REGULAR PHYSICAL ACTIVITY IS ASSOCIATED WITH BETTER ASTHMA CONTROL IN ADULTS

SHILPA DOGRA

A DISSERTATION SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSPHY

GRADUATE PROGRAM IN KINDSIOLOGY AND HEALTH SCIENCE
YORK UNIVERSITY
TORONTO, ONTARIO

DECEMBER 2009

Your file Votre référence
ISBN: 978-0-494-64889-6
Our file Notre référence
ISBN: 978-0-494-64889-6

ABSTRACT

Background: Total control is the goal of asthma management; however as a result of poor compliance to medication, asthma control levels in Canada are sub-optimal.

Purposes: The goal of this dissertation was to understand the role of regular physical activity on the level of asthma control of partly controlled adults using cross-sectional population data and longitudinal exercise interventions.

Methods and Results: Two research designs were implemented in order to answer the research question. *First*, a cross-sectional epidemiological analysis using the Canadian Community Health Survey (cycle 3.1) was conducted to determine whether physical activity levels were associated with health care use (a proxy for asthma control). A sample of adults with asthma (n=6,835) were classified as 'active', 'moderately active' or 'inactive' based on self-reported frequency and duration of a variety of physical activities. Asthma control was measured using the number of overnight hospital stays and the number of physician consultations in the previous 12 months. Logistic regression models were used to determine the odds ratios for each of the asthma control outcomes using physical activity levels and body mass index as the main exposure variables while controlling for demographics, lifestyle, and comorbid chronic disease. Inactive asthmatics were more likely to have an overnight hospital stay (OR=1.68, CI=1.31-2.16) and ≥3 physician consultations (OR=1.23, CI=1.04-1.46) than active asthmatics (OR=1.00). Inactive obese asthmatics were 2.35 (CI=1.69-3.27) times more likely to have an overnight hospital stay, and 2.76 (CI=2.11-3.60) times more likely to have ≥3 physician consultations than active normal weight asthmatics (OR=1.00).

Second, a longitudinal exercise intervention with three groups (supervised, unsupervised, and control) was conducted with sedentary partly controlled adults with asthma to determine whether regular exercise would lead to improvements in asthma control and aerobic fitness. The intervention was 12-weeks in length; the supervised group completed an additional 12-week unsupervised exercise program. Participants completed a series of tests to measure asthma control, pulmonary function and physical fitness. Analysis of covariance and repeated measures analysis of variance were conducted to determine differences between the exercise groups and the control group. Significant improvements in measured and perceived asthma control were observed for the supervised group compared to the control group however only perceived asthma control improved in the unsupervised group. The supervised group was able to maintain their improvements in asthma control at the end of the 12-week follow-up. Finally, a comparison of the two interventions indicated that the supervised intervention had a greater impact on asthma control, aerobic and musculoskeletal fitness.

Conclusion: The results of this dissertation suggests that physically active adults with asthma have better asthma control than inactive adults with asthma, and sedentary adults with partly controlled asthma can improve their levels of asthma control with 12-weeks of exercise. These findings implicate the use of exercise as an adjunct therapy for adults with asthma.

DEDICATION

This dissertation is dedicated to my late grandparents who passed away during the course of my graduate career. To my grandfather Shri Jagan Nath Dhar who dedicated his life to educating children and to my grandmother Shmt Satyavati Dhar who dedicated her life to her husband, her family, and her community; I hope to be loved and respected by my community the way you two were by yours. You two will be missed but never forgotten.

ACKNOWLEDGEMENTS

The completion of this dissertation would not have been possible without the unwavering support of so many people.

First and foremost I would like to thank my supervisor Dr. Joseph Baker for taking a chance on me when no one else was willing to. You have taught me how to be diplomatic, how to prioritize work and life, and you have always made me feel like I have what it takes. I have learned so much from you, most important of all, I have learned that "data is plural!". Thank you to Dr. Veronica Jamnik who has been instrumental in my academic and professional career for the past 6 years. You sacrificed your time for my benefit, and for that I am grateful. To Dr. Chris Ardern, thank you for your never-ending quality checks of my work, and for taking me under your wing by taking me to conferences, collaborating with me on projects, and inviting me to your lab meetings and journal clubs. Thank you to Dr. Norman Gledhill who provided me with his laboratory and critical insight on my proposal and dissertation. You have been my role model from my first day here at York University; your work ethic is truly inspirational. In addition to my committee members there are some other faculty members who are perhaps unaware of the impact they have had on my work and career. Thank you to Dr. Michael Riddell who led me to believe that research can be cool and interesting; I would never have pursued this field if not for your teaching. Finally, a very special thanks to Dr. Jennifer Kuk who was an incredible support during the final leg of this race. Your professional advice and all you have taught me about research in the past year has been priceless!

I would like to thank my many past and present peers and labmates for lending their ears to my rants, and for making grad school an enjoyable experience. Thank you to Nick Wattie, Jane Logan, Jared Puterman, Harmonie Wong, Steve Cobley and Melissa Hopwood. A special thanks to Brad Meisner for constantly reminding me that I love academia in return for constantly reminding him of the same. I will miss my days in the BLAB! Thank you to the many staff in the Kinesiology department at York. You all have been incredible over the past many, many years! Thank you to Laura Austen, Maria Pestrin, Stephanie Marston, Monica Hamilton Elliott, Zeripha Moses, Vicki Aramatanov and Robert Bishop. I would also like to thank the many participants and students who assisted me with my data collection; thank you for contributing to science and to my success.

Finally, I would like to thank the members of my family for being so understanding and supportive throughout my graduate career. To Ravi uncle for convincing me that I truly wanted to pursue academia in the first place. To Monika and Derek for constantly bragging about me to others and being my ever-enthusiastic cheerleaders. To my younger but far wiser sister Kavita, who by constantly looking up to me has pulled me out of my lowest lows; your admiration for me is my inspiration to be a better person. And most importantly, to my mother, who has invested so much of herself into my success that everything I accomplish I owe to her. Thank you ma for being such an amazing role model throughout my life; I hope that everything I do makes you proud.

TABLE OF CONTENTS

Abstract....iv
Dedication....vi
Acknowledgements....vii
Table of Contents....ix
List of Tables....xi
List of Figures....xii
Chapter 1: Introduction....1
Section A: Asthma Pathophysiology....3
Section B: Diagnosis and Management of Asthma....5
Section C: The Burden of Asthma....8
Section D: Asthma Classification: Severity versus Control....10
Section E: Asthma and Exercise....17
Section F: Rationale, Purposes and Hypotheses....21
Section G: Outline of Studies....22
References....25
Chapter 2: The Role of Physical Activity and Body Mass Index in the Health Care Use of Adults with Asthma....39
Abstract....40
Introduction....42
Methods....43
Results....47
Discussion....57
References....59
Chapter 3: The Impact of Supervised and Unsupervised Exercise on Asthma Control in Partly Controlled Adults....63
Abstract....64
Introduction....66
Methods....68
Results....72
Discussion....77
References....81
Chapter 4: General Discussion....85
Cross Sectional Findings....86
Exercise Intervention Findings....86
Overall Findings....88
Study Design....90
Implications for Adults with Asthma....92
Implications for Physicians and Health Care Professionals....93
Implications for Public Health and Health Care Spending....94
The Role of the Exercise Expert....95
Future Research Directions....96
References....98

Appendices.....100
Appendix A: Glossary of Terms.....101
Appendix B: Supplemental information for Chapter 2.....102
Appendix C: Questionnaires and Exercise Programs.....104

LIST OF TABLES

Table 1.1 GINA Classification of Asthma Severity 13
Table 1.2 GINA Classification of Asthma Control.....14

Table 2.1 Characteristics of patients with and without asthma by physical activity level.....50
Table 2.2 Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With and Without Asthma.....54
Table 2.3 Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Only.....55
Table 2.4 Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Classified by Body Mass Index and Activity Levels.....56

Table 3.1 Baseline characteristics of the exercise and control group. Data is presented as mean ± standard error.....74
Table 3.2 Differences between groups from baseline to week 12 and week 24.....76

LIST OF FIGURES

Figure 3.1 Allocation of participants into three groups.....73
Figure 4.1 The Physical Activity recommendations for each level of asthma control.....95

CHAPTER 1: INTRODUCTION

INTRODUCTION

Physical activity (PA) has been shown to induce acute physiological responses and chronic physiological adaptations that lead to an increase in cardio-respiratory and musculoskeletal fitness and health[1-7]. These adaptations include, but are not limited to lower resting heart rate[2], increased blood volume[3], angiogenesis[4], increased insulin sensitivity[5], mitochondrial biogenesis[6] and lower systemic inflammation[7]. As a result of its influence on health parameters, PA is becoming a vital component of chronic disease prevention and management[8,9].

On the prevention side, physical inactivity is considered a modifiable risk factor for conditions such as hypertension[8], type 2 diabetes[9] and many cancers[10]. However certain chronic disorders such as asthma[11], type 1 diabetes[12], and cystic fibrosis[13] cannot be prevented despite a healthy, active lifestyle. Nevertheless, PA plays an important role in the management or secondary prevention of all of the aforementioned chronic diseases[8,9,10,12,13,14].

Although PA is implicated, it is only utilized as an adjunct therapy in a handful of chronic diseases. For example, physician's counsel those with type 2 diabetes on exercise as it is an essential component of treatment[15], and post-myocardial infarction patients are sent to cardiac rehabilitation programs that emphasize exercise[16]. The current health care system in Canada does not have such a referral process in place for chronic conditions such as arthritis, cancer or asthma.

Although pulmonary diseases such as cystic fibrosis and chronic obstructive pulmonary disease have encouraged the use of PA, and in fact have small-scale existing

pulmonary rehabilitation[17] or physical therapy programs, programs for asthma are lacking. Asthma is a highly prevalent condition affecting over 8% of the adult population[18], and is associated with acute attacks that require urgent care[19]. Physical activity has been shown to have a positive impact on asthma symptomatology[20]; however the dearth of research currently does not support the need for PA programs in asthma management. It is therefore essential to determine the impact of PA on asthma management in order to make recommendations for government funded programs and health services.

Review of Literature

SECTION A: Asthma Pathophysiology

Asthma is a chronic respiratory disease characterized by chronic inflammation and acute bronchoconstriction. It is a complex and multi-factorial disease of varying severities.

Inflammation: Inflammation occurs as a result of disruption to the epithelium of the airways, thickened airway walls, and airway wall edema[21]. Four categories of cytokines and inflammatory markers are responsible for this inflammation: lymphocytes, mast cells, eosinophils, and macrophages[21]. T-lymphocytes, particularly t-helper cells, play a major role in allergic inflammation. These cells are thought to increase the secretion of interleukin (IL) 5 and IL-3, which leads to an influx of eosinophils and further inflammation through the release of mediators such as leukotrienes and platelet activating factor. Immunoglobin E (IgE), an antibody regulated by t-lymphocytes, binds to the mast cells leading to degranulation and release of histamine and enzymes. This leads to the

synthesis of leukotrienes, prostaglandins and platelet-activating factor. These inflammatory mediators increase smooth muscle contraction, vascular permeability and mucous gland secretion[22]. Finally, the epithelial cells that line the airway secrete arachadonic acid, nitric oxide and endothelin, which all contribute to airway narrowing[22]. Two potential pathways of increased inflammation in asthma have been identified: 1) allergic inflammation characterized by elevated levels of IgE and 2) proinflammatory cytokines, enzymes, and growth factors generated by the damaged bronchial epithelium and submucosal cells of the activated airway, which lead to structural change of the bronchial tissues[22].

Bronchoconstriction: In addition to underlying chronic inflammation, acute attacks of bronchoconstriction occur in response to a trigger. This response is essentially the same as chronic inflammation i.e. it leads to degranulation of mast cells, and production of inflammatory mediators; but it occurs at an accelerated rate. One of the hallmarks of bronchoconstriction, or acute inflammation, is the production of a large amount of mucous. This mucous may form mucous plugs when combined with plasma proteins released by the epithelium[23]. The acute response can be broken down into early and late-phase reactions. In the early-phase there is a rapid activation of mast cells and macrophages and release of proinflammatory markers such as histamine and reactive oxygen species[23]. The reactive oxygen species are responsible for the aforementioned mucous secretion in addition to vasodilation and contraction of airway smooth muscle[23]. The late-phase occurs up to nine hours after initial contact with the trigger and involves

the recruitment of eosinophils, t-helper cells and the release of proinflammatory cytokines [23]. This bronchoconstriction is considered reversible[23].

Airway Remodelling: There is evidence to suggest some irreversible damage to the airways in asthma, in particular, the thicker walls of the airway. This increase in thickness may be the result of an increase in muscle mass and mucous glands, and in vessel area; this leads a significant and permanent reduction in airways caliber[23].

Triggers: There are numerous triggers that initiate an acute response in those with asthma. These triggers can be allergic or non-allergic in nature. Examples of allergic triggers are pollen, dust mites, pet dander and foods such as peanuts. Non-allergic triggers are pollution, cigarette smoke, stress and exercise[22]. Most individuals with asthma have more than one trigger and must work to minimize exposure to these triggers in order to control their symptoms[22].

SECTION B: DIAGNOSIS AND MANAGEMENT OF ASTHMA

Risk Factors for Development of Asthma: Few established risk factors for asthma exist. These include genetics or family history of asthma or atopy, exposure to chemicals or allergens, exposure to tobacco smoke (including in-utero exposure), frequent respiratory infections and low birth weight[24].

Diagnosis: Diagnosis of asthma involves a thorough physical examination, a detailed history of signs and symptoms, genetic susceptibility, and finally pulmonary function tests (PFTs). Findings from the physical examination that lead to asthma diagnosis are atopy or skin rashes, abnormal sounds in the chest, and upper respiratory abnormalities such as mucous or nasal secretion[25]. Symptoms include wheezing, shortness of breath,

chest pain, coughing, nocturnal symptoms, and a worsening of symptoms in the presence of triggers. To confirm a diagnosis of asthma, standard PFTs are conducted to determine lung function before and after a provocation test. The American Thoracic Society and European Respiratory Society have published five documents describing the Standardization of Lung Function Testing[26-30] to establish standard protocol and interpretation guidelines for simple spirometry. The two parameters measured using spirometry are forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC). The ratio of these two parameters should be greater than 80% in a normal airway. Flow-volume loops can also be drawn and analyzed if the FEV_1 is assessed at different time points.

Management and Treatment: There is no cure for asthma; however pharmacological treatment has been shown to control disease symptoms. Chronic inflammation is often treated with inhaled corticosteroids, but in more severe cases may be treated with oral steroids such as prednisone[31]. The medications for inflammation are typically taken daily or twice daily and are referred to as controller medication in laymen's terms. The acute bronchoconstriction is treated with short acting beta 2 agonists. These medications are taken at the onset of an acute exacerbation and lead to bronchodilation. This class of medications is commonly referred to as reliever medication. Bronchodilators also come in long acting doses; which allow for protection from triggers for a 12 hour period. They are often combined with inhaled corticosteroids into one inhaler; this is referred to as combination therapy. Other medications prescribed include leukotriene modifiers,

theophylline, anti IgE, and mast cell stabilizers; these lead to modest bronchodilation. The class of medication and dose prescribed will vary depending on the individual[31].

In the case of severe exacerbation the patient may require oxygen supplementation and/or hospitalization. Severe airway constriction can lead to oxygen saturation levels <92% thus requiring oxygen therapy[31]. Additionally, patients in these extreme circumstances may be placed on steroids to reverse airway constriction[31].

Alternative therapies have also been credited to improve asthma symptoms. These are not as potent, and have not been studied as extensively as pharmacotherapy. A Cochrane review published in 2003 concluded that inspiratory muscle training may lead to increases in maximal inspiratory pressure but the clinical benefit is unclear[32]. Similar conclusions were drawn for the role of breathing exercises in asthma[33]. A clinical trial using Buteyko (breathing exercises that aim to reduce hyperventilation) found that breathing exercises and Buteyko led to similar improvements in asthma control[34]. Finally, a review of alternative therapies concluded that there was not enough evidence for the prescription of acupuncture, homeopathy, or herbal remedies for treatment of asthma[35].

The most important part of asthma management is developing an action plan for the patient. The Global Initiative for Asthma (GINA) stresses the importance of this action plan for self-management of asthma[31]. These plans should contain information on medication use, avoidance of triggers, and peak flow monitoring. Asthma action plans and asthma education have been shown to improve asthma control[36,37], increase appropriate use of prescribed medications[38] and decrease health care services use[39]. In

fact, an asthma education intervention alone was sufficient to significantly improve lung function in asthmatics over a 12 month period[37].

SECTION C: THE BURDEN OF ASTHMA

In 2004 the GINA report entitled the ***Global Burden of Asthma*** stated that using conservative criteria, over 300 million people in the world were currently living with asthma[40]. The prevalence of asthma in western countries was shown to be much higher in both adults and children. Countries such as the United Kingdom and Ireland report prevalence rates of 25% among children and over 15% among all ages[40]. The mean prevalence of asthma in the United States of America and Canada was estimated to be over 10%[40] and the prevalence of asthma among children in Canada was higher than in adults[41]. Incidence rates have increased since the early part of the 1900s in both men and women and it is estimated from pooled data that the incidence rate in women is slightly higher than that for men; 4.6 per 1000 person-years in women compared to 3.6 per 1000 person-years in men[42].

Limited mortality data were shown in the GINA report. Of note, countries with lower prevalence rates of asthma had some of the highest asthma related deaths[40]. This may be credited to the lack of access to medication and treatment. In Canada the mortality rate attributed to asthma has been declining since the mid 1980s[41]. In 2001, for example, only 299 deaths in Canada were directly attributed to asthma[41].

A low death rate goes hand in hand with an increase in health care utilization. Physician visits[43], hospitalizations and emergency care are services used frequently by those with active or current asthma. A report on The Burden of Asthma in New Zealand

showed that approximately 200 in every 100,000 hospitalizations were attributable to asthma[44]. In Canada, an estimated 80,000 hospital admissions over a three year span were attributable to asthma[41]. The most current Canadian Community Health Survey (cycle 3.1, 2005) indicates that in the past 12 months 13.5% of all hospital admissions were from asthmatics, and 11.6% of physician visits (3 or more visits) were from asthmatics.

The economic burden of such health care use has been studied extensively. A recent systematic review by Bahadori et al[45] found that a majority of the direct costs associated with asthma were related to hospitalizations and pharmacotherapy, and direct costs accounted for between 53-100% of total asthma-related costs. Indirect costs associated with asthma are lost school or work days, a decrease in productivity, and asthma caretaker time, which may account for up to 75% of the costs associated with asthma[45]. This study found that the costs were greater in those with poorer asthma control. A European study found similar results such that those with poorer control accounted for a greater proportion of hospitalizations, doctor visits, pharmacological treatments and indirect costs[46]. They also noted that poorly controlled asthmatics accounted for 46% of the total costs associated with asthma. The indirect costs in this study far exceeded the direct costs and were mainly attributed to productivity losses.

