,

We are conducting a research study to investigate the health and psycho-socio-economic outcomes of patients with work-related asthma, entitled “Survey of Work and Non-work Related Respiratory Symptoms and their Impact”. We enclosed an information sheet describing the study. Your participation is completely voluntary and would not affect any medical care you would receive in our clinic.

Unless you indicate otherwise, you will be contacted by telephone by a graduate student (Joshua Lipszyc) who is conducting (under my supervision) this research study as part of his Masters’ program at the University of Toronto. He will phone you within the next 6 weeks to ask you whether or not you would like to participate. If you wish to participate, the questionnaire will be completed by the graduate student with you, over the phone or in the clinic, whichever is more convenient for you. It will take approximately 45 minutes to complete. In addition, we ask you to please return the signed consent form indicating whether you agree to the study. We enclose a stamped, self-addressed envelope so that you may return this to us after any questions you may have are answered by the graduate student.

To find out more information about the study, please read the enclosed study description, and please feel free to ask any questions about this study to Joshua Lipszyc when he phones you, or you may call me at 416 864 - 5056. If you do not wish to participate in the study and do not want to receive further correspondence from us please call Ms. Pilar Gomez, a member of the clinic team, after 5:00 pm within the next 3 weeks and leave a message on her voicemail at 1 877- 877-6781 ext. 3223. Please include your first and last name and the title of this study, “Survey of Work and Non-work Related Respiratory Symptoms and their Impact”, and state you do NOT wish to participate. If you wish to participate, there is no need to follow-up with a phone call; a graduate student will correspond with you sometime in the
near future.

With many thanks,

Susan M. Tarlo
Appendix B

GRADUATE RESEARCH CONSENT FORM FOR NEW PATIENTS

Title of Study
Survey of Work and Non-work Related Respiratory Symptoms and their Impact

Principal Investigator:  Dr. Susan Tarlo

Master's Student:  Mr. Joshua Lipszyc

Contact Information
Dr. Susan Tarlo, Mr. Joshua Lipszyc,
Toronto Western Hospital, East Wing 7-449, joshua.lipszyc@mail.utoronto.ca
399 Bathurst Street, Toronto, Ontario,
M5T 2S8
416-603-5177
susan.tarlo@utoronto.ca

Name of Sponsor: Not applicable.

Introduction of Research Study
You are being asked to dedicate some of your time to be a participant in a graduate student research study. Please read the enclosed background, purpose and procedures to acquire an understanding of the study at hand and the associated risks and benefits. Please
take as much time as you need to decide if you wish to participate. You can refuse or withdraw from the study at any time. If there is content you do not adequately understand in this application, please deliver inquiries to Dr. Tarlo or Mr. Lipszyc. It is important that you have an understanding of the research content and protocol prior to providing your informed consent. Your involvement in this study will afford us with valuable knowledge concerning the different models of clinic structure and its effect on work-related asthma outcomes. This study should take no more than 45 minutes of your time.

**Purpose/Background of Research Study**

The purpose of this research study is to better understand the psycho-socio-economic and health outcomes of patients with asthma induced or aggravated by work conditions, and those with non-work-related asthma treated from two tertiary clinics. The non-work-related asthma patients will be recruited from the Asthma and Airway Center of Toronto Western Hospital. The work-related asthma patients will be reviewed from the two tertiary lung clinics in Toronto; at Toronto Western Hospital and St. Michael’s Hospital. Although the diagnostic process is the same at hospitals, the referral process and clinic organization structure differs. Referrals at St. Michael’s hospital are mainly from the Ontario Workplace Safety and Insurance Board, in comparison to Toronto Western Hospital which receives direct physician referrals.

**Study Design/ Description of Research**

The following research protocol will be employed in this study:

1. Mr. Lipszyc will administer 5 questionnaires to you concerning quality of life, past and present work history, and psychological profile of the patient. This interview will take place either on the phone or in-person at the clinic.
2. An examination of your health charts will be carried out to acquire previous and current environmental exposures, history of asthmatic symptoms, and severity of symptoms based on pulmonary function tests.
3. You will be offered a medical follow-up appointment with Dr. Tarlo to determine any changes in your work-related asthma through pulmonary function testing and methacholine challenge tests.
Procedures

1. **Marks Asthma Quality of Life Questionnaire**
   This questionnaire will take approximately 5 minutes. This assessment comprises 20 items that measures the extent that asthma has negatively affected your life and contains four domains: Breathlessness, Mood Disturbance, Social Disruption, and Health Concerns.

2. **Beck Anxiety and Depression Inventories**
   These questionnaires are 21 items each and measures the severity of anxiety and depression. These two questionnaires will take approximately 20 minutes.

3. **Survey of Work and Non-Work-Related Respiratory Symptoms and their Impact**
   This questionnaire assesses your demographic details, workplace environment and medication use. This questionnaire should take approximately 15 minutes.