In addition to lost days at work or school absenteeism, asthma can lead to a compromised quality of life (QOL). In general terms, as the severity of disease increases, QOL decreases[47]. This may be due to the greater frequency of symptoms that occur in individuals with severe-persistent asthma compared to those with mild or intermittent asthma. A compromised QOL may be directly related to the intermittent nature of the

disease. It is difficult for an asthmatic to know when and where they might have an acute exacerbation, therefore daytime activities may be stressful. In fact, asthmatics are more likely than the general population to have anxiety and mood disorders[48,49]. Additionally, nocturnal symptoms (i.e. asthma symptoms that occur at night time) severely compromise sleep quality in asthmatics. Other comorbidities associated with asthma such as atopy[50], obesity[51], gastroesophageal reflux disorder (GERD) [52] and allergies[53] may further impact QOL. On a positive note, studies have shown that both prescribed medication and exercise programs lead to significant improvements in QOL in both children and adults. Adults who adhere to their prescribed medication have been shown to have greater work place productivity and greater QOL compared to those who do not[54]. Additionally, research examining combination therapy (combination of inhaled corticosteroids and long acting beta 2 agonists) has shown significant improvements in QOL in adults[55,56]. Exercise intervention studies in children and adults with asthma have shown significant improvements in QOL[57,58]. In fact, data from the National Asthma Education and Prevention Program assessing the short-term, long-term, functional impact and global burden of asthma in adults and children found that asthma had the greatest impact on activity restriction and that this was a significant burden[59].

SECTION D: ASTHMA CLASSIFICATION: SEVERITY VERSUS CONTROL

Traditionally asthma has been classified in terms of severity; more specifically, the underlying disease state and the responsiveness to treatment[31]. Severity is assessed prior to prescription of medication to determine the extent of chronic inflammation and

airway responsiveness to a trigger. This gives the health care provider a framework for dosage and types of medications. Some of the tests used to assess severity are:

Bronchoprovocation Challenge Tests: These tests put asthmatics in contact with a trigger and measure changes in pulmonary function repetitively over a 10-15 minute period. The two most common challenge tests are the methacholine challenge and the exercise challenge. The methacholine challenge requires the patient to breathe in a minimal dose of methacholine for two minutes and then perform spirometry. If the FEV_1 is normal, the next dose is administered. The test is terminated when the patient's FEV_1 drops more than 20% from baseline. The exercise challenge requires the patient to inhale dry air during a treadmill run or pedalling on a cycle ergometer at an intensity that elicits a minimum of 80-90% of their age-predicted heart rate maximum for 6-8 minutes. The FEV_1 is measured upon completion of the exercise, and is continuously monitored for a minimum of 10 minutes post-exercise[60]. Here again, a drop in FEV_1 of 20% is indicative of asthma.

Exhaled Breath Condensate (EBC): This technique involves the cooling and analysis of exhaled air. The contents of the EBC that are generally analysed include hydrogen peroxide, nitric oxide, adenosine, arachadonic acid, leukotrienes, measures of oxidative stress, ammonia, cytokines and finally pH[61].

Exhaled Nitric Oxide: Exhaled nitric oxide content is measured as it is highly correlated with eosinophillic airway inflammation; a low value is indicative of lower levels of inflammation. It is also used to measure responsiveness to treatment and may play a role in asthma diagnosis[62]. This is a relatively straightforward and simple technique[62].

Induced Sputum: This technique generally involves the inhalation of a hypertonic saline solution to irritate the airway leading to a desire to cough up phlegm. The sputum is collected and analyzed for inflammatory markers such as eosinophils, neutrophils, mast cells and lymphocytes[63].

These techniques allow the physicians to determine baseline severity, but perhaps more importantly, it allows them to monitor improvements in airway responsiveness with pharmacological treatment. According to GINA guidelines, asthma severity is based on airflow limitation, symptoms, and lung function variability. Individuals can be placed into one of four categories (Table 1): intermittent, mild-persistent, moderate-persistent, and severe-persistent[31]. These guidelines also state that severity should no longer be used as the basis for ongoing treatment; instead asthma control should be utilized.

Table 1.1: GINA classification of asthma severity[31]

	Intermittent	**Mild-Persistent**	**Moderate-Persistent**	**Severe-Persistent**
Symptoms	< once per week	More than once a week but less than once a day	Daily	Daily
Exacerbations	Brief	May affect activity and sleep	May affect activity and sleep	Frequent
Nocturnal Symptoms	Not more than twice per month	More than twice a month	More than once a week	Frequent
Lung Function	FEV1 or PEF ≥ 80% predicted PEF or FEV1 variability < 20%	FEV1 or PEF ≥ 80% predicted PEF or FEV1 variability < 20 – 30%	Daily use of inhaled short-acting _2-agonist FEV1 or PEF 60-80% predicted PEF or FEV1 variability > 30%	Limitation of activities FEV1 or PEF ≤ 60% predicted PEF or FEV1 variability > 30%

Asthma control can be classified as controlled, partly controlled, or uncontrolled based on the occurrence of the following symptoms: daytime symptoms, limitation of activities, nocturnal symptoms, need for reliever/rescue medication and lung function (Table 2). The Canadian Asthma Consensus Guidelines[64] use the above symptoms plus two additional criteria: absence from school/work and an assessment of peak expiratory flow diurnal variation. Asthma control has gained much attention in the last decade and it is generally agreed that while asthma cannot be cured, it can be controlled. Control can

be achieved for all levels of asthma severity, and it is the primary goal of asthma management and asthma action plans[31].

Table 1.2: GINA classification of asthma control[31]

	Controlled	**Partly Controlled**	**Uncontrolled**
Daytime Symptoms	None (≤Twice)	> Twice	Three or more features of partly controlled asthma present in any week
Limitation of Activities	None	Any	
Nocturnal Symptoms	None	Any	
Need for reliever medication	None (≤Twice)	> Twice	
Lung Function	Normal	<80% predicted or personal best	
Exacerbations	None	Once or more per year	

Currently asthma control levels are suboptimal in North America and Europe. Data from the United States indicate that 55% of asthmatics are uncontrolled, and that control levels do not vary by the type of care the patient is receiving i.e. specialist versus general practitioner[65]. A more recent study conducted in 2009 found that 41% of asthmatics in the US were uncontrolled and that this varied significantly by ethnicity such that a greater proportion of asthmatics who were African Americans or Hispanic were uncontrolled[66]. Similarly, a European study found that of those taking inhaled corticosteroids, 49% were uncontrolled and only 15% were controlled[67]. They found a large amount of variation between the countries with Italy, Switzerland, the United Kingdom, Spain and Sweden all having more than 50% of uncontrolled asthmatics[67]. In Canada, 59% of asthmatics are considered to be uncontrolled[68]. An analysis of the change in asthma control levels since 1996 found that, in Canada, levels of uncontrolled asthma

remained above 50% over an eight year period[69]. Interestingly, a patient's perceived level of control does not coincide well with measured control such that 50% of poorly controlled asthmatics believe they have well controlled asthma[43].

Uncontrolled asthmatics are more likely to visit their physicians for urgent care[68], visit the emergency department of hospitals and require hospitalization[70,71]. This increased health care use has been associated with poorer QOL as well[69]. Quality of life and asthma control have been found to have a strong positive association such that higher QOL is associated with higher levels of control[72]. In fact, Chen et al[73] showed that asthma control can predict future QOL in patients regardless of their severity levels suggesting that control and severity have an independent effect on QOL. Specific control factors such as use of short acting beta 2 agonists, sleep disturbance and restriction in activity levels have a greater impact on QOL[74]. This relationship between levels of asthma control and QOL has also been shown to depend on the presence of rhinitis and respiratory infections[75].

Asthma control can be greatly improved with proper medication use[76]; however, most asthmatics do not take their medications as prescribed[77]. Patients feel that using medication on a daily basis is unhealthy[77] and fear their potential side-effects[78]. Although there are some documented side-effects of these medications[79], unequivocal evidence exists that proper medication use improves asthma control. Inhaled corticosteroid[80] use and combination therapy interventions[81] have shown significant improvements in control; however 80% adherence is required to maintain these levels[82].

De Vries et al[83] found that those with poorer asthma control were more likely to be on higher dosages of inhaled corticosteroids, and suggested that prescription of these drugs alone was insufficient to improve asthma control. Along with adherence to medication, many other factors have been shown to predict poor levels of asthma control such as female sex[43], low socioeconomic status[43,83,84], lack of asthma action plans[43], high number of physician visits[43], frequent use of reliever medication[43], patient's lack of understanding of the underlying disease[43], current smoking status[83], higher bronchial hyperresponsiveness[83], improper use of inhaled corticosteroids[83], frequent hospitalization[84] and comorbidities such as obesity and GERD[84]. Schatz et al conducted a longitudinal prediction analysis and found that many of these factors predict long-term asthma control; particularly ethnic background, socioeconomic status, specialist care, use of inhaled corticosteroids, use of reliever medication, GERD and body mass index (BMI)[85].

Although asthma has been associated with many comorbidities such as atopy[50], allergies[53], cardiovascular disease[86] and obesity[87]; obesity in particular warrants further attention, as it has a considerable impact on asthma control[88,89,90]. Lavoie et al found that a higher BMI was associated with poorer asthma control and QOL, independent of asthma severity. The authors noted that a higher BMI was significantly associated with greater restriction of activities, more shortness of breath and more wheezing[88]. Similarly, after adjusting for demographics, smoking status and a variety of asthma related factors, Mosen et al[89] found that a higher BMI was associated with more hospitalizations, poorer asthma control and lower QOL. Both of these studies reported greater medication use in

those asthmatics with a higher BMI. This is not surprising given research indicating that obese asthmatics are less likely to achieve control with inhaled corticosteroids or combination therapy compared to non-obese asthmatics[90]. Upon losing weight, particularly dramatic weight loss as a result of surgery, obese asthmatics are able to improve their asthma control significantly[91]. In fact, obese females show significant improvements in shortness of breath and rescue medication use one year post gastric bypass surgery[91]. Recent research on exercise habits of adults with asthma suggests that obesity is the most powerful predictor of exercise levels, even more so than asthma control[92]. It should be noted that there is a paucity of epidemiological evidence to suggest that there is no difference between asthma control levels of obese and non-obese patients[93], but cellular research does indicate common pathways and a biological plausibility for a cause and effect relationship through inflammatory, hormonal and mechanical factors[94].

The aforementioned variables predict overall asthma control, however sub-analyses have consistently shown that the activity limitations component contributes the most to poor asthma control levels[59,71,74]. In fact restricted activity levels have been found to contribute the greatest to health care use and poor QOL[71]. Nevertheless PA levels, exercise capacity or fitness levels have not been assessed as predictors of asthma control levels to date.

SECTION E: ASTHMA AND EXERCISE

Exercise is a trigger for asthma or acute bronchoconstriction. Exercise induced asthma (EIA) symptoms occur in approximately 90% of asthmatics[95,96] and is considered

to be a reason for high levels of activity restriction reported by poorly controlled asthmatics.

There are two hypotheses for the onset of EIA. The *osmotic hypothesis* suggests that the increase in ventilation during exercise leads to drying of the airways i.e. evaporative water loss from the surface of the airway. This increase in osmolarity leads to provocation of mast cell mediators, thereby inducing bronchoconstriction[97]. The *thermal hypothesis* suggests that the cooling of airways during exercise followed by the warming of the airways post-exercise leads to reactive hyperaemia of the bronchial microvasculature and edema of the walls of the airway causing narrowing. There is no role for inflammatory mediators in this hypothesis[98]. Anderson et al conducted a comprehensive review on these two hypotheses and concluded that the dehydrating and osmotic effects of respiratory water loss leads to mediator release and this is a result of hyperpnea[98]. Hyperpnea[99] or an increase in minute ventilation[100] has been shown to induce EIA; this generally occurs when exercising beyond the ventilatory threshold[99]. Asthmatics respond to exercise in a similar manner as non-asthmatics i.e. they have a normal heart rate, blood pressure, oxygen consumption and minute ventilation response[101]. Exercise tolerance is not limited by asthma related factors such as increased residual volume, increased ratio of physiological dead space to tidal volume, mild arterial hypoxaemia and desaturation; in fact these respiratory variables that are compromised at rest return to normal during exercise [102]. Ventilatory reserve in asthmatics is adequate to allow sustained exercise at work intensities sufficient to produce increases in maximal

oxygen consumption[103]. Unfortunately, regardless of fitness level, patients challenged at or above their ventilatory threshold are likely to experience EIA[102].

The frequency of EIA can be reduced by using prescribed bronchodilators 10-20 minutes prior to an attack[104], by warming up at 60% of VO_2max for 15 minutes[105] or by increasing physical fitness levels[99]. Exercise training is thought to reduce EIA by decreasing the sensitivity of airway receptors, which in turn decreases the hyperresponsiveness of airways[99,102]. Despite having the ability to prevent EIA, asthmatics are a largely sedentary[106-109] and unfit segment[110] of the population. Studies have shown that asthmatics abstain from exercise in order to prevent the onset of EIA[108111]. Moreover, they lack the self-efficacy to participate in exercise programs[112].

Physical inactivity has been shown to be a primary and secondary risk factor for chronic diseases such as cardiovascular disease and diabetes[8,9]. Not surprisingly, asthmatics have been shown to have higher rates of obesity and overweightedness in all age groups[113] and there is some evidence that asthmatics are at an increased risk of cardiovascular disease[114,115]. Physically active asthmatics have been shown to have higher self-perceived health, higher self-perceived mental health, fewer functional limitations, fewer additional chronic conditions and higher satisfaction with life in general[117].

In addition to the advantages of PA shown at the cross sectional level, exercise intervention studies in asthmatics have also shown promise. In a 10-week exercise program with asthmatic adults, Hallstrand et al found an increase in anaerobic threshold and a significant reduction in dyspnea index at 75% of maximal and at maximal

exercise[117]. They also noted a trend for improvement in maximal voluntary ventilation and reduced minute ventilation at any given workload. The authors concluded that exercise decreased hyperpnea in mild asthmatics[117]. Similarly, a training study with middle-aged adults found a decrease in minute ventilation at submaximal and maximal levels of exercise from pre-training to post-training[103]. The authors found that training led to improvements in maximal work capacity and oxygen delivery during submaximal exercise, and concluded that the improvements in EIA were a result of the reduction in minute ventilation seen at higher workloads[103].

Physical conditioning programs in adult asthmatics have shown improvements in ventilatory response and confidence, but have failed to find a clinically significant role in modifying lung pathology[118]. An editorial by Clark[119] noted that there is little evidence to support the notion that regular exercise leads to improvements in resting lung function, and that reported reductions in EIA are not likely due to changes in lung pathology. Emtner et al[58,120] conducted a physical training program in well-controlled adult asthmatics with somewhat incompatible results. They performed a 10-week rehabilitation program[58] with a follow up study three years later to determine the long-term consequences of participation in the program[120]. The program consisted of an inpatient and outpatient period in which the participants exercised at high intensities in a swimming pool. Although the initial program led to improvements in fitness measures, a significant improvement in mean FEV_1, a decrease in EIA occurrence, and a decrease in anxiety associated with exercise; the follow-up found that there were no significant changes in lung function, despite the fact that 68% of patients were still physically active

at least once per week and the medication use of the group decreased significantly at follow-up.

The majority of exercise training studies have focused on medically supervised rehabilitation programs with physicians or physical therapists. Although this approach is efficacious, it does not provide us with information on the impact of exercise on asthma in a real-world setting. It is evident that an increase in aerobic fitness leads to an improved ability to exercise at higher levels without inducing EIA. Overall, exercise interventions lead to improvements in QOL, breathlessness, EIA onset, and a decrease in medication use; and more importantly, exercise is well tolerated in partly controlled asthmatics.

SECTION F: RATIONALE, PURPOSES AND HYPOTHESES

It is clear that asthma control levels at the population level are suboptimal, and that non-pharmacological interventions are preferred by asthmatics. Given that the activity restriction component is the greatest predictor of asthma control, it seems plausible that an increase in exercise capacity or higher levels of PA would lead to improved asthma control; this could lead to a significant decrease in asthma related health care spending.

The overall purpose of this dissertation therefore was to investigate the relationship between PA and asthma control both at the population level and using an exercise intervention. Specifically the goals were to:

1. Use an existing nationally representative data set to determine whether lower levels of PA are associated with poorer asthma control in adults.

2. Conduct an exercise intervention using supervised and unsupervised exercise programs to determine whether
    a. Supervised exercise in adults with partly controlled asthma can improve asthma control and whether these gains can be maintained in the absence of supervision.
    b. Unsupervised exercise alone can lead to improvements in asthma control levels.
    c. Supervision is an essential component of exercise prescription in this population.

We hypothesized that at the population level, lower levels of PA would be associated with lower levels of asthma control and that asthmatics who increased their physical fitness levels with exercise programs would improve their asthma control. Furthermore, we hypothesized that supervised exercise would lead to a greater improvement in physical fitness compared to unsupervised exercise.

SECTION G: OUTLINE OF STUDIES

Study 1: The role of physical activity and body mass index in the health care use of adults with asthma

Objective: The purpose of this study was to determine whether asthma control varied by PA levels at the population level. For this study data from the Canadian Community Health Survey (CCHS, cycle 3.1) were analyzed. Using health care use (physician visits and overnight hospital stays) as a proxy measure for asthma control, we assessed the relationship between asthma control and PA levels (active versus inactive).

Variables: Health care use was self-reported as overnight hospital stays (yes/no), length of overnight hospital stay (<4/≥4), and physician consultations (<3/≥3). Self-reported physical activities were used to derive total energy expenditure and used to classify participants as active (≥3.0 $kcal.kg^{-1}.day^{-1}$), moderately active (1.5-2.9 $kcal.kg^{-1}.day^{-1}$), and inactive (<1.5 $kcal.kg^{-1}.day^{-1}$). BMI was categorized as underweight (>18.5 $kg.m^{-2}$), normal weight (18.5-24.9 $kg.m^{-2}$), overweight (25-29.9 $kg.m^{-2}$) and obese (30-59.9 $kg.m^{-2}$).

Sample: The final sample contained 6,835 adult asthmatics and 78,051 non-asthmatics, and was limited to adults between the ages of 20-64 y without chronic obstructive pulmonary disease.

Study 2: The impact of supervised and unsupervised exercise on asthma control in partly controlled adults

Objective: The purpose of this study was to determine 1) whether a 12-week exercise program (supervised or unsupervised) would lead to improvements in asthma control and fitness levels in partly controlled asthmatic adults compared to a matched control group and 2) whether the supervised group would be able to maintain benefits from the program after an additional 12-weeks of unsupervised exercise.

Variables: Asthma control was measured using the validated Asthma Control Questionnaire[121] and perceived asthma control; the mini-Asthma Quality of Life Questionnaire was used to measure QOL. Lung function measures (FEV_1/FVC), aerobic fitness measures (peak aerobic fitness), and musculoskeletal fitness (vertical jump, grip strength and flexibility) were also assessed.

Sample: A total of 72 adults with asthma were eligible for this study. Eligibility was limited to those who were not pregnant, currently had a prescription for asthma medication, and were partly controlled. Final analyses contained a total of 18 in the supervised group, 12 in the unsupervised group, and 12 in the control group.

REFERENCES:

1. Thompson PD, Crouse SF, Goodpaster B, Kelley D, Moyna N, Pescatello L. The acute versus the chronic response to exercise. Med Sci Sports Exerc. 2001;33(6):S438-S445.
2. Sandercock GR, Bromley PD, Brodie DA. Effects of exercise on heart rate variability: inferences from meta-analysis. Med Sci Sports Exerc. 2005;37(3):433-9.
3. Convertino VA. Blood volume: its adaptation to endurance training. Med Sci Sports Exerc. 1991;23(12):1338-48.
4. Prior BM, Lloyd PG, Yang HT, Terjung RL. Exercise-induced vascular remodeling. Exerc Sport Sci Rev. 2003;31(1):26-33.
5. Hawley JA, Lessard SJ. Exercise training-induced improvements in insulin action. Acta Physiol (Oxf). 2008;192(1):127-35.
6. Hood DA. Mechanisms of exercise-induced mitochondrial biogenesis in skeletal muscle. Appl Physiol Nutr Metab. 2009;34(3):465-72.
7. Kohut ML, McCann DA, Russell DW et al. Aerobic exercise, but not flexibility/resistance exercise, reduces serum IL-18, CRP, and IL-6 independent of β-blockers, BMI, and psychosocial factors in older adults. Brain Behav Immun. 2006;20(3):201-209.
8. Khan NA, Hemmelgarn B, Herman RJ et al. The 2009 Canadian Hypertension Education Program recommendations for the management of hypertension: Part 2--therapy. Can J Cardiol. 2009;25(5):287-98.

9. Colberg SR, Grieco CR. Exercise in the treatment and prevention of diabetes. Curr Sports Med Rep. 2009;8(4):169-75.
10. Newton RU, Galvão DA. Exercise in prevention and management of cancer. Curr Treat Options Oncol. 2008;9(2-3):135-46.
11. Székely JI, Pataki A. Recent findings on the pathogenesis of bronchial asthma. Part II. The role of hormonal predisposition, environmental influences and conditioning leading to bronchial asthma. Acta Physiol Hung. 2009;96(3):289-305.
12. Reimann M, Bonifacio E, Solimena M et al. An update on preventive and regenerative therapies in diabetes mellitus. Pharmacol Ther. 2009;121(3):317-31.
13. O'Sullivan BP, Freedman SD. Cystic fibrosis. Lancet. 2009;373(9678):1891-904.
14. Satta A. Exercise training in asthma. J Sports Med Phys Fitness. 2000;40(4):277-83.
15. Gavi S, Hensley J. Diagnosis and management of type 2 diabetes in adults: a review of the ICSI guideline. Geriatrics. 2009;64(6):12-29.
16. Balady GJ, Williams MA, Ades PA et al. Core components of cardiac rehabilitation/secondary prevention programs: 2007 update: a scientific statement from the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation. J Cardiopulm Rehabil Prev. 2007;27(3):121-9.
17. Ambrosino N, Casaburi R, Ford G et al. Developing concepts in the pulmonary rehabilitation of COPD. Respir Med. 2008;102(S1):S17-26.

18. Statistics Canada, CANSIM, tables 104-0001, 105-0001, 105-0201 and 105-0401, and Catalogue no. 82-221-X.. Persons with asthma, by age and sex. Accessed on October 9, 2007: http://www40.statcan.ca/l01/cst01/health49b.htm

19. Walsh-Kelly CM, Drendel AL, Gales MS, Kelly KJ. Childhood asthma in the emergency department: trends, challenges, and opportunities. Curr Allergy Asthma Rep. 2006;6(6):462-7.

20. Clark CJ, Cochrane LM. Physical activity and asthma. Curr Opin Pulm Med. 1999;5(1):68-75.

21. Pueringer RJ, Hunninghake GW. Inflammation and airway reactivity in asthma. Am J Med. 1992;92(6A):32S-38S.

22. Fireman P. Understanding asthma pathophysiology. Allergy Asthma Proc. 2003;24(2):79-83.

23. Bousquet J, Jeffery PK, Busse WW, Johnson M, Vignola AM. Asthma: From bronchoconstriction to airways inflammation and remodeling. Am J Respir Crit Care Med. 2000;161(5):1720-45.

24. Canadian Institute for Health Information, Canadian Lung Association, Health Canada, Statistics Canada. Respiratory Disease in Canada 2001. Available from the Public Health Agency of Canada website: http://www.phac-aspc.gc.ca/publicat/rdc-mrc01/index-eng.php. Accessed on September 28th, 2009.

25. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma-Summary Report 2007. J Allergy Clin Immunol. 2007;120(5S):S94-138.

26. Miller MR, Crapo R, Hankinson J et al. General considerations for lung function testing. Eur Respir J. 2005;26(1):153-61.

27. Miller MR, Hankinson J, Brusasco V et al. Standardisation of spirometry. Eur Respir J. 2005;26(1): 319–338.

28. Wanger J, Clausen JL, Coates A et al. Standardisation of the measurement of lung volumes. Eur Respir J. 2005;26(1):511–522.

29. MacIntyre N, Crapo RO, Viegi G et al. Standardisation of the single-breath determination of carbon monoxide uptake in the lung. Eur Respir J. 2005;26(1):720–735.

30. Pellegrino R, Viegi G, Brusasco V et al. Interpretative strategies for lung function tests. Eur Respir J. 2005;26(1): 948–968.

31. Bateman ED, Hurd SS, Barnes PJ et al. Global strategy for asthma management and prevention: GINA executive summary. Eur Respir J. 2008;31(1):143-78.

32. Ram FS, Wellington SR, Barnes NC. Inspiratory muscle training for asthma. Cochrane Database Syst Rev. 2003;(4):CD003792.

33. Holloway E, Ram FS. Breathing exercises for asthma. Cochrane Database Syst Rev. 2004;(1):CD001277.

34. Cowie RL, Conley DP, Underwood MF, Reader PG. A randomised controlled trial of the Buteyko technique as an adjunct to conventional management of asthma. Respir Med. 2008;102(5):726-32.

35. Passalacqua G, Bousquet PJ, Carlsen KH et al. ARIA update: I--Systematic review of complementary and alternative medicine for rhinitis and asthma. J Allergy Clin Immunol. 2006;117(5):1054-62.

36. Sarver N, Murphy K. Management of asthma: new approaches to establishing control. J Am Acad Nurse Pract. 2009;21(1):54-65.

37. Gallefoss F, Bakke PS. Impact of patient education and self-management on morbidity in asthmatics and patients with chronic obstructive pulmonary disease. Respir Med. 2000;94(3):279-87.

38. Janson SL, McGrath KW, Covington JK, Cheng SC, Boushey HA. Individualized asthma self-management improves medication adherence and markers of asthma control. J Allergy Clin Immunol. 2009;123(4):840-6.

39. Kaya Z, Erkan F, Ozkan M et al. Self-management plans for asthma control and predictors of patient compliance. J Asthma. 2009;46(3):270-5.

40. Masoli M, Fabian D, Holt S, Beasley R; Global Initiative for Asthma (GINA) Program. The global burden of asthma: executive summary of the GINA Dissemination Committee report. Allergy. 2004;59(5):469-78.

41. Chen Y, Johansen H, Thillaiampalam S, Sambell C. Asthma. Health Rep. 2005;16(2): Catalogue 82-003.

42. Eagan TM, Brøgger JC, Eide GE, Bakke PS. The incidence of adult asthma: a review. Int J Tuberc Lung Dis. 2005;9(6):603-12.

43. Soriano JB, Rabe KF, Vermeire PA. Predictors of poor asthma control in European adults. J Asthma. 2003;40(7):803-13.

44. Holt S, Beasley R. The burden of asthma in New Zealand. Asthma and Respiratory Foundation of New Zealand. 2002 Available from: http://www.asthmanz.co.nz/burden_of_asthma_in_nz.php Accessed on September 28th, 2009.

45. Bahadori K, Doyle-Waters MM, Marra C et al. Economic burden of asthma: a systematic review. BMC Pulm Med. 2009;19:9-24.

46. Accordini S, Bugiani M, Arossa W et al. Poor control increases the economic cost of asthma. A multicentre population-based study. Int Arch Allergy Immunol. 2006;141(2):189-98.

47. Everhart RS, Fiese BH. Asthma severity and child quality of life in pediatric asthma: a systematic review. Patient Educ Couns. 2009;75(2):162-8.

48. Nejtek VA, Brown ES, Khan DA, Moore JJ, Van Wagner J, Perantie DC. Prevalence of mood disorders and relationship to asthma severity in patients at an inner-city asthma clinic. Ann Allergy Asthma Immunol. 2001;87(2):129-33.

49. Scott KM, Von Korff M, Ormel J et al. Mental disorders among adults with asthma: results from the World Mental Health Survey. Gen Hosp Psychiatry. 2007;29(2):123-33.

50. Hill VL, Wood PR. Asthma epidemiology, pathophysiology, and initial evaluation. Pediatr Rev. 2009;30(9):331-5.

51. Chen Y, Dales R, Jiang Y. The association between obesity and asthma is stronger in nonallergic than allergic adults. Chest. 2006;130(3):890-5.

52. Huggins S. The role of gastroesophageal reflux disease in asthma. J Am Acad Nurse Pract. 2008;20(5):238-42.

53. Boulet LP. Influence of comorbid conditions on asthma. Eur Respir J. 2009;33(4):897-906.

54. Joshi AV, Madhavan SS, Ambegaonkar A, Smith M, Scott VG, Dedhia H. Association of medication adherence with workplace productivity and health-related quality of life in patients with asthma. J Asthma. 2006;43(7):521-6

55. Juniper EF, Jenkins C, Price MJ, James MH. Impact of inhaled salmeterol/fluticasone propionate combination product versus budesonide on the health-related quality of life of patients with asthma. Am J Respir Med. 2002;1(6):435-40.

56. Markham A, Jarvis B. Inhaled salmeterol/fluticasone propionate combination: a review of its use in persistent asthma. Drugs. 2000;60(5):1207-33.

57. Fanelli A, Cabral AL, Neder JA, Martins MA, Carvalho CR. Exercise training on disease control and quality of life in asthmatic children. Med Sci Sports Exerc. 2007;39(9):1474-80.

58. Emtner M, Herala M, Stålenheim G. High-intensity physical training in adults with asthma. A 10-week rehabilitation program. Chest. 1996;109(2):323-30.

59. Fuhlbrigge AL, Adams RJ, Guilbert TW et al. The burden of asthma in the United States: level and distribution are dependent on interpretation of the national asthma education and prevention program guidelines. Am J Respir Crit Care Med. 2002;166(8):1044-9.

60. Crapo RO, Casaburi R, Coates AL et al. Guidelines for methacholine and exercise challenge testing-1999. Am J Respir Crit Care Med. 2000;161(1):309-29.

61. Horváth I, Hunt J, Barnes PJ et al. Exhaled breath condensate: methodological recommendations and unresolved questions. Eur Respir J. 2005;26(3):523-48.

62. Taylor DR, Pijnenburg MW, Smith AD, De Jongste JC. Exhaled nitric oxide measurements: clinical application and interpretation. Thorax. 2006;61(9):817-27.

63. Bacci E, Cianchetti S, Carnevali S et al. Induced sputum is a reproducible method to assess airway inflammation in asthma. Mediators Inflamm. 2002;11(5):293-8.

64. Becker A, Lemière C, Bérubé D et al. Summary of recommendations from the Canadian Asthma Consensus guidelines, 2003. CMAJ. 2005;173(6 Suppl):S3-11.

65. Peters SP, Jones CA, Haselkorn T, Mink DR, Valacer DJ, Weiss ST. Real-world Evaluation of Asthma Control and Treatment (REACT): findings from a national Web-based survey. J Allergy Clin Immunol. 2007;119(6):1454-61.

66. Fuhlbrigge A, Reed ML, Stempel DA, Ortega HO, Fanning K, Stanford RH. The status of asthma control in the U.S. adult population. Allergy Asthma Proc. 2009 Sep 11.

67. Cazzoletti L, Marcon A, Janson C et al. Asthma control in Europe: a real-world evaluation based on an international population-based study. J Allergy Clin Immunol. 2007;120(6):1360-7.

68. Chapman KR, Boulet LP, Rea RM, Franssen E. Suboptimal asthma control: prevalence, detection and consequences in general practice. Eur Respir J 2008;31(2):320-5.

69. McIvor RA, Boulet LP, FitzGerald JM, Zimmerman S, Chapman KR. Asthma control in Canada: no improvement since we last looked in 1999. Can Fam Physician. 2007;53(4):673-7.

70. Vollmer WM, Markson LE, O'Connor E et al. Association of asthma control with health care utilization and quality of life. Am J Respir Crit Care Med. 1999;160(5 Pt 1):1647-52.

71. Vollmer WM, Markson LE, O'Connor E, Frazier EA, Berger M, Buist AS. Association of asthma control with health care utilization: a prospective evaluation. Am J Respir Crit Care Med. 2002;165(2):195-9.

72. Axelsson M, Emilsson M, Brink E, Lundgren J, Torén K, Lötvall J. Personality, adherence, asthma control and health-related quality of life in young adult asthmatics. Respir Med. 2009 Jul;103(7):1033-40.

73. Chen H, Gould MK, Blanc PD et al. Asthma control, severity, and quality of life: quantifying the effect of uncontrolled disease. J Allergy Clin Immunol. 2007;120(2):396-402.

74. King MT, Kenny PM, Marks GB. Measures of asthma control and quality of life: longitudinal data provide practical insights into their relative usefulness in different research contexts. Qual Life Res. 2009;18(3):301-12.

75. Braido F, Baiardini I, Balestracci S et al. Does asthma control correlate with quality of life related to upper and lower airways? A real life study. Allergy. 2009;64(6):937-43.

76. Taegtmeyer AB, Steurer-Stey C, Price DB, Wildhaber JH, Spertini F, Leuppi JD. Predictors of asthma control in everyday clinical practice in Switzerland. Curr Med Res Opin. 2009;25(10):2549-55.

77. Laforest L, Van Ganse E, Devouassoux G et al. Influence of patients' characteristics and disease management on asthma control. J Allergy Clin Immunol. 2006;117(6):1404-10.

78. Boulet LP. Perception of the role and potential side effects of inhaled corticosteroids among asthmatic patients. Chest. 1998;113(3):587-92.

79. Dahl R. Systemic side effects of inhaled corticosteroids in patients with asthma. Respir Med. 2006;100(8):1307-17.

80. Adams NP, Jones PW. The dose-response characteristics of inhaled corticosteroids when used to treat asthma: an overview of Cochrane systematic reviews. Respir Med. 2006;100(8):1297-306.

81. Lundbäck B, Rönmark E, Lindberg A et al. Control of mild to moderate asthma over 1-year with the combination of salmeterol and fluticasone propionate. Respir Med. 2006;100(1):2-10.

82. Lasmar L, Camargos P, Champs NS et al. Adherence rate to inhaled corticosteroids and their impact on asthma control. Allergy. 2009;64(5):784-9.

83. de Vries MP, van den Bemt L, Lince S, Muris JW, Thoonen BP, van Schayck CP. Factors associated with asthma control. J Asthma. 2005;42(8):659-65

84. Schatz M, Mosen DM, Kosinski M et al. Predictors of asthma control in a random sample of asthmatic patients. J Asthma. 2007;44(4):341-5.

85. Schatz M, Zeiger RS, Vollmer WM, Mosen D, Cook EF. Determinants of future long-term asthma control. J Allergy Clin Immunol. 2006;118(5):1048-53.

86. Dogra S, Ardern CI, Baker J. The relationship between age of asthma onset and cardiovascular disease in Canadians. J Asthma. 2007;44(10):849-54.

87. Chen Y, Rennie D, Cormier Y, Dosman J. Atopy, obesity, and asthma in adults: the Humboldt study. J Agromedicine. 2009;14(2):222-7.

88. Lavoie KL, Bacon SL, Labrecque M, Cartier A, Ditto B. Higher BMI is associated with worse asthma control and quality of life but not asthma severity. Respir Med. 2006;100(4):648-57.

89. Mosen DM, Schatz M, Magid DJ, Camargo CA Jr. The relationship between obesity and asthma severity and control in adults. J Allergy Clin Immunol. 2008;122(3):507-11.

90. Boulet LP, Franssen E. Influence of obesity on response to fluticasone with or without salmeterol in moderate asthma. Respir Med. 2007 Nov;101(11):2240-7.

91. Maniscalco M, Zedda A, Faraone S et al. Weight loss and asthma control in severely obese asthmatic females. Respir Med. 2008;102(1):102-8.

92. Westermann H, Choi TN, Briggs WM, Charlson ME, Mancuso CA. Obesity and exercise habits of asthmatic patients. Ann Allergy Asthma Immunol. 2008;101(5):488-94.

93. Clerisme-Beaty EM, Karam S, Rand C et al. Does higher body mass index contribute to worse asthma control in an urban population? J Allergy Clin Immunol. 2009;124(2):207-12.

94. Shore SA. Obesity and asthma: possible mechanisms. J Allergy Clin Immunol. 2008;121(5):1087-93; quiz 1094-5.

95. Rundell KW, Jenkinson DM. Exercise-induced bronchospasm in the elite athlete. Sports Medicine. 2002; 32(9): 583-600.

96. Weiler JM, Bonini S, Coifman R et al. American Academy of Allergy, Asthma & Immunology Work Group report: exercise-induced asthma. J Allergy Clin Immunol. 2007;119(6): 1349-58.

97. Anderson SD. How does exercise cause asthma attacks? Curr Opin Allergy Clin Immunol. 2006;6(1): 37-42.

98. Anderson SD, Daviskas E. The mechanism of exercise-induced asthma is ... J Allergy Clin Immunol. 2000 Sep;106(3):453-9.

99. Arborelius M, Svenonius E. Decrease of exercise-induced asthma after physical training. Eur J Respir Dis Suppl. 1984; 136:25-31.