4. **Work Limitation Questionnaire (WLQ)**
   This survey assesses the stresses particular job demands have on you and should take approximately 5 minutes.

5. **Pulmonary Function Testing (PFT) and Methacholine Challenge Tests**
   As part of a routine medical visit, PFT and methacholine challenge tests will be used to objectively assess the severity of the patient’s asthma.

**Voluntary Participation and Withdrawal**

   This study is entirely voluntary. You can refuse or withdraw from this study at any time. If you choose to participate or refuse, it will have no bearing on the quality of the health care provided to you. Furthermore, if you choose to withdraw from the study you may request for the withdrawal of data collected.

**Potential Risks/Harms of this Study**

   There are no predictable harms or risks associated with this study by being a participant. However, the study takes approximately 40 minutes which may be time-consuming, but breaks are permitted.

**Potential Benefits of this Study**

   As a participant, you will not receive direct benefits or compensation. However, your involvement in the study will advance our knowledge on psycho-socio-economic and health outcomes of work-related and non-work-related asthma patients. The knowledge acquired by
this research is intended to advance clinical applications for work-related and non-work-related asthma populations.

**Reminders**

If you have inquiries regarding the study please do not hesitate to ask the study investigators. If you decide to change your mind regarding your involvement in the study, please let us know at your earliest convenience.

**Alternatives to being in the Study**

Should you choose to not be in this research study, your quality of treatment will not be affected. You will continue to receive medical treatments and interventions to manage your work-related asthma.

**Confidentiality**

Maintaining confidentiality is important to us. The investigators will only extract the information relevant to the study from your health records and through the assessment questionnaires we use. Your information will only be seen by the investigators of this study, unless you consent otherwise or is required by law. Any information collected from your file and through the questionnaires will be represented by a “study number” to ensure external parties are unable to identify you. Information that is considered identifiable will not be permitted to leave hospital premises. Moreover, identifiable information will be stored in password-protected computers within the hospital premises where only study investigators are granted access.

**Study Contact Information**

If you have questions or concerns about this study, please contact Dr. Susan Tarlo (Susan.Tarlo@utoronto.ca) at (416) 603 – 5177 or Mr. Joshua Lipszyc (Joshua.Lipszyc@mail.utoronto.ca). Please be advised that emails are not secure and confidential, health-related and sensitive information should not be included.

**Research Ethics Board Contact Information**

If you have questions or concerns regarding your rights as a participant of this study,
please contact the UHN Research Ethics Board at (416) 581 – 7849.

Statement of Informed Consent

This study has been explained to me and any questions I had have been answered. I know that I may leave the study at any time. I agree to take part in this study.

1. I will allow the investigators of this study to collect information regarding my work-related asthma from health centre charts. □ Yes □ No

2. I agree to answer questions related to my work-related asthma through assessment questionnaires. □ Yes □ No

__________________________                  ________________                    ____________
Print Study Participant’s Name                     Signature                                    Date

(You will be given a signed copy of this consent form)

My signature means that I have explained the study to the above participant. I have answered all questions.

__________________________                  ________________                    ____________
Print Name of Person Obtaining Consent     Signature                        Date
Letter of Information and Consent to Participate in an Asthma Research Study

Title of Research Study: Survey of Work and Non-work Related Respiratory Symptoms and their Impact

Introduction:
Prior to agreeing to partake in this research study, it is important that you read the information in this research consent form. It includes details we think you need to know in order to decide if you wish to take part in the study. If you have any questions regarding the study, ask the study doctor or other study personnel. You should not sign this form until you are certain you understand the information. All research is entirely voluntary. You may also wish to discuss the study with your family physician, a family member or a friend. If you decide to take part in the study, it is important that you are truthful regarding your health history and any medications you are taking. This will help prevent unnecessary harm to you.

Principal Investigator: Dr. Susan Tarlo, MB, BS, FRCPC,
St. Michael's Hospital, 30 Bond St., Toronto, Ontario M5B 1W8
Tel: (416) 864 – 5074 susan.tarlo@utoronto.ca
Time of availability: Thursday, 9AM – 12PM

Co-Investigators:
Linn Holness MD, MHSc, FRCPC,
St. Michael's Hospital, 30 Bond St., Toronto, Ontario M5B 1W8
Tel: (416) 864 – 5074 holnessl@smh.ca
Time of availability: Thursday, 9AM – 5PM
**Frances Silverman, PhD.** Gage Occupational and Environmental Health Unit, 223 College St., Toronto, Ontario, M5T 1R4  Tel: (416) 978 – 5883 frances.silverman@utoronto.ca

**Gary Liss, MD.** MSc, FRCPG Gage Occupational and Environmental Health Unit, 223 College St., Toronto, Ontario, M5T 1R4  Tel: (416) 326 – 7880 gary.liss@utoronto.ca

**Graduate Student:** Mr. Joshua Lipszyc (supervised by Dr. Susan Tarlo). Toronto Western Hospital, East Wing 7-449, 399 Bathurst Street, Toronto, Ontario, M5T 2S8 joshua.lipszyc@mail.utoronto.ca

---

*This is a student project being completed by Mr. Lipszyc who is in his 2nd year of his MSc program (in Sept. 2014) at the Institute of Medical Science, University of Toronto. Dr. Tarlo is a respiratory physician in St. Michael’s Hospital’s Occupational Disease Specialty Program and in Toronto Western Hospital’s Asthma and Airway Centre.*

---

**Introduction of Research Study**

You are being asked to consider dedicating some of your time to be a participant in a graduate student research study. Please read the enclosed background, purpose and procedures to acquire an understanding of the study at hand and the associated risks and benefits. Please take as much time as you need to decide if you wish to participate. You can decline or withdraw from the study at any time. If there is content you do not adequately understand in this application, please deliver inquiries to Dr. Tarlo or Mr. Lipszyc. It is important that you have an understanding of the research content and study prior to providing your informed consent. Your involvement in this study will provide us with valuable knowledge concerning the health status and quality of life of patients with work-related asthma. This study may take up to 1.5 hours of your time.

**Purpose/Background of Research Study**

The purpose of this research study is to better understand the mental and physical health, and financial consequences of patients with work-related asthma and those with non-work-related asthma treated from two clinics. The non-work-related asthma patients will be recruited from the Asthma and Airway Center of Toronto Western Hospital. The work-related asthma patients will be reviewed from the two lung clinics in Toronto; at Toronto Western Hospital and St. Michael’s Hospital. Although the diagnostic process is the same at hospitals, the referral process and clinic personnel slightly differ. Referrals at St. Michael’s hospital are from the Ontario Workplace Safety and Insurance Board, in
comparison to Toronto Western Hospital which receives direct physician referrals. It is estimated that 150 patients will partake in this study from the two clinics.

**Study Design/ Description of Research**

The following research protocol will be employed in this study:

4. Mr. Lipszyc will administer 5 questionnaires to you concerning quality of life, past and present work history, and psychological profile of the patient. This interview will take place either on the phone or in-person at the clinic.

5. If you consent to take part in the study we will review your health charts and collect the following information: previous and current environmental exposures, history of asthmatic symptoms, and severity of symptoms based on pulmonary function tests.

6. You will be offered a medical follow-up appointment with Dr. Tarlo to determine any changes in your work-related asthma through pulmonary function testing and methacholine challenge tests.

**Procedures**

6. *Marks Asthma Quality of Life Questionnaire*
   
   This questionnaire will take approximately 5 minutes. This assessment comprises 20 items that measures the extent that asthma has negatively affected your life and contains four domains: Breathlessness, Mood Disturbance, Social Disruption, and Health Concerns.

7. *Beck Anxiety and Depression Inventories*
   
   These questionnaires are 21 items each and measures the severity of anxiety and depression. If your responses on the anxiety and depression inventories are clinically worrisome, Dr. Tarlo will discuss these with you and may suggest further assessment through your family doctor or a referral to a mental health specialist. An assessment of your responses will proceed the same day of the completion of the questionnaires. These two questionnaires will take approximately 20 minutes.

8. *Survey of Work and Non-Work-Related Respiratory Symptoms and their Impact*
   
   This questionnaire assesses your demographic details, workplace environment and medication use. This questionnaire should take approximately 15 minutes.

9. *Work Limitation Questionnaire (WLQ)*
   
   This survey assesses the stresses particular job demands have on you and should take approximately 5 minutes.

10. *(Optional) Pulmonary Function Testing - PFT (breathing tests) and Methacholine Challenge Tests.*
    
    If you are able to attend the clinic for an optional follow-up assessment, breathing tests will be conducted to assess the severity of your asthma. These tests are similar to tests that you have done during your regular medical visits. The pulmonary function test involves breathing in and out of a machine to measure narrowing of the airways. Methacholine challenge tests involve breathing increasing amounts of spray of methacholine through a device called a nebulizer. These are commonly used clinical tests, but will be performed for this study as research tests. If your evaluation on these pulmonary tests are deemed abnormal or significantly differ from previous assessments, your physician may advise a modification of your current regimen. This is an optional component of the study and may take 45 minutes of your time (in addition to the other segments of the study). Please note that if these tests have
Voluntary Participation and Withdrawal

This study is entirely voluntary. You can decline or withdraw from this study at any time. If you choose to participate or decline, it will have no bearing on the quality of the health care provided to you. Furthermore, if you choose to withdraw from the study you may request for the withdrawal of data collected.