100. Clark CJ. The role of physical training in asthma. Chest. 1992;101(5S):293S-298S.

101. Satta A. Exercise training in asthma. J Sports Med Phys Fitness. 2000; 40(4):277-283.

102. Carroll N. Exercise training as an adjunct to asthma management? Thorax. 1999; 54:190-1.

103. Cochrane LM, Clark CJ. Benefits and problems of a physical training programme for asthmatic patients. Thorax. 1990;45(5):345-51.

104. Tan RA, Spector SL. Exercise induced asthma. Sports Med. 1998; 25(1): 1-6.

105. McKenzie DC, McLuckie SL, Stirling DR. The protective effects of continuous and interval exercise in athletes with exercise-induced asthma. Med Sci Sports Exerc. 1994; 26(8): 951-6

106. Shaaban R, Leynaert B, Soussan D et al. Physical activity and bronchial hyperresponsiveness: European Community Respiratory Health Survey II. Thorax. 2007;62(5):403-10.

107. Chen Y, Dales R, Krewski D. Leisure-time energy expenditure in asthmatics and non-asthmatics. Respir Med. 2001;95(1):13-8.

108. Firrincieli V, Keller A, Ehrensberger R et al. Decreased physical activity among Head Start children with a history of wheezing: use of an accelerometer to measure activity. Pediatr Pulmonol. 2005;40(1):57-63.

109. Ford ES, Heath GW, Mannino DM et al. Leisure-time physical activity patterns among US adults with asthma. Chest. 2003;124(2):432-7.

110. Counil FP, Karila C, Varray A et al. Anaerobic fitness in children with asthma: adaptation to maximal intermittent short exercise. Pediatr Pulmonol. 2001;31(3):198-204.

111. Glazebrook C, McPherson AC, Macdonald IA et al. Asthma as a barrier to children's physical activity: implications for body mass index and mental health. Pediatrics. 2006;118(6):2443-9.

112. Mancuso CA, Sayles W, Robbins L et al. Barriers and facilitators to healthy physical activity in asthma patients. J Asthma. 2006;43(2):137-43.

113. Ford ES, Mannino DM. Time trends in obesity among adults with asthma in the United States: findings from three national surveys. J Asthma. 2005;42(2):91-5.

114. Dogra S, Ardern CI & Baker J. The Relationship between Asthma Age of Onset and Cardiovascular Disease in Canadians with Asthma. J Asthma. 2007; 44:849–854.

115. Iribarren C, Tolstykh IV, Eisner MD. Are patients with asthma at increased risk of coronary heart disease? Int J Epidemiol. 2004;33(4):743-8.

116. Dogra S, Baker J. Physical activity and health in Canadian asthmatics. J Asthma. 2006;43(10):795-9.

117. Hallstrand TS, Bates PW, Schoene RB. Aerobic conditioning in mild asthma decreases the hyperpnea of exercise and improves exercise and venilatory capacity. Chest. 2000; 118:1460-69.

118. Robinson DM, Egglestone DM, Hill PM et al. Effects of a physical conditioning programme on asthmatic patients. N Z Med J. 1992;105(937):253-6.

119. Clark CJ. Asthma and exercise: a suitable case for rehabilitation? Thorax. 1992;47(10):765-7.

120. Emtner M, Finne M, Stålenheim G. A 3-year follow-up of asthmatic patients participating in a 10-week rehabilitation program with emphasis on physical training. Arch Phys Med Rehabil. 1998;79(5):539-44.

121. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. Eur Respir J. 1999;14(4):902-7.

CHAPTER 2: THE ROLE OF PHYSICAL ACTIVITY AND BODY MASS INDEX IN THE HEALTH CARE USE OF ADULTS WITH ASTHMA

[1,2]Shilpa Dogra, [1,2]Joseph Baker, [2]Chris I Ardern
[1]Lifespan Health and Performance Laboratory
[2]School of Kinesiology and Health Science, York University, Toronto, ON.
Published in *Annals of Allergy, Asthma and Immunology* (2009 Jun;102(6):462-8)

ABSTRACT

Background: Health care use in patients with asthma is affected by many factors including sex, and ethnicity. The role of physical activity (PA) and body mass index (BMI) in this relationship is unknown. ***Objective:*** To determine the role of PA and BMI in health care use of patients with asthma. ***Methods:*** A sample of patients with asthma (n=6,835) and patients without asthma (n=78,051) from Cycle 3.1 of the Canadian Community Health Survey were identified. Health care use was self-reported as overnight hospital stays (yes/no), length of overnight hospital stay (<4/≥4), and physician consultations (<3/≥3). Self-reported PA was used to derive total energy expenditure and to classify participants as active (≥3.0 $kcal.kg^{-1}.day^{-1}$), moderately active (1.5-2.9 $kcal.kg^{-1}.day^{-1}$), or inactive (<1.5 $kcal.kg^{-1}.day^{-1}$). BMI was categorized as normal weight (18.5-24.9 $kg.m^{-2}$), overweight (25-29.9 $kg.m^{-2}$) and obese (30-59.9 $kg.m^{-2}$). ***Results:*** Adjusted logistic regression models revealed that patients with asthma were more likely to have an overnight hospital stay (OR=2.25, CI=1.95-2.60), ≥4 overnight hospital stays (OR=1.48, CI=1.12-1.96) and ≥3 physician consultations (OR=2.43, CI=2.18-2.71) compared to patients without asthma (OR=1.00). Inactive patients with asthma were more likely have an overnight hospital stay (OR=1.68, CI=1.31-2.16) and ≥3 physician consultations (OR=1.23, CI=1.04-1.46) than inactive patients with asthma (OR=1.00). Inactive obese patients with asthma were 2.35 (CI=1.69-3.27) times more likely to have an overnight hospital stay, and 2.76 (CI=2.11-3.60) times more likely to have ≥3 physician consultations than active normal weight patients with asthma (OR=1.00). ***Conclusion:*** Higher PA levels are associated with lower health care use in patients with asthma and

patients without asthma. In patients with asthma, PA was a more important factor in overnight hospital stays than BMI, whereas both BMI and PA were important determinants of physician consultations.

INTRODUCTION

Physical activity (PA) and fitness levels have been shown to be lower in patients with asthma when compared with healthy peers[1–3]. At the same time, many patients with asthma are overweight or obese[4]. Obese individuals have more physician visits and are more likely to seek medical care[5-7]; this increased health care use has proven to be a great burden on the health care system[8]. Studies examining obesity and health care use have also found that obese individuals are more likely to use prescription asthma medications[9] and that asthma increases the odds of health care use by 33% in obese individuals[10]. Nevertheless, PA-induced weight loss has been shown to improve asthma symptoms in an obese population[11].

Previous literature has established an association between direct and indirect health care costs of patients with asthma such that cost increases with the severity of disease[12]. Other factors related to increased health care use in patients with asthma include female sex[13], lower asthma-specific health related quality of life[14], low socioeconomic status[15], ethnicity[15,16], smoking status[16], and type of insurance coverage[17]. In the general population, higher cardiorespiratory fitness has been associated with lower health care use[18].Research has yet to examine the relationship between PA levels of asthmatic patients and health care use while accounting for obesity. We, therefore, sought to determine the following: (1) whether the health care use of asthmatic patients and non-asthmatic patients differs by PA levels in a sub-sample of the Canadian population with universal health care coverage and (2) whether health care use differs among asthmatic patients based on PA levels and body mass index (BMI). We hypothesized that inactive

overweight and inactive obese asthmatic patients would be greater consumers of health care.

METHODS

Participants

Data from the 2005 Canadian Community Health Survey (CCHS), cycle 3.1, a nationally representative population based cross-sectional survey, were used. All data contained in the CCHS are self-reported, and respondents provided informed consent before participation. For data collection purposes, each province was divided into health regions and each territory was designated as a single health region. The CCHS provides health information for all 125 health regions, including estimates of health determinants, health status, and health system use. One of the primary objectives of the CCHS is to collect information on health system use. Detailed information on data collection methods and data weighting can be found in the CCHS user guide[19].

Main Outcome and Exposure Variables

Physician consultations and overnight hospital stays were used as a proxy for health care use. These measures were additionally chosen because they are services that are universally available to all Canadians and do not require private medical insurance. With regard to physician consultations, participants were asked the following: "Not counting when you were an overnight patient, in the past 12 months how many times have you seen, or talked on the telephone, about your physical, emotional or mental health with a family doctor, pediatrician or general practitioner?" The median number of consultations was calculated for the sample and subsequently used to dichotomize the

variable into fewer than 3 consultations and 3 or more consultations. Pertaining to overnight stays, participants were asked the following 2 questions: "In the past 12 months, have you been a patient overnight in a hospital, nursing home or convalescent home?" and "For how many nights in the past 12 months?" Similar to physician consultations, the median number of overnight stays was calculated for the sample and divided into fewer than 4 nights and 4 or more nights.

The main exposure variables were PA levels and BMI. In the CCHS, participants were asked a series of questions pertaining to mode and time spent in physical activities. Because each activity is associated with a time and frequency (per week), total PA or metabolic equivalents can be calculated. The energy expenditure is based on the estimated kilocalories of energy spent per kilogram of body weight per day. A PA index is then derived to classify participants as "active" (>3.0 kcal/kg of body weight per day), "moderately active" (1.5–3.0 kcal/kg of body weight per day), or "inactive" (<1.5 kcal/kg of body weight per day)[19]. The BMI was calculated by dividing self-reported weight in kilograms by height in meters squared. All pregnant women were excluded, and BMI values above 59.9 were eliminated to minimize potential error and extreme values. Participants were then classified as underweight (BMI <18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0 –29.9), and obese (BMI ≥30.0) using standard BMI criteria. Because of the low prevalence of CCHS participants who were underweight (n=136 asthmatic patients and n=1502 non-asthmatic patients), analyses were subsequently limited to those whose weight was normal and above normal. These exposure variables were then cross-classified with asthma status to create 2 new variables: the PA index

categories were combined with asthma status to form inactive asthmatic patients, moderately active asthmatic patients, active asthmatic patients, inactive non-asthmatic patients, moderately active non-asthmatic patients, and active non-asthmatic patients. Similarly, BMI categories were combined with activity levels of asthmatic patients to form normal weight/active, normal weight/inactive, overweight/active, overweight/inactive, obese/active, and obese/inactive. Because of a small sample size in multivariate analyses with asthmatic patients cross-classified by BMI, the active and moderately active categories were collapsed to form the active group.

Main Covariates and Demographic Variables

The following variables were used to characterize the demographics of the sample and identify potential covariates of health care use in subsequent analyses.

Daily fruit and vegetable consumption was included because of the profound impact of proper nutrition or diet on asthma symptoms[20,21]. It was reported and classified as "low" (<5 servings per day), "adequate" (5–10 servings per day), or "high" (>10 servings per day). Smoker type was classified as "daily smoker", "occasional smoker," or "non-smoker". These categories were derived by the CCHS, such that occasional smokers were either those who were self-reported former daily smokers or those who had smoked fewer than 100 cigarettes in their lives. Similarly, alcohol consumption was classified as "regular", "occasional", "former", or "never." Again, categories of alcohol consumption were derived by standard CCHS questions regarding the number of alcoholic units consumed per week and the number of times the individual had binged in a 12-month period. The presence or absence of chronic diseases (high blood pressure,

heart disease, diabetes mellitus, cancer, or stroke) was also self-reported and included in multivariate analyses. Demographic variables included ethnicity, educational level, and annual income. Participants were asked to specify their cultural or ethnic background from 21 categories. These were subsequently dichotomized into "white" and "non-white" to account for smaller numbers within the non-white categories. To account for socioeconomic status, participants' highest level of education was reported as "less than secondary school", "secondary school graduate," "some postsecondary education," and "postsecondary graduate"; household income was coded as "low" (<Can$15,000 if 1 or 2 people; <Can$20,000 if 3 or 4 people; <Can$30,000 if ≥5 people), "low-middle" (Can$15,000-Can$29,999 if 1 or 2 people; Can$20,000-Can$39,999 if 3 or 4 people; Can$30,000- Can$59,999 if ≥5 people), "upper-middle"(Can$30,000- Can$59,999 if 1 or 2 people; Can$40,000-Can$79,999 if 3 or 4 people; Can$60,000-Can$79,999 if ≥5 people), and "high" (>Can$60,000 if 1 or 2 people; >Can$80,000 if ≥3 people).

Statistical Analysis

All data were analyzed using SPSS statistical software, version 15.0 (SPSS Inc, Chicago, Illinois), and a master weight was applied to the data to ensure representativeness of the sample to the Canadian population. χ^2 tests were performed to test for differences across activity levels within asthmatic and non-asthmatic patients for all outcomes, exposures, and covariates. Multivariate logistic regression models were produced using the Enter method such that all variables were entered in a single step. Two models were run for all analyses. Model 1 adjusted for age and sex, and model 2 additionally adjusted for all other covariates. Logistic regression was used to estimate the

odds ratios and 95% confidence intervals of having 3 or more physician consultations, having an overnight hospital stay, and having 4 or more overnight stays within the past year. All analyses were limited to adults between the ages of 20 and 64 years and to those without chronic obstructive pulmonary disease.

RESULTS

In total, there were 6,835 asthmatic patients (2,592 males) and 78,051 non-asthmatic patients (38,510 males) with complete data on variables of interest. Overall, 12.2% of asthmatic patients and 7.3% of non-asthmatic patients had at least 1 overnight hospital stay (χ^2=122.1; p<0.001) in the past year, whereas 42.4% of asthmatic patients and 38.6% of non-asthmatic patients had 4 or more overnight hospital stays (χ^2=2.5; p=.12). In addition, 61.8% of asthmatic patients and 46.3% of non-asthmatic patients had 3 or more physician consultations (χ^2=295.2, p< 0.001) within the past year.

The association between covariates and study outcomes was evaluated at the bivariate level, and all significant factors were included in the fully adjusted models. Table 1 depicts the distribution of the outcome measures and exposures. Bivariate analysis revealed significant differences in PA across all covariates, with the exception of stroke (χ^2=3.86, p=.15) and cancer (χ^2=4.61, p=.10) for asthmatic patients. Although most associations were intuitive, such that active individuals displayed healthier behaviours, this was not the case for alcohol consumption in either asthmatic or non-asthmatic patients. A higher percentage of active asthmatic patients and active non-

Table 2.1: Characteristics of patients with and without asthma by physical activity level[a]

	Patients with Asthma			Patients without Asthma		
	Inactive (n=3,400)	**Moderate** (n=1,758)	**Active** (n=1,677)	**Inactive** (n=38,275)	**Moderate** (n=20,072)	**Active** (19,704)
N (unweighted)	3400	1758	1677	38275	20072	19704
Sex						
Male	35.5	37.2	43.6	47.8	47.7	54.0
Female	64.5	62.8	56.4	52.2	52.3	46.0
Age						
20-24y	11.4	13.4	20.3	8.4	10.4	14.3
25-29y	10.2	10.9	14.8	9.7	9.8	10.9
30-34y	10.1	13.6	12.8	10.3	10.4	10.5
35-39y	9.8	11.6	10.6	12.8	12.2	11.9
40-44y	13.1	12.2	11.6	14.2	13.8	14.4
45-49y	12.4	12.6	9.9	13.2	13.4	11.1
50-54y	12.8	10.7	8.5	12.5	12.6	10.2
55-59y	11.3	8.7	5.7	10.9	10.0	9.2
60-64y	8.9	6.4	5.9	8.1	7.5	7.6
BMI						
Underweight	2.8	2.1	2.0	2.8	2.0	1.7
Normal	39.5	40.5	50.1	44.8	47.0	51.0
Overweight	29.3	35.3	30.4	33.8	35.2	35.3
Obese I	15.6	14.8	12.1	13.2	12.1	9.4
Obese II	8.2	5.5	4.0	3.9	2.9	2.0
Obese III	4.6	1.7	1.6	1.4	0.9	0.5

Chronic Disease						
High BP	19.2	13.5	10.0	13.2	11.5	8.7
Diabetes	7.6	4.1	2.8	4.2	3.6	2.9
Heart Disease	6.8	3.6	2.2	3.2	2.6	2.3
Cancer	1.6	1.5	0.7[b]	1.3	1.0	1.0
Stroke	1.1	0.5	0.7[b]	0.6	0.4	0.4
Fruit and Vegetable Consumption						
<5	68.4	60.0	46.5	69.4	56.9	49.0
5-10	29.0	36.3	44.4	28.4	39.6	44.6
>10	2.6	3.8	9.1	2.3	3.5	6.4
Smoking Status						
Daily	26.0	20.6	18.3	27.0	19.0	17.5
Occasional	4.7	5.8	8.0	5.1	6.0	7.0
Not at all	69.3	73.7	73.6	67.9	75.0	75.5
Alcohol						
Regular	53.6	67.8	68.8	61.6	70.0	72.3
Occasional	23.5	18.1	16.1	19.0	16.7	14.7
Former	17.3	10.3	11.5	12.5	9.0	9.5
Never	5.7	3.8	3.6	6.9	4.3	3.5
Ethnicity						
White	85.8	91.6	85.3	80.7	86.1	85.1
Non-White	14.2	8.4	14.7	19.3	13.9	14.9
Education						
Sec.	20.7	13.7	12.5	18.8	12.2	11.2
Sec. Grad	16.9	20.0	21.2	20.4	18.9	18.7
Post-Sec	9.3	8.1	10.0	7.7	8.0	9.2
Post Grad	53.2	58.3	56.4	53.2	60.9	60.9
Income						
Low	15.9	11.6	10.9	11.1	7.8	8.3
Low-mid	23.4	15.8	15.7	20.3	14.8	14.4

Up-mid	33.6	30.0	27.4	36.5	34.8	31.8
High	27.2	42.6	45.9	32.1	42.7	45.5
Overnight Stays						
Yes	14.9	9.8	9.0	8.0	6.6	6.4
Length of Stay						
≥4	44.8	39.4	35.9	41.3	35.4	33.9
Physician Consultations						
≥3	66.0	58.1	57.5	48.6	45.3	42.7

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure.

[a]Data are given as percentage of each group (and may not total 100% for each category because of rounding) and are from cycle 3.1 of the Canadian Community Health Survey. All associations between activity levels within asthmatic or non-asthmatic groups are significant unless otherwise indicated.

[b]Denotes a non-significant χ^2 across physical activity levels of asthmatic and non-asthmatic groups.

asthmatic patients tended to be regular drinkers compared with inactive asthmatic patients and inactive non-asthmatic patients, respectively. Also, a lower percentage of inactive asthmatic patients and inactive non-asthmatic patients were in the high income category, suggesting a lower socioeconomic status in the inactive group. In both asthmatic and non-asthmatic patients, a higher percentage of individuals in the inactive group used health care services compared with the active group.