Potential Risks/Harms of this Study

The questionnaire component of the study takes approximately 40 minutes which may be time-consuming, but breaks are permitted. 

Pulmonary Function testing (breathing tests) and Methacholine Challenge Tests:

This test is typically safe for patients, and individuals that have certain medical conditions including heart disease or surgery will not be asked to take it. There is a possibility you may experience some lightheadedness, fainting, or a possible asthmatic episode (though unlikely).

Methacholine challenge tests involve breathing increasing amounts of spray of methacholine through a device called a nebulizer. This can cause slight narrowing of the airways in people with asthma that is easily reversed with Ventolin if it does occur. The test may cause you to cough or feel some of your common asthma symptoms for a few minutes that will clear with Ventolin. Other potential risks include lightheadedness, throat irritation and headaches. This component may take an additional 45 minutes.

Potential Benefits of this Study

As a participant, you will not receive direct benefits or compensation. However, your involvement in the study will advance our knowledge on psycho-socio-economic and health outcomes of work-related and non-work-related asthma patients. The knowledge acquired by this research is intended to improve health management approaches for work-related and non-work-related asthma populations.

Costs to Participation and Reimbursement

If you decide to complete the questionnaires in-person at the clinic, and/or agree to be assessed with pulmonary function testing and methacholine challenge tests, we will reimburse you for parking and/or TTC costs.

Alternatives to being in the Study

Should you choose to not be in this research study, your quality of treatment will not be affected. You will continue to receive medical treatments and interventions to manage your work-related asthma.

Protecting Your Health Information

All persons involved in the study, including the study investigators and coordinators (hereby referred
to as “study staff”), are committed to respecting your privacy. No other persons will have access to your personal health information without your consent, unless required by law. The study personnel will make every effort to keep your personal health information private and confidential in accordance with all applicable privacy legislations, including the Personal Health Information Protection Act (PHIPA) of Ontario.

Personal health information is any information that could be used to identify you and includes your:

- name,
- address,
- date of birth,
- new or existing medical records, that includes types, dates and results of medical tests or procedures.

Any personal identifying information (such as your name) will be "de-identified" by replacing your personal identifying information with a “unique code/number”. The principal investigator at your hospital is in control of the study unique code key, which is needed to connect the study data to you. The link between the study number and your personal identity will be safeguarded by the principal investigator at St. Michael’s Hospital.

To protect your privacy, data will be password-protected and securely stored. In addition, access to records and data will be limited to authorized persons and transmission of the data will be secure.

The study personnel will use your study information to conduct the study and to support applications for approval of the study.

All information collected during this study, including your personal health information, will be kept confidential and will not be shared with anyone outside the study unless required by law. You will not be named in any reports, publications, or presentations that may come from this study.

If you decide to withdraw from the study, the information about you that was collected before you left the study will still be used. No new information will be collected without your permission, unless required for your safety.

If the results of this study are presented or published (i.e., in the medical literature), you will never be directly identified.
The study investigators will keep your study records securely stored for 5 years.

**Participation and Withdrawal**

Participation in any research study is voluntary. If you choose not to participate, you and your family will continue to have access to customary care at St. Michael’s Hospital. If you decide to participate in this study you can change your mind without giving a reason, and you may withdraw from the study at any time without any effect on the care you and your family will receive at St. Michael's Hospital.

If you decide to withdraw from the study, the information about you that was collected before you left the study will still be used. No new information will be collected without your permission, unless required for your safety.

**Study Contact Information**

If you have questions or concerns about this research study, please contact Dr. Susan Tarlo (susan.tarlo@utoronto.ca) at 416-603-5177 or Mr. Joshua Lipszyc (joshua.lipszyc@mail.utoronto.ca). Please be advised that emails are not secure and confidential, health-related and sensitive information should not be included.

**Research Ethics Board Contact**

If you have any questions about your rights as a research participant or have concerns about this study, call the Chair of the St. Michael’s Hospital Research Ethics Board or the Research Ethics office number at 416-864-6060, Ext. 2557. The REB is a group of people who oversee the ethical conduct of research studies. The St. Michael’s REB is not part of the study team. Everything that you discuss will be kept confidential.
Survey of Work and Non-work Related Respiratory Symptoms and their Impact

Principal Investigator: Dr. Susan Tarlo, Tel: (416) 864 – 5074

Statement of Informed Consent

I acknowledge that the research study described above has been explained to me and that any questions that I have asked have been answered to my satisfaction. I have been informed of the alternatives to participation in this study, including the right not to participate and the right to withdraw without compromising the quality of medical care at St. Michael’s Hospital for me and for other members of my family. As well, the potential risks, harms and discomforts have been explained to me and I also understand the benefits (if any) of participating in the research study.