Regression analyses confirm the findings at the bivariate level. There was a joint effect of inactivity and asthma such that inactive asthmatic patients were more likely to report an overnight stay and more frequent physician consultations than active non-asthmatic patients (Table 2). Inactive non-asthmatic patients were consistently at greater odds of overnight hospital stays and 3 or more physician consultations in both models 1 and 2 when compared with active non-asthmatic patients. When examining these patterns within the sample of asthmatic patients exclusively, inactive (but not moderately active) asthmatic patients had a higher likelihood of overnight hospital stays and physician consultations than their more active peers (Table 3). A graded increase in the odds of overnight hospital stays and physician consultations was also observed across BMI/activity strata in age- and sex-adjusted analyses, with no significant relationship for the length of hospital stays (Table 4). After adjustment for additional covariates in model 2, the odds of overnight stays were higher in the inactive group regardless of BMI, whereas both BMI and PA were important determinants of physician consultations.

Table 2.2: Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With and Without Asthma[a]

	Overnight Hospital Stay (Yes)	Length of Stay (≥4)	Physician Consul. (≥3)
		Model 1:	
Patients with Asthma			
Inactive	2.25[b] (1.95-2.60)	1.48[b] (1.12-1.96)	2.43[b] (2.18-2.71)
Moderately Active	1.39[b] (1.12-1.73)	1.33 (0.86-2.05)	1.75[b] (1.52-2.02)
Active	1.34[b] (1.07-1.68)	1.19 (0.75-1.88)	1.91[b] (1.66-2.20)
Patients without Asthma			
Inactive	1.24[b] (1.13-1.35)	1.26[b] (1.05-1.50)	1.24[b] (1.18-1.31)
Moderately Active	1.02 (0.93-1.13)	0.99 (0.80-1.22)	1.08[b] (1.02-1.15)
Active[c]	1.00	1.00	1.00
		Model 2:	
Patients with Asthma			
Inactive	1.75[b] (1.48-2.07)	1.28 (0.92-1.77)	2.15[b] (1.90-2.44)
Moderately Active	1.26 (0.98-1.62)	1.22 (0.74-2.01)	1.70[b] (1.44-2.00)
Active	1.09 (0.83-1.42)	1.02 (0.59-1.79)	1.69[b] (1.44-1.98)
Patients without Asthma			
Inactive	1.16[b] (1.05-1.28)	1.15 (0.94-1.41)	1.12[b] (1.05-1.19)
Moderately Active	1.02 (0.91-1.14)	1.00 (0.79-1.27)	1.04 (0.98-1.11)
Active[c]	1.00	1.00	1.00

[a]Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.
[b] $p \leq 05$; [c] Referent

Table 2.3: Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Only[a]

	Overnight Hospital Stay (Yes)	Length of Stay (≥4)	Physician Consul. (≥3)
		Model 1	
Inactive	1.68[b] (1.31-2.16)	1.29 (0.79-2.11)	1.23[b] (1.04-1.46)
Moderately Active	1.03 (0.77-1.39)	1.13 (0.63-2.04)	0.89 (0.73-1.08)
Active	1.00	1.00	1.00
		Model 2	
Inactive	1.78[b] (1.31-2.41)	1.37 (0.72-2.58)	1.26[b] (1.03-1.55)
Moderately Active	1.21(0.85-1.72)	1.08 (0.52-2.25)	1.00 (0.80-1.25)
Active	1.00	1.00	1.00

[a]Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.
[b]$p \leq 0.05$
[c]Referent

Table 2.4: Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Classified by Body Mass Index and Activity Levels[a]

	Overnight Hospital Stay (Yes)	Length of Stay (≥4)	Physician Consul. (≥3)
		Model 1	
Inactive Obese	2.35[b] (1.69-3.27)	1.61(0.84-3.06)	2.76[b] (2.11-3.60)
Inactive Overweight	1.75[b] (1.24-2.48)	2.08 (1.06-4.07)	1.30[b] (1.02-1.65)
Inactive Normal	1.81[b] (1.33-2.47)	1.51 (0.81-2.81)	1.59[b] (1.27-1.98)
Active Obese	1.48 (0.99-2.20)	1.87 (0.86-4.05)	2.18[b] (1.65-2.88)
Active Overweight	1.18 (0.82-1.70)	1.23 (0.59-2.55)	1.29[b] (1.02-1.63)
Active Normal	1.00	1.00	1.00
		Model 2	
Inactive Obese	1.95[b] (1.31-2.88)	1.68 (0.75-3.74)	2.22[b] (1.64-3.01)
Inactive Overweight	1.54[b] (1.03-2.30)	1.53 (0.67-3.51)	1.28 (0.98-1.69)
Inactive Normal	1.67[b] (1.17-2.39)	1.61 (0.76-3.45)	1.49[b] (1.16-1.91)
Active Obese	1.13 (0.71-1.78)	1.72 (0.67-4.39)	1.81[b] (1.33-2.46)
Active Overweight	1.16 (0.77-1.74)	1.19 (0.50-2.84)	1.23 (0.95-1.59)
Active Normal	1.00	1.00	1.00

[a]Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.
[b]$p \leq 0.05$
[c]Referent

DISCUSSION

Our analyses confirm that asthmatic patients are more likely to use health care services than non-asthmatic patients and that inactive asthmatic patients are more likely to use health care services than active asthmatic patients. We also found that overnight hospital stays were more common in inactive asthmatic patients regardless of BMI, whereas both BMI and PA were important determinants of the frequency of physician consultations.

The finding that asthmatic patients are more likely to have overnight hospital stays and 3 or more physician consultations is not surprising. Research has shown that only 19.1% of patients in the United States[22] and 24% of patients in Canada[23] have well-controlled asthma according to the National Asthma Education and Prevention Program and the Canadian Asthma Consensus Guidelines, respectively. Furthermore, suboptimal control of asthma has been associated with excess health care use, such that 51% of asthmatic patients require urgent care for their asthma[23]. In addition to asthma control evaluated by physicians, perceived asthma control has also been linked to health care use. Calfee et al[24] showed that higher perceived control of asthma was associated with a decreased likelihood of emergency department visits and hospitalizations for asthma. Vollmer et al[25] reported a dose-response relationship between both the number of measured asthma control problems and perceived asthma control with physician visits, emergency department care, and hospitalization in asthmatic patients.

According to the Global Initiative for Asthma, asthmatic patients are classified as having controlled, partly controlled, or uncontrolled asthma using the following criteria:

daytime symptoms, activity limitations, nocturnal symptoms, need for reliever medication, lung function (as measured by forced expiratory volume in 1 second), and acute asthma exacerbations[26]. Studies have shown that asthma control[27] and health care use[25] have a stronger association with the activity domain of asthma control measurement tools compared with other domains. In addition, greater perceived control is associated with fewer days of restricted activity[24]. In conjunction with our findings, this suggests that PA level may have a direct impact on health care use through its association with asthma control. Because physical inactivity is pervasive in North America, adoption of initiatives such as the American College of Sports Medicine's "Exercise is Medicine campaign"[28] may be particularly useful in this regard.

Our analyses pertaining to overnight hospital stays support the fit-fat concept such that activity seemed to be of greater importance than BMI per se. Compared with normal weight/active asthmatic patients, obese/inactive asthmatic patients were 95% more likely to have reported an overnight hospital stay in the previous year. Although obese individuals incur significantly more medical expenses and hospitalization costs and consume more prescription medications than their lower-risk counterparts[10], previous research has shown that obesity does not necessarily affect health care use to the same extent in asthmatic patients[28]. Among a group of adult asthmatic patients presenting to the emergency department, the severity of the exacerbations did not differ between obese and non-obese patients[29]. Furthermore, in an urban pediatric population with optimal asthma control, obesity was not a factor in time to achieve control or its subsequent maintenance[30].

To verify that physical inactivity is indeed a moderator of health care use in asthmatic patients, prospective cohort studies of inactive asthmatic patients with variable levels of control should be conducted to monitor health care use before and after exercise interventions. Health care use measures should include emergency department visits, medication use, physician consultations, and overnight hospital stays. In addition, research pertaining to the direct relationship between asthma control and exercise is required to better understand its impact on health care use. It is also imperative that psychological conditions such as depression be carefully controlled for in such studies, because depression is closely related to both asthma[31] and physical inactivity[32].

The greatest limitation of this study is the self-reported nature of the asthma, BMI, and PA data. Although physician diagnosed asthma would have been preferable to reduce the possibility of misclassification bias, recent evidence suggests that physicians over-diagnose asthma in both obese and non-obese individuals[33]. Our use of self-reported height and weight as a measure of overall adiposity also likely underestimated the prevalence of overweight and obese[34], whereas PA may have been overestimated by self-report[35]. Nevertheless, self-reported PA remains an adequate and reliable population-based measure[36]. Furthermore, the underreporting of BMI and over-reporting of PA are likely to be equal in all groups leading to a non-differential bias. Another limitation is that the outcome measures did not allow us to differentiate between urgent and non-urgent care, which is an important variable to consider when assessing asthma control. Unfortunately, the CCHS does not contain a variable for emergency department visits. This is an area that should be considered in future research. Finally, because the CCHS is

cross-sectional, reverse causality cannot be ruled out. In other words, we are unable to verify whether asthmatic patients have greater health care use as a result of lower activity levels or whether they are inactive as a result of their higher health care use (ie, poorer asthma control).

In summary, results from this population-based sample of Canadians indicate that health care use is higher in adult asthmatic patients when compared with non-asthmatic patients and that both inactivity and obesity contribute to increased health care use in asthmatic patients. Independent of BMI, active asthmatic patients are less likely to have an overnight hospital stay, whereas both BMI and PA are important determinants of physician consultations. Future research using administrative data is needed to corroborate these self-reported findings within emergency department and other health care settings.

REFERENCES:

1. Pianosi PT, Davis HS. Determinants of physical fitness in children with asthma. Pediatrics. 2004;113:e225– e229.

2. Williams B, Powell A, Hoskins G, Neville R. Exploring and explaining low participation in physical activity among children and young people with asthma: a review. BMC Fam Pract. 2008;9:40 –51.

3. Ford ES, Heath GW, Mannino DM, Redd SC. Leisure-time physical activity patterns among US adults with asthma. Chest. 2003;124:432–437.

4. Ford ES. The epidemiology of obesity and asthma. J Allergy Clin Immunol. 2005;115:897–909.

5. Shore SA. Obesity and asthma: cause for concern. Curr Opin Pharmacol. 2006;6:230-236.

6. Luder E, Ehrlich RI, Lou WY, Melnik TA, Kattan M. Body mass index and the risk of asthma in adults. Respir Med. 2004;98:29 –37.

7. Trakas K, Lawrence K, Shear NH. Utilization of health care resources by obese Canadians. CMAJ. 1999;160:1457–1462.

8. Katzmarzyk PT, Janssen I. The economic costs associated with physical inactivity and obesity in Canada: an update. Can J Appl Physiol. 2004;29:90 –115.

9. Raebel MA, Malone DC, Conner DA, Xu S, Porter JA, Lanty FA. Health services use and health care costs of obese and nonobese individuals. Arch Intern Med. 2004;164:2135–2140.

10. Pronk NP, Tan AW, O'Connor P. Obesity, fitness, willingness to communicate

and health care costs. Med Sci Sports Exerc. 1999;31:1535–1543.

11. Eneli IU, Skybo T, Camargo CA Jr. Weight loss and asthma: a systematic review. Thorax. 2008;63:671– 676.

12. Cisternas MG, Blanc PD, Yen IH, et al. A comprehensive study of the direct and indirect costs of adult asthma. J Allergy Clin Immunol. 2003;11:1212–1218.

13. Schatz M, Camargo CA Jr. The relationship of sex to asthma prevalence, health care utilization, and medications in a large managed care organization. Ann Allergy Asthma Immunol. 2003;91:553–558.

14. Eisner MD, Ackerson LM, Chi F, et al. Health-related quality of life and future health care utilization for asthma. Ann Allergy Asthma Immunol. 2002;89:46 –55.

15. Stingone JA, Claudio L. Disparities in the use of urgent health care services among asthmatic children. Ann Allergy Asthma Immunol. 2006;97:244 –250.

16. Ng TP, Lim TK, Abisheganaden J, Eng P, Sin FL. Factors associated with acute health care use in a national adult asthma management program. Ann Allergy Asthma Immunol. 2006;97:784 –793.

17. Peters AT, Klemens JC, Haselkorn T, et al. Insurance status and asthma related health care utilization in patients with severe asthma. Ann Allergy Asthma Immunol. 2008;100:301–307.

18. Mitchell TL, Gibbons LW, Devers SM, Earnest CP. Effects of cardiorespiratory fitness on healthcare utilization. Med Sci Sports Exerc. 2004;36:2088 –2092.

19. Statistics Canada. CCHS cycle 1.1. http://www.statcan.ca/english/concepts/health/. Accessed August 2, 2008.

20. Mickleborough TD. A nutritional approach to managing exercise-induced asthma. Exerc Sport Sci Rev. 2008;36:135–144.

21. Mickleborough TD, Fogarty A. Dietary sodium intake and asthma: an epidemiological and clinical review. Int J Clin Pract. 2006;60:1616–1624.

22. Marcus P, Arnold RJ, Ekins S, Sacco P, Massanari M, Stanley Young S. A retrospective randomized study of asthma control in the US: results of the CHARIOT study. Curr Med Res Opin. 2008;24:3443–3452.

23. Chapman KR, Ernst P, Grenville A, Dewland P, Zimmerman S. Control of asthma in Canada: failure to achieve guideline targets. Can Respir J. 2001;(suppl A):35A–40A.

24. Calfee CS, Katz PP, Yelin EH, Iribarren C, Eisner MD. The influence of perceived control of asthma on health outcomes. Chest. 2006;130:1312–1318.

25. Vollmer WM, Markson LE, O'Connor E, et al. Association of asthma control with health care utilization and quality of life. Am J Respir Crit Care Med. 1999;160:1647–1652.

26. Global Initiative for Asthma. Global strategy for asthma management and prevention: revised 2006. http://www.ginasthma.org. Accessed February 9, 2009.

27. Chen H, Gould MK, Blanc PD, et al. Asthma control, severity, and quality of life: quantifying the effect of uncontrolled disease. J Allergy Clin Immunol. 2007;20:396–402.

28. Exercise is medicine. Available at: http://www.exerciseismedicine.org/index.htm. Accessed on August 26, 2008.

29. Thomson CC, Clark S, Camargo CA Jr; MARC Investigators. Body mass index and asthma severity among adults presenting to the emergency department. Chest. 2003;124:795– 802.

30. Chen Y, Rennie D, Cormier Y, Dosman J. Sex specificity of asthma associated with objectively measured body mass index and waist circumference: the Humboldt study. Chest. 2005;128:3048 –3054.

31. Krommydasa GC, Gourgoulianisb KI, Angelopoulosc NV, et al. Depression and pulmonary function in outpatients with asthma. Respir Med. 2004;98:220 –224.

32. Dunn AL, Trivedi MH, O'Neal HA. Physical activity dose-response effects on outcomes of depression and anxiety. Med Sci Sports Exerc. 2001;33:S587–S597.

33. Aaron SD, Vandemheen KL, Boulet LP, et al. Overdiagnosis of asthma in obese and non-obese adults. CMAJ. 2008;179:1121–1131.

34. Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev. 2007;8:307–326.

35. Prince SA, Adamo KB, Hamel M, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. Int J Behav Nutr Phys Act. 2008;5:56–80.

36. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport. 2000;1(suppl):S1–S14.

CHAPTER 3: THE IMPACT OF SUPERVISED AND UNSUPERVISED EXERCISE ON ASTHMA CONTROL IN PARLTY CONTROLLED ADULTS

Shilpa Dogra, Jennifer L Kuk, Joseph Baker, Veronica Jamnik

School of Kinesiology and Health Science, York University, Toronto, ON.

ABSTRACT

Background: Exercise may be a safe and effective adjunct therapy for adults with asthma who have poor compliance to pharmacotherapy, leading to sub-optimal asthma control levels. ***Objective***: To determine 1) whether a 12-week exercise program (supervised or unsupervised) would lead to improvements in asthma control and fitness levels in partly controlled adults with asthma compared to a matched control group and 2) whether the supervised group would be able to maintain benefits from the program after an additional 12-weeks of unsupervised exercise. ***Methods***: Adults with asthma were placed in either a supervised exercise group (SG, n=21), an unsupervised exercise group (USG, n=15) or a control group (CON, n=15). The SG exercised three times per week with an exercise specialist for 12-weeks, followed by unsupervised exercise for 12-weeks. The exercise specialist provided participants in the USG with a 12-week self-administered individualized exercise program. Asthma control, measured using the Asthma Control Questionnaire (ACQ), perceived asthma control, quality of life, aerobic fitness and musculoskeletal fitness (vertical jump, grip strength, and sit and reach) were measured both before and after the exercise program, and a third time for the SG at week 24. ANCOVAs were performed to determine group treatment differences over 12 weeks; repeated measures ANOVAs were conducted to detect treatment effects from baseline and week 12 to week 24 in the SG. ***Results***: The SG had a clinically and statistically significant improvement in ACQ from baseline to week 12 compared to CON. Both SG and USG had significant improvements in perceived asthma control and no improvements in aerobic fitness or musculoskeletal fitness from baseline to week 12

compared to CON. In the SG, there was a significant improvement in quality of life from baseline to week 12, which further increased from week 12 to week 24. Asthma control improved from baseline to week 12, and was maintained with unsupervised exercise from week 12 to 24. Finally, there were significant improvements for measured and perceived asthma control, aerobic fitness, grip strength, flexibility and perceived fitness in the SG from baseline to week 24. ***Conclusions:*** Supervised exercise in adults with partly controlled asthma leads to improved asthma control while unsupervised exercise does not. Future research should explore the optimal volume of exercise required to benefit asthma control.

INTRODUCTION:

There is no known cure for asthma[1,2]; however, medical intervention can significantly improve asthma symptoms[3-5]. Pharmacological therapy using inhaled corticosteroids, long acting $ß_2$-agonists, or a combination of these medications has been shown to improve asthma control[3,4] but compliance rates of greater than 80% are required to maintain optimal levels of control[6]. Unfortunately, compliance to asthma treatment in countries where treatment is readily accessible remains poor[7,8].

Asthma control is determined by the frequency of daytime symptoms, limitation of activities, nocturnal symptoms, need for reliever medication, lung function, and exacerbations[1]. Accordingly, patients are classified as having controlled, partly controlled or uncontrolled asthma based on the presence or absence of these symptoms. Recent data shows that only 23% of asthmatics are controlled[9] and, despite receiving specialist care, 50% of patients are not well controlled[8]. Poor asthma control is associated with more emergency room visits, physician visits and days spent in hospital[10].