I understand that I have not waived my legal rights nor released the study doctors, sponsor, or involved institutions from their legal and professional duties. I know that I may ask now, or in the future, any questions I have about the study or the research procedures. I have been assured that records relating to me and my care will be kept confidential and that no information will be released or printed that would disclose my personal identity without my permission unless required by law. I have been given sufficient time to read and understand the above information.

I consent to participate. I have been told I will be given a signed copy of this consent form.

I agree to undergo the optional pulmonary function and methacholine challenge tests. □ Yes □ No

______________________                 ________________                              ____________
Participant’s Name                               Participant’s Signature

I, the undersigned, have fully explained the study to the above participant.

__________________________                 __________________   ____________
Name of Person Obtaining Consent   Signature of Person Obtaining Consent     Date
Appendix C

**Beck Anxiety Inventory**

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not At All</th>
<th>Mildly but it didn’t bother me much</th>
<th>Moderately - it wasn’t pleasant at times</th>
<th>Severely - it bothered me a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbness or tingling</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling hot</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Wobbliness in legs</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Unable to relax</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fear of worst happening</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizzy or lightheaded</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Heart pounding racing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Unsteady</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Terrified or afraid</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nervous</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling of choking</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Hands trembling</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shaky / unsteady</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fear of losing control</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty in breathing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fear of dying</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Scared</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Indigestion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Faint / lightheaded</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Face flushed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Hot/cold sweats</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Column Sum**
Beck Depression Inventory

This questionnaire contains 21 groups of statements. Please pick the statement that best describes how you have been feeling in the preceding 2 weeks including today. Do not choose more than one statement per category.

1. **Sadness**
   - □ 0 – I do not feel sad.
   - □ 1 – I feel sad much of the time.
   - □ 2 – I am sad all the time.
   - □ 3 – I am so sad or so unhappy that I can’t stand it.

2. **Pessimism**
   - □ 0 – I am not discouraged about my future.
   - □ 1 – I feel more discouraged about my future than I used to be.
   - □ 2 – I do not expect things to work out for me.
   - □ 3 – I feel my future is hopeless and will only get worse.

3. **Past Failure**
   - □ 0 – I do not feel like a failure.
   - □ 1 – I have failed more than I should have.
   - □ 2 – As I look back, I see a lot of failures.
   - □ 3 – I feel I am a total failure as a person.

4. **Loss of Pleasure**
   - □ 0 – I get as much pleasure as I ever did from the things I enjoy.
   - □ 1 – I don’t enjoy things as much as I used to.
   - □ 2 – I get very little pleasure from the things I used to enjoy.
   - □ 3 – I can’t get any pleasure from the things I used to enjoy.

5. **Guilty Feelings**
   - □ 0 – I don’t feel particularly guilty.
   - □ 1 – I feel guilty over many things I have done or should have done.
   - □ 2 – I feel quite guilty most of the time.
   - □ 3 – I feel guilty all of the time.

6. **Self-Dislike**
   - □ 0 – I feel the same about myself as ever.
   - □ 1 – I have lost confidence in myself.
   - □ 2 – I am disappointment in myself.
   - □ 3 – I dislike myself.

7. **Self-Criticalness**
   - □ 0 – I don’t criticize or blame myself more than usual.
   - □ 1 – I am more critical of myself than I used to be.
   - □ 2 – I criticize myself for all of my faults.
   - □ 3 – I blame myself for everything bad that happens.

8. **Suicidal Thoughts or Wishes**
   - □ 0 – I don’t have any thoughts of killing myself.
   - □ 1 – I have thoughts of killing myself, but I would not carry them out.
   - □ 2 – I would like to kill myself.
   - □ 3 – I would kill myself if I had the chance.

9. **Crying**
   - □ 0 – I don’t cry any more than I used to.
   - □ 1 – I cry more than I used to.
   - □ 2 – I cry over every little thing.
   - □ 3 – I feel like crying, but I can’t.

10. **Agitation**
    - □ 0 – I am no more restless or wound up than usual.
    - □ 1 – I feel more restless or wound up than usual.
    - □ 2 – I am so restless or agitated that it’s hard to stay still.
    - □ 3 – I am so restless or agitated that I have to keep moving or doing something.
11. Indecisiveness
   □ 0 – I make decisions about as well as ever.
   □ 1 – I find it more difficult to make decisions than usual.
   □ 2 – I have much greater difficulty making decisions than I used to.
   □ 3 – I have trouble making any decisions.

12. Worthlessness
   □ 0 – I do not feel I am worthless.
   □ 1 – I don’t consider myself as worthwhile and useful as I used to.
   □ 2 – I feel more worthless as compared to other people.
   □ 3 – I feel utterly worthless.

13. Loss of Energy
   □ 0 – I have as much energy as ever.
   □ 1 – I have less energy than I used to have.
   □ 2 – I don’t have enough energy to do very much.
   □ 3 – I don’t have energy to do anything.

14. Changes in Sleeping Pattern
   □ 0 – I have not experienced any change in my sleeping pattern.
   □ 1a – I sleep somewhat more than usual.
   □ 1b – I sleep somewhat less than usual.
   □ 2a – I sleep a lot more than usual.
   □ 2b – I sleep a lot less than usual.
   □ 3a – I sleep most of the day.
   □ 3b – I wake up 1-2 hours early and can’t get back to sleep

15. Irritability
   □ 0 – I am no more irritable than usual.
   □ 1 – I am more irritable than usual.
   □ 2 – I am much more irritable than usual.
   □ 3 – I am irritable all the time

16. Changes in Appetite
   □ 0 – I have not experienced any change in appetite.
   □ 1a – My appetite is somewhat less than usual.
   □ 1b – My appetite is somewhat greater than usual.
   □ 2a – My appetite is much less than before.
   □ 2b – My appetite is much greater than usual.
   □ 3a – I have no appetite at all.
   □ 3b – I crave food all the time.

17. Concentration Difficulty
   □ 0 – I can concentrate as well as ever.
   □ 1 – I can’t concentrate as well as usual.
   □ 2 – It’s hard to keep my mind on anything for very long.
   □ 3 – I find I can’t concentrate on anything.

18. Tiredness or Fatigue
   □ 0 – I am no more tired or fatigued than usual.
   □ 1 – I get more tired or fatigued more easily than usual.
   □ 2 – I am too tired or fatigued to do a lot of the things I used to.
   □ 3 – I am too tired or fatigued to do most of the things I used to.

19. Loss of Interest in Sex
   □ 0 – I have not noticed any recent change in my interest sex.
   □ 1 – I am less interested in sex than I used to be.
   □ 2 – I am much less interested in sex now.
   □ 3 – I have lost interest in sex completely.

20. Punishment Feelings
   □ 0 – I don’t feel I am being punished.
   □ 1 – I feel I may be punished.
   □ 2 – I expect to be punished.
   □ 3 – I feel I am being punished.

21. Loss of Interest
   □ 0 – I have lost interest in other people or activities.
   □ 1 – I am less interested in other people or things than before.
   □ 2 – I have lost my interest in other people or things.
   □ 3 – It’s hard to get interested in anything.
ASTHMA QUESTIONNAIRE

Thank you for taking this questionnaire. It is part of a research project to learn about the way asthma affects people’s lives. All your answers will be treated confidentially.

What follows is a series of statements describing the way in which asthma (or its treatment) affects some people. You are asked to tick the response to each statement which most closely applies to you over the last four weeks.

1. I have been troubled by episodes of shortness of breath.
   - Not at all
   - Mild
   - Moderate
   - Severe
   - Very Severe

2. I have been troubled by wheezing attacks.
   - Not at all
   - Mild
   - Moderate
   - Severe
   - Very Severe

3. I have been troubled by tightness in the chest.
   - Not at all
   - Mild
   - Moderate
   - Severe
   - Very Severe

4. I have been restricted in walking down the street on level ground or doing light housework because of asthma or shortness of breath.
   - Not at all
   - Mild
   - Moderate
   - Severe
   - Very Severe

5. I have been restricted in walking up hills or doing heavy housework because of asthma or shortness of breath.
   - Not at all
   - Mild
   - Moderate
   - Severe
   - Very Severe
6. I have felt tired or a general lack of energy.

7. I have been unable to sleep at night.

8. I have felt sad or depressed.

9. I have felt frustrated with myself.

10. I have felt anxious, under tension or stressed.

11. I have felt that asthma or shortness of breath is preventing me from achieving what I want from life.

12. Asthma or shortness of breath has interfered with my social life.

13. I have been limited in going to certain places because they are bad for my asthma.

14. I have been limited in going certain places because I have been afraid of getting an asthma attack and not being able to get help.

15. I have been restricted in the sports, hobbies or other recreations I can engage in because of my asthma or shortness of breath.

16. I have felt generally restricted.

17. I have felt that asthma is controlling my life.
18. I have been worried about my present or future health because of asthma.

19. I have been worried about asthma shortening my life.

20. I have felt dependent on my asthma inhalers.
Health problems can make it difficult for working people to perform certain parts of their jobs. We are interested in learning about how your health may have affected you at work during the past 2 weeks.

(1) The questions will ask you to think about your physical health or emotional problems. These refer to any ongoing or permanent medical conditions you may have and the effects of any treatments you are taking for these. Emotional problems may include feeling depressed or anxious.

(2) Most of the questions are multiple choice. They ask you to answer by circling a number.