Recent research demonstrates that health care use is higher in physically inactive asthmatics compared to active asthmatics[11]. It may follow therefore, that active asthmatics have better asthma control, if health care use is a proxy measure of asthma control. Exercise interventions of adults with asthma show improvements in a variety of measures including quality of life[12], breathlessness[13-15], and controller therapy[16]. Animal models also show improvements in airway inflammation with aerobic exercise[18,19]; however a direct link between asthma control and exercise has not yet been made.

According to an analysis done by Vollmer et al[17] activity (physical and non-physical activity) limitation is the most powerful predictor of asthma control. This suggests that improvements in aerobic fitness would lead to improvements in asthma control of partly controlled but physically inactive asthmatics. Exercise interventions to date have had positive outcomes; however they have focused primarily on medically supervised exercise[15, 20]. The effects of such programs on future physical activity habits are largely unknown; furthermore, the effects of unsupervised exercise programs are unknown. Unsupervised exercise may be a more cost-effective and readily available therapy for the general population of adults with asthma. If exercise is determined to positively impact asthma control, it may be an important adjunct therapy for adults with partly controlled asthma who do not comply with their prescribed medication.

It is therefore imperative that we gain a better understanding of the effect of regular exercise on asthma control and determine whether there is a clinically relevant benefit. The purpose of the current investigation therefore was to determine 1) whether a 12-week exercise program (supervised or unsupervised) would lead to improvements in asthma control levels and fitness levels in adults with partly controlled asthma compared to a matched control group and 2) whether the supervised group would be able to maintain the benefits from the program after an additional 12-weeks of unsupervised exercise.

METHODS:

Participants:

Participants were recruited from the Greater Toronto Area in Ontario, Canada. Inclusion was limited to adults with partly controlled asthma over the age of 18 years, who were not pregnant, had a current prescription for asthma medication, and were inactive as defined by the Canadian Physical Activity Guidelines[21]. All participants provided informed consent prior to testing, and the study protocol was approved by the Human Participants Review Sub-Committee of the Ethics Committee at York University.

Study Design:

The study was a non-randomized control trial. Placement in the supervised exercise group (SG) was based on availability to meet with the exercise specialist three times per week for three months. Both the SG and unsupervised exercise group (USG) were able to exercise uninterrupted for the study duration. The control group (CON) was matched for age and sex and were provided exercise programs upon completing the control period.

Exercise Program:

Participants in the SG met with a Certified Exercise Physiologist™ (CEP) three times per week for 12 weeks. This was followed by an additional 12-week period of unsupervised exercise for which the CEP provided the participant with a self-administered exercise program. The USG completed self-administered exercise programs provided by a CEP. For both the SG and USG, the self-administered programs were individualized based on a questionnaire which provided the CEP with information on the

participant's access to equipment, activity preferences, and short and long term fitness goals. The CON was asked to maintain their current lifestyle.

Exercise programs for both groups during the first 12-weeks consisted of 30 minute aerobic exercise bouts, strength training of the upper and lower body, and stretching. The intensity for aerobic exercise was based on the maximum heart rate (HRmax) obtained during exercise testing. As the participants were previously sedentary, the prescribed exercise intensity progressively increased by 5% every three weeks from 70% HRmax to 85% HRmax. The SG was required to wear HR monitors (Polar S625x, Finland) during the exercise sessions to ensure that the appropriate intensity was achieved. The USG was provided with values from the Rating of Perceived Exertion scale that corresponded to the prescribed HR intensity if they did not have access to heart rate monitors. This scale was introduced to them during the exercise testing sessions. The strength training portion consisted of a single set of resistance exercises targeting the major muscle groups: chest, back, shoulders, triceps, biceps, quadriceps, hamstrings, and abdominals. The number of repetitions varied, but participants were asked to continue until the muscle was completely fatigued, defined as the inability to complete another repetition in proper form. These programs were modified every three weeks. All participants were advised to end each session with at least 5-10 minutes of stretching. In order to keep track of exercise adherence, participants in the USG were given activity logs which were submitted at the end of the 12 weeks. Both groups were encouraged to exercise on five days of the week. The self-administered exercise programs provided to the SG for the second 12-week period included aerobic, strength and stretching exercises

at a higher intensity as the participants in the SG were now accustomed to exercise. The aerobic exercise intensity was a minimum of 85% HRmax and the amount of weight being lifted during strength training exercise was increased.

Testing Sessions

All participants were given standard instructions to follow before coming to the laboratory: 1) no short acting bronchodilators in the previous six hours 2) no caffeine in the previous six hours 3) no alcohol or heavy exercise in the previous 24 hours and 4) no smoking in the previous eight hours. Participants were not instructed to discontinue use of controller medication, as lung function tests and the exercise test were not intended to be diagnostic tools.

Spirometry: Forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC) were measured using a handheld spirometer (MicroSpirometer, Micro Medical Ltd, UK). The pre-bronchodilator FEV_1 was used to determine the percent predicted FEV_1, which was required for the Asthma Control Questionnaire (ACQ)[22]. The participants were asked to take their short acting bronchodilator to ensure that the exercise test would not be terminated due to exercise-induced asthma symptoms.

Cardiorespiratory Fitness: Participants completed a maximal aerobic test (VO_2max) on a treadmill. The associated measurements (fractional concentrations of oxygen and carbon dioxide plus minute ventilation) were determined directly via the open circuit technique with discrete components (120 Litre Tissot Spirometer, Applied Electrochemistry Oxygen and Carbon Dioxide analyzers). The loading protocol varied depending on the participant's comfort level and ability to run. All participants started with a 3-minute

walking workload and progressed from walking (3.0 – 4.0 mph) to jogging (5.0 -6.0 mph) to running (7.0 – 8.0 mph) at 0% grade; subsequent work rates were increased by increasing the incline by 2 % per work load. Participants who were unable to run completed a walking protocol that progressed from walking on a low grade (0 to 5%) which was increased 2% every 3 minutes. The attainment of VO_2max was confirmed when VO_2 plateaued or decreased with progressively increasing work rates. In many instances the criteron for VO_2max was volitional fatigue and therefore the aerobic test did not provide a true maximum, but rather a peak (VO_2peak).

Musculoskeletal Fitness: Participants completed a grip strength test using a handgrip dynamometer; the maximum of two trials for each hand were summed to determine the combined grip strength in kilograms. A vertical jump test using the Vertec (Sports Import, Colorado, Ohio, USA) was performed and the maximum jump height from two trials was used. The sit and reach test was used to assess flexibility of the lower back and hamstrings; the best of two trials was recorded to the nearest 0.1 cm.

Questionnaires: The main outcome measure, asthma control, was measured using the ACQ[22] and a single-item perceived asthma control question. The ACQ is a validated questionnaire where a mean score of <0.75 is indicative of well-controlled asthma, 0.75-1.5 denotes relatively well-controlled asthma and >1.5 is indicative of poorly controlled asthma. This questionnaire can be used with and without spirometric measures[22]. Perceived asthma control was determined from a single multiple choice question with the following options: 1) Total Control 2) Well Controlled 3) Moderately Controlled 4) Low Control and 5) Poor Control; this variable was included in the study as perceived control

is significantly associated with activity restriction in adults with asthma[23]. Quality of life was assessed using the mini-Asthma Quality of Life Questionnaire (mini-AQLQ)[24]. Perceived fitness was assessed using a single question from the Healthy Physical Activity Participation Questionnaire[25]. Additional information pertaining to demographics, asthma symptoms, and activity history was also collected.

Statistical Analyses:

Baseline characteristics between groups were compared using a one way ANOVA and chi squares. ANCOVAs were used to determine treatment differences between groups over the 12-week intervention adjusting for baseline values. Repeated measures ANOVAs were conducted to determine treatment effects over the first and second 12 week periods in the SG. Power calculations were conducted for the primary outcome. All statistics were conducted using SPSS 17.0.

RESULTS:

A total of 72 participants were assessed for eligibility (Figure 1). Eleven were ineligible as they were physically active, while 19 declined to participate in the study. Twenty one participants were placed in the SG, 15 in the USG and 15 in CON. Accounting for drop-outs and loss to follow-up, a total of 18 in the SG, 12 in the USG, and 12 in the CON group were included in the current analyses.

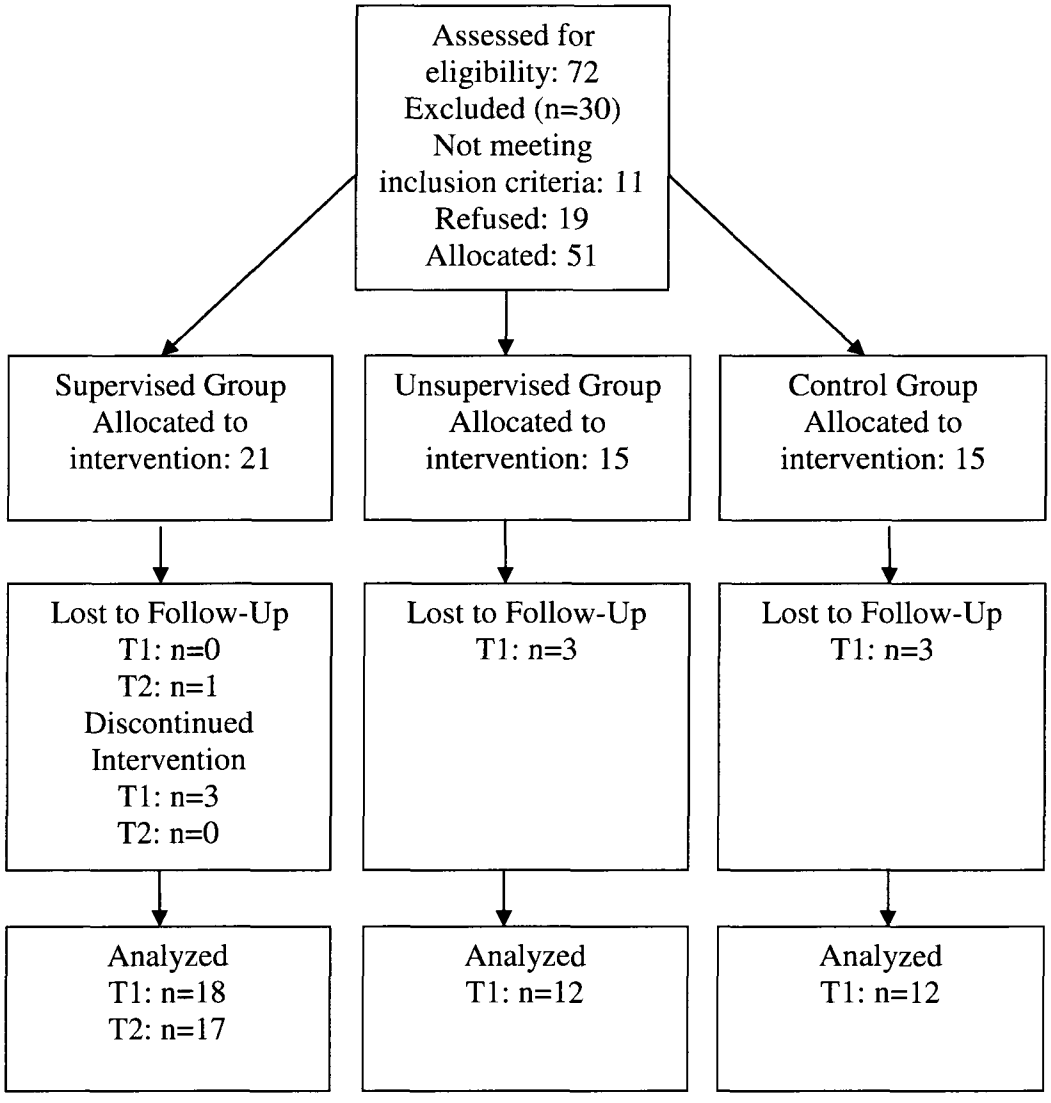


Figure 3.1 Allocation of participants into three groups.

Baseline characteristics were similar between all three groups (Table 1 and 2). The mean ACQ score was significantly higher in the SG than CON group at baseline.

Table 3.1: Baseline characteristics by group. Data are presented as mean ± standard error or as frequency.

	CON (n=12)	**SG (n=18)**	**USG (n=12)**
Sex (F)	9	13	9
Age	34.00±3.42	34.20±3.19	31.17±4.16
Age of Diagnosis	10.33±2.06	11.30±2.73	12.67±2.69
BMI	24.36±1.05	25.83±0.90	23.19±0.89
FEV1	2.96±0.26	2.86±0.19	2.95±0.24
ICS	9	11	10
Short Acting BD	12	16	12
Allergies	11	17	10
Never Smoked	4	12	8

SG: supervised group; USG: unsupervised group; CON: control group; F: female; BMI: body mass index; FEV_1: forced expiratory volume in 1 second; ICS: inhaled corticosteroids; BD: bronchodilator

Baseline to week 12: Over the treatment period, ACQ without spirometry significantly improvement in the SG as compared to CON (Table 2). ACQ score with spirometry did not improve significantly in either exercise group compared to CON; however there was a trend toward significance (p=0.086). Perceived asthma control improved in both the SG and USG compared to CON (p=0.025). There was a clinically significant improvement in both the mini-AQLQ and ACQ in the SG (improvement of 0.5 in mean score); however the mini-AQLQ did not reach statistical significance. There was also a statistical trend for treatment differences in combined grip strength (p=0.082), the activity limitations domain of the ACQ (p=0.095), and the symptoms domain of the mini-AQLQ (p=0.051). There were no improvements in aerobic fitness, vertical jump, grip strength, sit and reach or perceived fitness for either exercise group compared to CON.

Week 12 to 24: During follow-up, there were no changes in asthma control or perceived asthma control i.e. the groups maintained the initial benefits. The SG had a further significant improvement in mini-AQLQ scores and a trend for significant improvements in the activity domain of the mini-AQLQ ($p=0.093$) and perceived fitness ($p=0.052$).

Baseline to Week 24: Significant improvements in ACQ, perceived asthma control, and the symptoms domain, emotional domain and environmental domain of the mini-AQLQ were observed ($P <0.05$). There were also significant improvements in aerobic fitness, grip strength and flexibility over the entire 24 weeks that were not apparent after the first 12 weeks of exercise. Further, there was a trend for significant improvements in the activity limitations component of the ACQ ($p=0.054$) and the activity domain of the mini-AQLQ ($p=0.054$).

Table 3.2: Differences between groups from baseline to week 12 and week 24

	Control Group		Supervised Group			Unsupervised Group	
	Baseline	**12-weeks**	**Baseline**	**12-weeks**	**24-weeks**	**Baseline**	**12-weeks**
ACQ no spirometry	0.90±0.15	0.99±0.16	1.30±0.19[#]	0.72±0.10*	0.72±0.17^	0.83±0.17	0.75±0.17
ACQ spirometry	1.06±0.10	0.80±0.14	1.37±0.21	0.95±0.11	1.01±0.18	0.99±0.13	0.70±0.16
Activity Limitations	1.08±0.29	1.08±0.26	1.50±0.32	0.47±0.19	0.47±0.22	1.00±0.30	0.75±0.28
Perceived Control	2.33±0.19	2.25±0.18	2.56±0.15	1.94±0.10*	2.00±0.12^	2.90±0.31	2.40±0.16*
Mini-AQLQ	5.79±0.15	5.90±0.17	5.00±0.21	5.84±0.17	6.11±0.21^v	5.71±0.24	5.93±0.27
Symptoms	5.82±0.22	5.68±.20	4.98±0.26	5.71±0.16	5.95±0.19^v	5.55±0.25	5.68±0.32
Activity	6.04±0.17	6.40±0.11	5.94±0.22	6.47±0.19	6.42±0.23	6.27±0.19	6.48±0.17
Emotional	5.92±0.34	6.03±0.21	4.78±0.32	6.04±0.29	6.13±0.29^	5.53±0.36	5.86±0.29
Environmental	5.28±0.19	5.47±0.33	4.04±0.29	5.00±.028	5.38±.036^	4.75±0.32	4.89±0.36
Aerobic Fitness	2.66±0.27	2.78±0.29	2.63±0.20	2.88±0.21	2.96±0.27^	3.01±0.29	2.76±0.28
Vertical Jump	28.47±2.81	29.33±2.12	33.53±3.50	30.63±3.04	33.11±3.33^	33.78±3.03	35.70±2.95
Grip Strength	58.50±7.10	63.09±5.24	52.72±4.74	66.06±4.79	68.81±5.04^	64.50±6.48	66.60±6.86
Flexibility	29.72±2.41	29.53±2.80	26.12±2.16	30.43±2.31	29.11±2.50^	28.44±2.29	28.70±2.22
Perceived Fitness	3.33±0.19	3.08±0.23	3.50±0.17	2.44±0.22	2.11±0.24^	2.90±0.31	2.40±0.16

[#] $p<0.05$ for differences between groups at baseline

* $p<0.05$ for differences between groups from baseline to 12 weeks

[v] $p<0.05$ for differences within the supervised group from 12 weeks to 24 weeks

^ $p<0.05$ for differences within the supervised group from baseline to 24 weeks

ACQ: Asthma Control Questionnaire; AQLQ: Asthma Quality of Life Questionnaire

DISCUSSION:

The effect of a 12-week exercise intervention on asthma control was assessed in adults with partly controlled asthma. Our primary finding is that despite no improvements in aerobic or musculoskeletal fitness, 12 weeks of supervised exercise led to significant improvements in measured and perceived asthma control. Furthermore, these improvements were maintained 12 weeks post intervention using self-administered exercise programs. This is in contrast with improvements only in perceived asthma control in the group that received unsupervised exercise. These results provide the basis for making supervised exercise prescription an essential component of asthma management plans.

Our finding that quality of life improved with supervised exercise is consistent with previous research using 10-16 week supervised exercise interventions[12,20]. The improvement in asthma control with supervised exercise however is novel and highlights the importance of encouraging exercise in this population. While previous research has been able to conclude that exercise leads to improvements in medication use[12], the frequency of exercise-induced asthma[26], and even lung function[20], this study is the first to show that exercise can lead to a change in overall asthma control. It is important to highlight that there were also clinically relevant improvements in mean ACQ score and mini-AQLQ score from baseline to week 12 in the SG that exceeded cut offs that have been used in the past[27-29] for meaningful interpretation of change.

Based on previous research, we expected a significant improvement in fitness in the SG and in clinical measures for both the SG and USG[30-32], but with larger treatment

effects in the SG. While there was a significant improvement in perceived asthma control in both groups, improvements in ACQ scores were only observed in the SG, and neither group improved their physical fitness within the first 12-weeks. However the SG did have significant improvements in aerobic fitness, grip strength and flexibility at week 24. It is unclear whether the USG would also have had significant improvements in fitness had the study extended over a longer period of time. The lack of fitness improvements over the first 12 weeks may have been related to the small volume of exercise prescribed.