For example: How satisfied are you with each of the following . . .?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Your local schools</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Your local police department</td>
<td>1</td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

These marks tell us you are very satisfied with your local schools and moderately satisfied with your local police department.
Questionnaire

These next set of questions ask you to rate the amount of time you had difficulty handling certain parts of your job. Please read and answer every question. Then choose a response.

- Mark the “Does Not Apply” box only if the question describes something that is not part of your job

- If you have more than one job, report on your main job only

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

<table>
<thead>
<tr>
<th>1. work the required number of hours</th>
<th>Difficult all of the time (100%)</th>
<th>Difficult most of the time</th>
<th>Difficult some of the time (about 50%)</th>
<th>Difficult a slight bit of the time</th>
<th>Difficult none of the time (0%)</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. get going at the beginning of the workday</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3. start on your job as soon as you arrived at work</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4. do your work without stopping to take breaks or rests</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5. stick to a routine or schedule</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
These next set of questions ask you to rate the amount of time you were able to handle certain parts of your job without difficulty.

In the past 2 weeks, how much of the time were you able to...

<table>
<thead>
<tr>
<th>Question</th>
<th>All of the time (100%)</th>
<th>Most of the time (50%)</th>
<th>Some of the time (25%)</th>
<th>A slight bit of the time (12.5%)</th>
<th>None of the time (0%)</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. walk or move around different work locations (for example, go to meetings), without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7. to lift, carry, or move objects at work weighing more than 10 lbs, without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>8. sit, stand, or stay in one position for longer than 15 minutes while working, without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9. repeat the same motions over and over again while working, without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10. bend, twist, or reach while working, without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>11. to use hand-held tools or equipment (e.g., a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander), without difficulty caused by physical health or emotional problems?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
These next set of questions ask about difficulties you may have had at work

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

<table>
<thead>
<tr>
<th></th>
<th>Difficult all of the time (100%)</th>
<th>Difficult most of the time</th>
<th>Difficult some of the time (about 50%)</th>
<th>Difficult a slight bit of the time</th>
<th>Difficult none of the time (0%)</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. keep your mind on your work</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>13. think clearly when working</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14. do work carefully</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>15. concentrate on your work</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>16. work without losing your train of thought</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>17. easily read or use your eyes when working</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
The next set of questions ask about difficulties in relation to the people you came in contact with while working. These may include employers, supervisors, coworkers, clients, customers, or the public.

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

<table>
<thead>
<tr>
<th></th>
<th>Difficult all of the time (100%)</th>
<th>Difficult most of the time</th>
<th>Difficult some of the time (about 50%)</th>
<th>Difficult a slight bit of the time</th>
<th>Difficult none of the time (0%)</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. speak with people in-person, in meetings or on the phone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>19. control your temper around people when working</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>20. help other people to get work done</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

These next set of questions ask about how things went at work overall.

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?
<table>
<thead>
<tr>
<th></th>
<th>(100%)</th>
<th>the time</th>
<th>(about 50%)</th>
<th>the time</th>
<th>time (0%)</th>
<th>apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. handle the workload</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>22. work fast enough</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>23. finish work on time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>24. do your work without making mistakes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>25. feel you’ve done what you are capable of doing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Survey of Work and Non-work- related respiratory symptoms and

For clinic use ONLY, please do not write in this area:

Subject ID: ________________________

Date of Birth: mmm / yyyy Gender: M / F

Date of questionnaire completion

dd / mmm / yyyy Comments: ____
5 Demographics

Choose **ONE** option for each question

1. What is the highest level of education attained?
   - (a) Grade 8 or below
   - (b) Some high school
   - (c) High school graduate
   - (d) Technical or vocational training
   - (e) Some college or university
   - (f) College or university graduate

2. What is your best estimate of your total income, before tax and deduction, from all sources in the past 12 months?
   - (a) Less than $20,000
   - (b) $20,000 - $39,000
   - (c) $40,000 - $59,000
   - (d) $60,000 - $79,000
   - (e) $80,000 or more
   - (f) Prefer not to answer
   - (g) Don’t know

3. What is your best estimate of your total income, before tax and deduction, from all sources in the year before your work-related asthma started?
   - (a) Less than $20,000
   - (b) $20,000 - $39,000
   - (c) $40,000 - $59,000
   - (d) $60,000 - $79,000
   - (e) $80,000 or more
   - (f) Prefer not to answer
   - (g) Don’t know

   Compared with your income in the year before your work-related asthma symptoms has your total income in the past year (including any benefits from WSIB or other sources),
   - (a) increased
   - (b) decreased

What is your marital status?
   - (a) Single
   - (b) Married/common-law
   - (c) Widowed
   - (d) Divorced
   - (e) Separated
   - (f) Other ____________