It should be emphasized that all participants became physically active, and more importantly, this small increase in physical activity led to a significant improvement in perceived and measured asthma control in the SG. This is in line with the finding by Vollmer et al[17] indicating that activity restriction is a powerful predictor of asthma control. Previous research has shown that pharmacotherapy can lead to significant increases in control[3,33] and that exercise can lead to improvements in quality of life[12], however this research is the first to show that exercise can lead to improved asthma control. This is important as poor asthma control is associated with greater healthcare use, and supervised exercise followed with unsupervised exercise may be a sustainable solution to improve asthma control and relieve some of the burden on public healthcare systems.

The lack of significant improvements in asthma control, fitness measures and quality of life in the USG, were unexpected but could be related to poor compliance to the exercise program. On average, the USG completed approximately 60 minutes of moderate-vigorous aerobic exercise per week and only five participants reported any

strength training activities; of these only three reported doing these exercises at least once per week. This is similar to findings from a previous study suggesting that home exercise has poor compliance and does not lead to improvements in lung function in children with asthma or cystic fibrosis[34]. Alternatively, the lack of improvement observed in the ACQ may be related to power, as a sample size of 24 per group (current n = 12) would be required for a power of 80% at a $p < 0.05$[35]. These estimates were based on the variability of the USG. Despite the poor compliance and low power, there was a significant improvement in perceived asthma control in the USG. Perceived asthma control has been associated with better quality of life, fewer activity restrictions and a decreased risk of emergency department visits and hospitalization[23]. Therefore it is possible that the observed change in perceived asthma control in the USG in our study is still clinically relevant.

The results of this study should be interpreted in light of the following limitations: 1) We demonstrate changes in ACQ with the intervention, but the current analysis was underpowered for seeing treatment effects using ACQ with spirometry. Although the use of ACQ without spirometry is a valid method[22], based on previous literature[13], resting spirometric values are not expected to change with regular exercise. Therefore use of the ACQ without spirometry is perhaps an equivalent measure for longitudinal changes with exercise. 2) We did not have any clinical measures of asthma control or severity such as peak flow variability or exhaled nitric oxide. 3) Our sample consisted mainly of women and therefore may impact the generalizability to a mixed population and 4) We were

unable to randomize the sample into intervention groups due to logistics pertaining to gym access and time.

In conclusion, we found that supervised exercise is more beneficial than unsupervised exercise in a population of partly controlled adults with asthma as it leads to improvements in asthma control. Our findings suggest that it is essential for this population to have a period of supervised exercise in order for asthma control to improve. Further, supervised exercise may offer long-term sustainability as indicated by the unsupervised follow-up period. Future research is required to determine the optimal volume of exercise to provide benefits for asthma control. Also, research should seek to determine whether regular exercise has an impact on clinical measures of asthma control such as flow variability, in children and adults.

REFERENCES:

1. Global Strategy for Asthma Management and Prevention. GINA Report 2006. Available at: www.ginasthma.org. Accessed on August 12th, 2009.
2. Warner JO, Naspitz CK. Third international pediatric consensus statement on the management of childhood asthma. Pediatr Pulmonol. 1998;25:1–17.
3. O'Byrne PM, Naya IP, Kallen A, Postma DS, Barnes PJ. Increasing doses of inhaled corticosteroids compared to adding long-acting inhaled beta2-agonists in achieving asthma control. Chest. 2008;134(6):1192-9.
4. Lalloo UG, Malolepszy J, Kozma D, Krofta K, Ankerst J, Johansen B, Thomson NC. Budesonide and formoterol in a single inhaler improves asthma control compared with increasing the dose of corticosteroid in adults with mild-to-moderate asthma. Chest. 2003;123(5):1480-7.
5. Foresi A, Morelli MC, Catena E. Low-dose budesonide with the addition of an increased dose during exacerbations is effective in long-term asthma control. On behalf of the Italian study group. Chest. 2000;117(2):440-6.
6. Lasmar L, Camargos P, Champs NS, Fonseca MT, Fontes MJ, Ibiapina C, Alvim C, Moura JA. Adherence rate to inhaled corticosteroids and their impact on asthma control. Allergy. 2009;64(5):784-9.
7. Legorreta AP, Christian-Herman J, O'Connor RD, Hasan MM, Evans R, Leung KM. Compliance with national asthma management guidelines and specialty care: a health maintenance organization experience. Arch Intern Med. 1998;158(5):457-64.
8. Gaga M, Papageorgiou N, Zervas E, Gioulekas D, Konstantopoulos S. Control of asthma under specialist care: is it achieved? Chest 2005;128(1):78-84.
9. Chapman KR, Boulet LP, Rea RM, Franssen E. Suboptimal asthma control: prevalence, detection and consequences in general practice. Eur Respir J. 2008;31(2):320-5.

10. Williams SA, Wagner S, Kannan H, Bolge SC. The association between asthma control and health care utilization, work productivity loss and health-related quality of life. J Occup Environ Med. 2009;51(7):780-5.
11. Dogra S, Baker J, Ardern CI. The role of physical activity and body mass index in the health care use of adults with asthma. Ann Allergy Asthma Immunol. 2009;102(6):462-8.
12. Fanelli A, Cabral AL, Neder JA, Martins MA, Carvalho CR. Exercise training on disease control and quality of life in asthmatic children. Med Sci Sports Exerc. 2007;39(9):1474-80.
13. Cochrane LM, Clark CJ. Benefits and problems of a physical training programme for asthmatic patients. Thorax 1990;45(5):345-51.
14. Clark CJ. The role of physical training in asthma. Chest. 1992;101(5 Suppl):293S-298S.
15. Hallstrand TS, Bates PW, Schoene RB. Aerobic conditioning in mild asthma decreases the hyperpnea of exercise and improves exercise and ventilatory capacity. Chest. 2000;118(5):1460-9.
16. Neder JA, Nery LE, Silva AC, Cabral AL, Fernandes AL. Short-term effects of aerobic training in the clinical management of moderate to severe asthma in children. Thorax. 1999;54(3):202-6
17. Vollmer WM, Markson LE, O'Connor E, Frazier EA, Berger M, Buist AS. Association of asthma control with health care utilization: a prospective evaluation. Am J Respir Crit Care Med. 2002;165(2):195-9.
18. Pastva A, Estell K, Schoeb TR, Atkinson TP, Schwiebert LM. Aerobic exercise attenuates airway inflammatory responses in a mouse model of atopic asthma. J Immunol. 2004;172(7):4520-6.
19. Vieira RP, Claudino RC, Duarte AC, Santos AB, Perini A, Faria Neto HC, Mauad T, Martins MA, Dolhnikoff M, Carvalho CR. Aerobic exercise decreases chronic allergic lung inflammation and airway remodeling in mice. Am J Respir Crit Care Med. 2007;176(9):871-7.

20. Emtner M, Herala M, Stålenheim G. High-intensity physical training in adults with asthma. A 10-week rehabilitation program. Chest. 1996;109(2):323-30.
21. Public Health Agency of Canada. Canada's Physical Activity Guide to Healthy Active Living. http://www.phac-aspc.gc.ca/pau-uap/paguide/. Accessed on August 12th, 2009.
22. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. Eur Respir J. 1999;14(4):902-7.
23. Calfee CS, Katz PP, Yelin EH, Iribarren C, Eisner MD. The influence of perceived control of asthma on health outcomes. Chest 2006;130(5):1312-8.
24. Juniper EF, Guyatt GH, Cox FM, Ferrie PJ, King DR. Development and validation of the mini asthma quality of life questionnaire. Eur Respir J. 1999;14(1):32-8.
25. Canadian Society for Exercise Physiology. The Canadian Physical Activity, Fitness & Lifestye Approach Protocol. The Healthy Physical Activity Participation Questionnaire: page 8-83.
26. Bonsignore MR, La Grutta S, Cibella F et al. Effects of exercise training and montelukast in children with mild asthma. Med Sci Sports Exerc. 2008;40(3):405-12.
27. Walter MJ, Castro M, Kunselman SJ et al. Predicting worsening asthma control following the common cold. Eur Respir J. 2008;32(6):1548-54.
28. Keith PK, Koch C, Djandji M et al. Montelukast as add-on therapy with inhaled corticosteroids alone or inhaled corticosteroids and long-acting beta-2-agonists in the management of patients diagnosed with asthma and concurrent allergic rhinitis (the RADAR trial). Can Respir J. 2009;16 Suppl A:17A-31A.

29. Corren J, Busse W, Meltzer EO et al. A Randomized, Controlled, Phase 2 Study of AMG 317, an IL-4R{alpha} Antagonist, in Patients with Asthma. Am J Respir Crit Care Med. 2010 E-pub ahead of print.

30. Donat H, Ozcan A. Comparison of the effectiveness of two programmes on older adults at risk of falling: unsupervised home exercise and supervised group exercise. Clin Rehabil. 2007;21(3):273-83.

31. Olney SJ, Nymark J, Brouwer B et al. A randomized controlled trial of supervised versus unsupervised exercise programs for ambulatory stroke survivors. Stroke. 2006;37(2):476-81.

32. Ramsay C, Moreland J, Ho M et al. An observer-blinded comparison of supervised and unsupervised aerobic exercise regimens in fibromyalgia. Rheumatology (Oxford). 2000;39(5):501-5.

33. Lalloo UG, Malolepszy J, Kozma D et al. Budesonide and formoterol in a single inhaler improves asthma control compared with increasing the dose of corticosteroid in adults with mild-to-moderate asthma. Chest. 2003;123(5):1480-7.

34. Holzer FJ, Schnall R, Landau LI. The effect of a home exercise programme in children with cystic fibrosis and asthma. Aust Paediatr J. 1984;20(4):297-301.

35. Overall JE, Doyle SR. Estimating sample sizes for repeated measurement designs. Controlled Clin Trials. 1994; 15:100-123.

CHAPTER 4: GENERAL DISCUSSION

GENERAL DISCUSSION

Asthma control levels among adults are sub-optimal[1] and can be improved with appropriate medical intervention[2]; however asthmatics are reluctant to use pharmacotherapy as prescribed due to fear of their potential side-effects[3]. An alternative or adjunct therapy to pharmaceuticals would therefore be beneficial. The purpose of this dissertation was to examine the role of physical activity (PA) and exercise on asthma control of partly controlled adults using a nationally representative cross-sectional database and a longitudinal exercise intervention.

Cross Sectional Findings: Results of the Canadian Community Health Survey analysis indicated that adults with asthma who are physically inactive are more likely to have an overnight hospital stay and ≥ 3 physician consultations per year compared to physically active adults with asthma. The data also indicated a protective effect of PA in obese and overweight asthmatics as the odds of health care use were found to be lower in active asthmatics regardless of their body mass index (BMI). Additionally, adults with asthma had greater health care use than non-asthmatic adults. Overall, these findings suggest that adults with asthma are greater consumers of health care services, however, activity reduces this use significantly i.e. a higher PA level is associated with better asthma control regardless of BMI, socioeconomic status, sex, age, ethnicity, smoking status, diet, alcohol consumption and comorbid chronic diseases.

Exercise Intervention Findings: Results from the exercise intervention indicate that adults with partly controlled asthma are able to improve measured (Asthma Control Questionnaire[4]) and perceived asthma control with supervised exercise compared to a

control group. Furthermore, improvements gained in asthma control can be maintained over a 12-week follow-up period of unsupervised exercise using exercise programs provided by a Certified Exercise Physiologist^{TM} (CEP). Supervised exercise followed by unsupervised exercise also led to significant improvements in all measures of aerobic and musculoskeletal fitness from baseline to the end of the follow-up period. The finding that participants who were previously sedentary were able to maintain PA levels that led to an improvement in their peak aerobic fitness (VO_2peak) and maintenance of asthma control with minimal guidance was extremely promising. These findings suggest that initial work with an exercise professional leads to adherence to an active lifestyle once the supervised training period is complete. Moreover, it shows that an initial investment in educating adults on proper exercise would be prudent, as it may decrease future lifestyle-related health consequences.

Results of the intervention also indicated that in a group of adults with partly controlled asthma, an unsupervised exercise training program of 12-weeks leads to improvements in perceived but not measured asthma control. This intervention had no impact on measures of aerobic or musculoskeletal fitness when compared to the control group. The unsupervised group was educated on appropriate intensities using heart rate and Rating of Perceived Exertion, and were provided with a progressive target heart rate range and perceived exertion range. It is possible however that these previously sedentary individuals were unintentionally falling short of their target intensities, and were unable to correct this in the absence of professional feedback. The improvement in perceived asthma control was promising in light of the low adherence levels observed. It is possible

that measured control would become significant with higher levels of PA. Perhaps an unsupervised exercise program with a different delivery mode i.e. web-based program would have been more effective. This delivery mode would have allowed for greater interaction with the participants and may be a more appropriate low cost alternative to supervised exercise.

An important goal of this study was to compare the benefit of the two exercise interventions to determine whether one led to a greater benefit than the other. It is apparent from our results that supervised exercise is superior when considering the impact on asthma control. Measured and perceived control, as well as disease specific quality of life improved significantly in the supervised group compared to control whereas only perceived control improved in the unsupervised group. This implies that supervised exercise has a greater benefit than unsupervised exercise with regards to improving asthma control. Based on these observations, I strongly recommend that the initial period of exercise be supervised, and that future research assess the impact of different modes and longer unsupervised exercise interventions.

Overall Findings: It is apparent that PA plays an important role in the level of asthma control of adults. This is not surprising given literature suggesting that the 'restricted activities' component of asthma control is the greatest predictor of overall control[5]. While this finding relates to both physical and non-physical activities (playing chess, school/work attendance, going to watch movies etc), our finding is the first to make a direct link between PA and overall asthma control. Being regularly active at low to moderate intensities may not be an adequate stimulus for change in VO_2peak but it would

lead to a change in submaximal efficiency, perhaps shifting the threshold at which increases in ventilation induce asthma symptoms. This change in 'threshold' may also influence the number of daytime symptoms, number of daily/weekly exacerbations, and reliever medication components by reducing the frequency of symptoms. Thus the changes in asthma control from increased PA levels may have both a direct impact on activity restrictions but also an indirect impact on other components of control.

There are some conclusions that can be drawn regarding PA and exercise as independent contributors to asthma control from this dissertation. The Canadian Community Health Survey assigns the "active" and "inactive" group based on a calculation of kilocalorie per kilogram per day using the frequency and duration of a range of physical activities. These activities range from aerobic exercises such as running, swimming and cycling, to sports such as hockey, basketball and tennis, to recreational activities such as dance, gardening and bowling. Unfortunately, the calculated variable of total PA does not differentiate between leisure time activity and exercise, and does not contain information on exercise intensity. As such, we cannot say with certainty from this data that PA as a whole, and not exercise alone, is the reason for higher levels of control in adults with asthma. However, based on data from the exercise intervention conducted, we may be able to differentiate. The supervised group certainly exercised a minimum of three times per week and in some cases increased their non-exercise related PA levels as well. The unsupervised group however had no changes in aerobic fitness indicating that they did not 'exercise' at an intensity required for adaptation, but they did perform 'physical activity' as per self-report. This suggests that

an adequate intensity may be required for improvements in asthma control and that PA alone may be an inadequate stimulus for changes in asthma control.

This research supports the notion of using exercise as an adjunct to pharmacotherapy in asthma management; the main goal of which is to achieve total control. The novel finding that PA levels directly impact asthma control could change the current norm for asthma care in developed nations where health care is readily accessible and asthma prevalence is high. A model similar to that of type 2 diabetes could be adopted wherein exercise is considered to be necessary for disease control and attenuation of disease progression in addition to proper use of insulin or prescribed medications. Based on the research findings of this dissertation, exercise should become one of the cornerstones of asthma therapy, and physicians should be educated on how to prescribe exercise to their patients. Since we used Canada's Physical Activity Guide[6], exercise prescription would be fairly standard and straightforward for beginners; however progression should be monitored by a trained professional such as a CEP. In addition to prescription, the asthmatic would have to be educated on exercise-induced asthma and how to avoid its onset.

Study Design: Although cross-sectional studies are unable to show cause and effect, there are many advantages of including such a design in a novel area of research. For this dissertation it was necessary to obtain a snapshot of the PA-asthma control relationship at the national level as such an analysis provides a large sample size and data on a variety of variables. Cross-sectional designs do not allow the measurement of incidence, but the goal of the analysis of The Canadian Community Health Survey was to measure

prevalence as well as simple associations between activity levels and health care use. The inclusion of this analysis strengthened the overall findings of this dissertation as the large sample size increased the power of the analysis.

The longitudinal studies (i.e., the 12 and 24-week interventions) allowed us to determine the effects of an exercise program on asthma control. Although this study was not randomized, it allowed us to comment on changes that occurred in previously sedentary asthmatics who were interested in exercise as a mode of therapy. The exercise intervention studies were designed to determine the effectiveness and efficacy of exercise on asthma control levels. The supervised exercise group was provided with an efficacious intervention such that the volume of exercise was controlled and the participants were required to attain this weekly goal with a personal trainer. The unsupervised group and the follow-up of the supervised group on the other hand, were meant to determine the effectiveness i.e. the impact of exercise on asthma control levels in a real-world setting. This allowed for us to make two important statements regarding the impact of exercise on asthma control: 1) supervised exercise leads to a benefit in asthma control when the appropriate volume is performed 2) unsupervised exercise leads to maintenance of these benefits and, while unsupervised exercise alone may have some treatment effects, they are not clinically beneficial for asthma control.

Furthermore, the intervention studies were high in internal and external validity. It can be said with confidence that there was no referral bias as all participants were recruited from the community; and that there was no information bias or misclassification bias as the variables were assessed using validated measures. The two biases that effect

internal validity that may be of concern in these studies are sample selection bias and healthy worker effect. Sample selection bias would be a concern as the participants selected their group (supervised or unsupervised) based on their ability to attend sessions on campus; however this led to an increase in adherence and a decrease in drop-out. The second concern would be the healthy worker effect as all participants were healthy enough to participate in the exercise program; however the goal of the study was to measure effects in partly controlled asthmatics. The high internal validity led to stronger external validity, albeit for a smaller group of the asthmatic population. It should be noted however, that researcher bias may have played a role as all recruitment, data collection, intervention logistics and data analysis were conducted by the principle investigator.

Given the validity and potency of the findings of this dissertation PA and exercise programs should be included in asthma treatment regimens. In order for this to occur, changes would have to happen at many levels.