4. Do you understand written English?
   - Yes
   - No

5. What language is spoken at home?
   ___________________________
### Section B - Respiratory symptoms

#### Wheezing

6. At any time during the **last month** did you have a wheezing or whistling in your chest?

   a. During the **last month** how often did you experience a wheezing or whistling in your chest? (Choose one)

      - Daily
      - Weekly
      - 1-2 times per month
      - Don’t remember

   - Other *(Please specify): _______________________________

   b. In the **last month** how many days did you take off work due to a wheezing or whistling in your chest? __________

#### Shortness of Breath

7. At any time during the **last month** did you have shortness of breath that came on during the day when you were not doing anything strenuous?

   a. During the **last month** how often did you experience shortness of breath when you were not doing anything strenuous? (Choose one)

      - Daily
      - Weekly
      - 1-2 times per month
      - Don’t remember

   - Other *(Please specify): _______________________________

   b. In the **last month** how many days did you take off work due to shortness of breath when you were not doing anything strenuous? __________

#### Cough

8. At any time during the **last month** did you have a cough?

   a. During the **last month** how often did you have a cough? (Choose one)

      - Daily
      - Weekly
      - 1-2 times per month
      - Don’t remember

   - Other *(Please specify): _______________________________

   b. In the **last month** how many days did you take off work due to a cough? _____

#### Waking up with Shortness of Breath

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

---

Version 1 date: April 2010
9. At any time during the last month did you wake up at night by an attack of shortness of breath?  
   a. IF YES, during the last month how often did you wake up at night by an attack of shortness of breath? (Choose one)  
      ○ Daily  ○ Weekly  ○ 1-2 times per month  ○ Don’t remember  
      ○ Other (Please specify): _______________________________

Waking up with Chest Tightness

10. At any time during the last month did you wake up with a feeling of tightness in your chest?  
    a. IF YES, during the last month how often did you wake up with a feeling of tightness in your chest? (Choose one)  
       ○ Daily  ○ Weekly  ○ 1-2 times per month  ○ Don’t remember  
       ○ Other (Please specify): _______________________________

11. How often do you think your chest symptoms are worse from being at work in the past month? (Choose one)  
    ○ a) During or after every work shift  
    ○ b) At least once or twice a week during or after work  
    ○ c) At least once or twice a month during or after work  
    ○ d) Less often  
    ○ e) not at all  
    ○ f) Don’t remember

12. In the last 12 months how many days did you take off work due to your chest symptoms?  

13. In the last 12 months, when you were away from work for a week or longer what happened to your chest symptoms as a whole?  

    Improved  Same  Worse  Not worked in last 12 months

    ○  ○  ○  ○

14. In the last 12 months what happened to your chest symptoms as a whole on working days compared to non-working days?  

    Improved  Same  Worse  Not worked in last 12 months

    ○  ○  ○  ○
15. Did you have any of the following symptoms brought on by work before you started having breathing problems?

- Rhinitis (itchy, stuffy or runny nose)  
  - Yes
  - No
  - Don’t Know

- Conjunctivitis (itchy, red or watery eyes)  
  - Yes
  - No
  - Don’t Know

- Rash  
  - Yes
  - No
  - Don’t Know

16. Following your diagnosis of work-related asthma what happened to your chest symptoms as a whole?

- Improved
- Same
- Worse
- Cleared completely

17. What medications do you take now for your asthma?

   a) Ventolin or Bricanyl?  Yes / no

      If yes, how many puffs per day on average?

   b) Flovent or Pulmicort or Q Var?  Yes / no

      If yes, how many puffs per day on average?

      Strength of inhaler if known

   c) Symbicort or Advair?  Yes / no

      If yes, how many puffs per day on average?
Strength of inhaler if known

d) Singulair or Accolate? Yes / no

e) Other medications?

Please indicate the medication below and the number of puffs per day on average and the strength of the inhaler if known.
### Section E - Work history, job description and exposure after the onset of work-related asthma

<table>
<thead>
<tr>
<th></th>
<th>Job 1</th>
<th>Job 2</th>
<th>Job 3</th>
<th>Job 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.1 Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.2 Duration</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
</tr>
<tr>
<td>E.3 Nature of business</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.4 Main job activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.5 Symptoms related to work if any</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.6 Status (full time/part time/left work)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.7 Main Exposures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>E.8 Start of work-related asthma symptoms</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
<td>__ years __ months __ weeks</td>
</tr>
<tr>
<td>E.9 Reasons for job change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Current Work (check as many as apply)**

a) Unemployed  
b) Retired  
c) Supported by Workers’ compensation  
d) Working in same type of exposure as when work-related asthma started  
e) Working for same employer as when work-related asthma started, but no longer exposed to the cause of work-related symptoms
f) Different employer – part time with no further exposure to the cause of work-related symptoms

g) Different employer – full time with no further exposure to the cause of work-related symptoms

Thank you