Implications for Adults with Asthma: The fear associated with medication use in asthmatics is somewhat justified as long-term use has been shown to have negative consequences on bone density, body mass, and may lead to conditions such as thrush or dysphonia[7]. As a result, adults with asthma, as well as caregivers of children with asthma, often search for alternative therapies to pharmaceuticals. While some of these therapies have led to improvement in symptoms, there is not enough evidence to show that they make a clinically significant improvement. Their physiological effects are also not well established, for example, breathing exercises lead to an improvement in control of ventilation[8], but there is no physiological adaptation that occurs as a result of practicing

this technique. Exercise leads to physiological adaptations that decrease the frequency of symptoms thus preventing airway remodelling and eventually perhaps improving the underlying severity of asthma. Since exercise has been shown to have a marked impact on overall health and fitness, asthmatics may be less hesitant in adopting a physically active lifestyle, compared to other treatment options. Increasing the asthmatic's self-efficacy with regards to physically strenuous tasks would also improve their overall quality of life in addition to their control levels. Given that adults with asthma are at an increased risk of obesity and cardiovascular disease, both of which can be effectively prevented with an active lifestyle, adopting an active lifestyle could have considerable ancillary benefits for asthmatics.

In order to become exercisers these individuals would require guidance from either an exercise expert or an Asthma Educator. As such, exercise experts should be educated on asthma, and asthma educators should be taught about exercise. Additionally, since asthma is pervasive in those of lower socioeconomic status[9] it would be prudent for the public health agency of Canada to fund accessible programs for this group.

Implications for the Physicians and Health Care Workers: The findings of this dissertation could have a significant impact on the way general practitioners and specialists work with adult asthmatics, particularly those who have been using asthma medications for a long period of time. If relevant stakeholders encourage inclusion of exercise as a form of treatment it may lead to a decrease in the required types and doses of medications. The physician would have to monitor the patient's exercise capacity and make adjustments accordingly.

This research also influences the role of the Asthma Educator. Much like the Diabetes Educator, an Asthma Educator should include extensive information on exercise and asthma, including basic exercise prescription. The Asthma Educator provides a unique opportunity to increase awareness of the benefits of exercise on asthma control and overall health. It would also be prudent for alternative health practitioners such as homeopaths and naturopaths to advise their patients to adopt an active lifestyle as many adults with asthma seek these professionals for help with asthma symptom management.

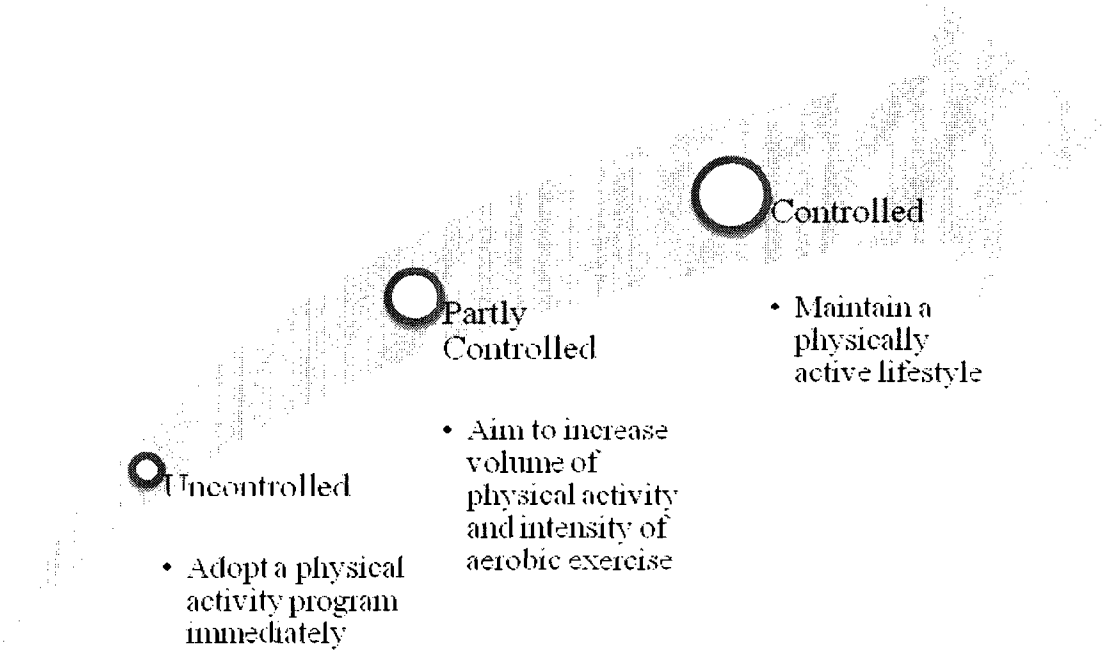
It is absolutely imperative that front-line workers be educated in proper exercise prescription prior to implementing it with their patients. Incorrect information can lead to injury, which would act as a deterrent to maintenance of an active lifestyle.

Implications for Public Health and Health Care Spending: This research provides additional support to an already impressive evidence base emphasizing initiatives to increase public awareness of the benefits of regular PA, especially among populations with chronic diseases. More importantly, this research provides evidence that publicly funded access to a CEP for just 12-weeks can lead to significant improvements in asthma control, and may thereby decrease health care spending related to hospital visits and physician/clinic visits. It would be prudent of the government to take a preventive approach to asthma such that those diagnosed with asthma have access to an Asthma Educator and/or a CEP for a three month period and perhaps annual follow-up appointments thereafter. Although this may sound like a costly initiative, it has the potential to save money associated with the direct and indirect costs of asthma. The government funding could go into setting up a model similar to cardiac rehabilitation

wherein a patient is referred to a program and has access to physicians as well as exercise experts. A simple model such as that depicted in Figure 6.1 could be implemented and expanded upon in order to achieve this goal.

Initiatives would also have to focus on having Asthma Educator's and physician's adequately educated regarding basic exercise prescription and the do's and don'ts of asthma and exercise so that they can assist their patients. It would be unfortunate if physicians discouraged exercise in those with asthma out of fear that exercise will lead to severe symptoms.

Figure 6.1: Physical Activity recommendations for each level of asthma control



The Role of the Exercise Expert: This research supports the need for trained exercise specialists when working with clinical populations. Both the supervised and unsupervised

exercise groups were tested and trained by CEPs, which resulted in injury free exercise interventions. More importantly, the supervised group had significant improvements in their aerobic fitness and were able to maintain improvements in the long-term. It seems that an initial period wherein the asthmatic becomes comfortable working at higher intensities, and learns how to exercises properly leads to greater adherence and greater improvements. Fitness practitioners could also use the ACQ, with or without spirometry, as a means to monitor improvements in asthma control levels.

Future Research Directions

This dissertation is the first to link exercise with asthma control, as a result, much work remains to be done before exercise can be prescribed for asthmatics. First, the target population needs to be expanded to include children, and asthmatics of varying severity levels and poorer control levels. Related to this, sex based analyses should be conducted as asthma has been shown to vary between males and females[10]. Second, large scale interventions would be required to overcome issues pertaining to power and error. Third, demographics should be controlled for as socioeconomic status and ethnicity have been related to asthma control levels[9]. Finally, the baseline levels of fitness or exercise capacity would be important to control as this may impact the changes in control levels.

It is also imperative that specialists in the asthma area work together with exercise experts to develop new guidelines, and update existing guidelines. The GINA document and the Canadian Consensus Guidelines mentioned throughout this dissertation accept that activity restrictions are an important component of asthma control, but make no further recommendation on how to overcome this. Furthermore, the terminology adopted

by these groups should be changed to state "physical activity restrictions", as this is a more accurate representation than the current "activity restrictions".

Conclusion

Based on the findings of this dissertation, PA should be recommended as an adjunct therapy to adults with asthma. The Canadian Physical Activity Guidelines can be used for PA prescription, but a CEP should be consulted before increasing the volume and intensity of PA.

This dissertation has shown that adults with asthma who are physically active have higher levels of asthma control, and those who become physically active can improve their asthma control with a low volume exercise program. Although further work is necessary to replicate and expand these results, this investigation provides an important first step regarding the role of exercise as a primary therapy (in conjunction with pharmacological treatment) for partly controlled asthmatics.

REFERENCES:

1. Chapman KR, Boulet LP, Rea RM, Franssen E. Suboptimal asthma control: prevalence, detection and consequences in general practice. Eur Respir J. 2008;31(2):320-5.
2. Bateman ED, Hurd SS, Barnes PJ et al. Global strategy for asthma management and prevention: GINA executive summary. Eur Respir J. 2008;31(1):143-78.
3. Boulet LP. Perception of the role and potential side effects of inhaled corticosteroids among asthmatic patients. Chest. 1998;113(3):587-92.
4. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. Eur Respir J. 1999;14(4):902-7.
5. Vollmer WM, Markson LE, O'Connor E, Frazier EA, Berger M, Buist AS. Association of asthma control with health care utilization: a prospective evaluation. Am J Respir Crit Care Med. 2002;165(2):195-9
6. Public Health Agency of Canada. Canada's Physical Activity Guide to Healthy Active Living. http://www.phac-aspc.gc.ca/pau-uap/paguide/. Accessed on August 12th, 2009.
7. Barnes PJ. Inhaled Glucocorticoids for Asthma. N Engl J Med. 1995; 332:868-875.
8. Holloway E, Ram FS. Breathing exercises for asthma. Cochrane Database Syst Rev. 2004;(1):CD001277.
9. Forno E, Celedon JC. Asthma and ethnic minorities: socioeconomic status and beyond. Curr Opin Allergy Clin Immunol. 2009;9(2):154-60.

10. McCallister JW, Mastronarde JG. Sex differences in asthma. J Asthma. 2008;45(10):853-61.

APPENDICES

APPENDIX A: GLOSSARY OF TERMS

Atopy: A hereditary hypersensitivity or allergic sensitivity to allergens such as dust, pollen etc. Conditions include: hay fever, rhinitis and asthma.

Buteyko: A series of breathing exercises that restore normal breathing patterns i.e. attempt to overcome hyperventilation.

CEP (Certified Exercise Physiologist): An exercise expert who has knowledge of fitness testing and training in both healthy and clinical populations. These individuals are certified by the Canadian Society for Exercise Physiology.

GERD (gastro-esophageal reflux disorder): Acid reflux that is often associated with asthma.

GINA(Global INitiative for Asthma): A collaboration of health care professionals and public health officials that represent the National Heart, Lung, Blood Institute, National Health Institue, and the World Health Organisation.

Hyperpnea: An exaggerated deep, rapid, or labored respiration. It occurs normally with exercise.

Inspiratory muscle training: Respiratory muscle exercises that involve breathing in against a pressure.

Minute Ventilation: The total volume of gas in litres exhaled from the lungs per minute.

VO_2peak: The peak oxygen consumption; a measure of aerobic fitness.

APPENDIX B: Additional values for Table 2.1

Characteristics of asthmatics by collapsed categories of physical activity level, Cycle 3.1 CCHS.

	Inactive	Moderate + Active
N(unweighted)	3400	3425
Sex		
Male	35.5	40.4
Female	64.5	59.6
Age		
20-24y	11.4	16.8
25-29y	10.2	12.8
30-34y	10.1	13.2
35-39y	9.8	11.1[a]
40-44y	13.1	11.9[a]
45-49y	12.4	11.2[a]
50-54y	12.8	9.6
55-59y	11.3	7.2
60-64y	8.9	6.2
BMI		
Underweight	2.8	2.0
Normal	39.5	45.3[a]
Overweight	29.3	32.8[a]
Obese I	15.6	13.5[a]
Obese II	8.2	4.7
Obese III	4.6	1.7
Chronic Disease		
High BP	19.2	11.8
Diabetes	7.6	6.9[a]
Heart Disease	6.8	2.9
Cancer	1.6	1.1[a]
Stroke	1.1	0.6[a]
Fruit and Vegetable Consumption		
<5	68.4	53.3
5-10	29.0	40.3
10+	2.6	6.4

Smoking Status		
Daily	26.0	19.4
Occasional	4.7	6.9
Not at all	69.3	73.7
Alcohol		
Regular	53.6	68.3
Occasional	23.5	17.1
Former	17.3	10.9
Never	5.7	3.7
Ethnicity		
White	85.8	88.5
Non-White	14.2	11.5
Education		
Sec.	20.7	13.1
Sec. Grad	16.9	20.6
Post-Sec	9.3	9.0[a]
Post Grad	53.2	57.3[a]
Income		
Low	15.9	11.3
Low-mid	23.4	15.8
Up-mid	33.6	28.7
High	27.2	44.3
Overnight Stays		
Yes	14.9	9.3
Length of Stay		
≥4	44.8	37.9[a]
Physician Consultations		
≥3	66.0	58.5

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure.
[a]Data are given as percentage of each group (and may not total 100% for each category because of rounding) and are from cycle 3.1 of the Canadian Community Health Survey. All associations between activity levels are significant unless otherwise indicated.

APPENDIX C: QUESTIONNAIRES FOR EXERCISE INTERVENTIONS

Date: _____ ID#: _____

Asthma Control Study: Screening Questionnaire

Contact Information

Name: _____

Phone #: _____

Email Address: _____

York Address: _____

Asthma Information

Asthma diagnosed by physician:	**Y**	**N**
Currently have asthma:	**Y**	**N**
Age of asthma diagnosis: _____		
Currently taking asthma medications (preventive):_____	**Y**	**N**
Currently taking asthma medications (emergency):_____	**Y**	**N**

Exercise Habits

Exercise regularly:	**Y**	**N**
Times per week: _____ (less than 3/week)	**Y**	**N**
Intensity:_____ (at or below moderate)	**Y**	**N**
Duration:_____ (less than 20minutes/session)	**Y**	**N**

Other Information

Pregnant:	**Y**	**N**
Other Conditions:	**Y**	**N**
Specify Condition:_____		
Other Medications:	**Y**	**N**
Specify medications: _____		

Weight:_____

Height:_____

BMI:_____

YORK
UNIVERSITÉ
UNIVERSITY

Shilpa Dogra, MSc

School of Kinesiology
and Health Science

4700 Keele St.
Toronto ON
Canada M3J 1P3
Tel 416 736 2100 ext. 20553
Fax 416 736 5774
Email: shilpad@yorku.ca

Information Letter

Dear Participant,

Thank you for your interest in the research project "**The Asthma Control Training Study**", conducted by Shilpa Dogra and Dr. Joseph Baker from the School of Kinesiology and Health Science at York University.

The purpose of this study is to examine the relationship between asthma control and exercise participation. Our goal is to determine whether increases in aerobic fitness lead to improvements in asthma management. In addition to completing some questionnaires with regards to your asthma and activity levels, we are asking you to participate in two fitness tests and weekly workout programs. This program is expected to last a total of 14 weeks.

It is important to us to protect your privacy during this study. Here is how we plan on doing so:

- No names will be used in the data or published work.
- The data will be stored electronically in a secure office at York University.
- Only the researchers and their trained students/assistants will have access to the data.
- The data will only be used for research purposes.

Your participation is voluntary; you are free to withdraw from the study at any time, without consequences. The risks associated with participation in this study are similar to the inherent risks associated with regular exercise. You are not obliged to answer any questions or participate in any activities that you find objectionable or which make you feel uncomfortable. Please be aware that the findings may be published in academic and professional journals in group form- no individual data will be released.

If you consent to participate in the research study, we ask that you sign the bottom of this form and return it to us as soon as possible. Your signature tells us that you understand the procedures involved and that you consent to participate. Please keep a copy of this letter for your information.

I consent to participate in this research project.

Name of Participant	**Signature**	**Date**

This research has been reviewed and approved by the Human Participants Review Sub-Committee; York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines.

If you have any questions, concerns or complaints about this study, please contact any of the individuals listed below. Your assistance with the research is appreciated.

Thank you,

Shilpa Dogra
School of Kinesiology and Health Science
York University
(416)7936-2100 ext. 20553
Email: shilpad@yorku.ca

Dr. Joe Baker
School of Kinesiology and Health Science
York University
416 736 2100 ext 22361

Alison Collins-Mrakas
Manager, Office of Research Ethics, York University
416 736 5914

Informed Consent

As a participant in the Asthma Exercise Program I, ,do hereby acknowledge that I will be required to actively participate in an exercise program that includes but is not limited to:

1) Aerobic fitness testing: maximal exercise test performed on a treadmill
2) Anthropometric measurements: measurement of height, weight and waist circumference
3) Musculoskeletal Strength and Endurance Tests: grip strength, flexibility and vertical jump
4) Exercise Training: Weekly aerobic, strength and flexibility training
5) Filling in questionnaires such as the Asthma Control Questionnaire, and the Mini-Asthma Quality of Life Questionnaire.
6) Completing and submitting weekly training logs

I further acknowledge that:

1) All testers and trainers are trained and certified in first aid and basic CPR. Additionally, they are certified exercise physiologists with the Canadian Society for Exercise Physiology. As a member of the supervised group, I will be required to exercise 3 times per week with a certified exercise physiologist. As a member of the unsupervised group, I will be expected to perform the exercise program as prescribed by the certified exercise physiologist.
2) There are potential risks associated with exercise; i.e. episodes of transient lightheadedness, fainting, chest discomfort, leg cramps and nausea, and that I assume willingfully those risks
3) There are potential benefits of participating in this study; improved cardiovascular fitness, increased strength, improved asthma control etc
4) I will be allowed to use my asthma medication during the testing and training if my asthma symptoms are exacerbated
5) I am obligated to immediately notify the tester of any pain, discomfort, fatigue or any other symptoms that I may suffer during and immediately after the testing or training
6) I may stop or delay the testing and training if I so desire and that the testing and training may be terminated by the appraiser upon observation of any symptoms of distress or abnormal response. Should I choose to withdraw from the study completely; all data pertaining to me will be destroyed.
7) I may ask questions or request further information about the procedures at any time before, during and after the testing and training, and I have the right to refuse to answer any questions being asked
8) The information collected over the course of this program will be used for data analysis. The data will be kept confidential, and confidentiality will be provided to the fullest extent possible by law. Data will be stored for a period of 7 years in a secure laboratory on the York University campus. Confidentiality will be provided to the fullest extent possible by law.

9) This program will be the basis of peer-reviewed publications in journals as well as a PhD dissertation
10) I have read, understood, and completed the Physical Activity Readiness Questionnaire and that answers to all questions with the exception of #7 are negative.

_____

Name of Participant

_____ _____

Signature of Participant Date

_____ _____

Signature of Witness Date

This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines.

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

Appendix A2

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	**Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?**
☐	☐	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☐	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	7.	**Do you know of <u>any other reason</u> why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can:

- *start becoming much more physically active – begin slowly and build up gradually. This is the* safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

→ **DELAY BECOMING MUCH MORE ACTIVE:**

- If you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- *If you are or may be pregnant – talk to your doctor before you* start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

<u>Informed Use of the PAR-Q</u>: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

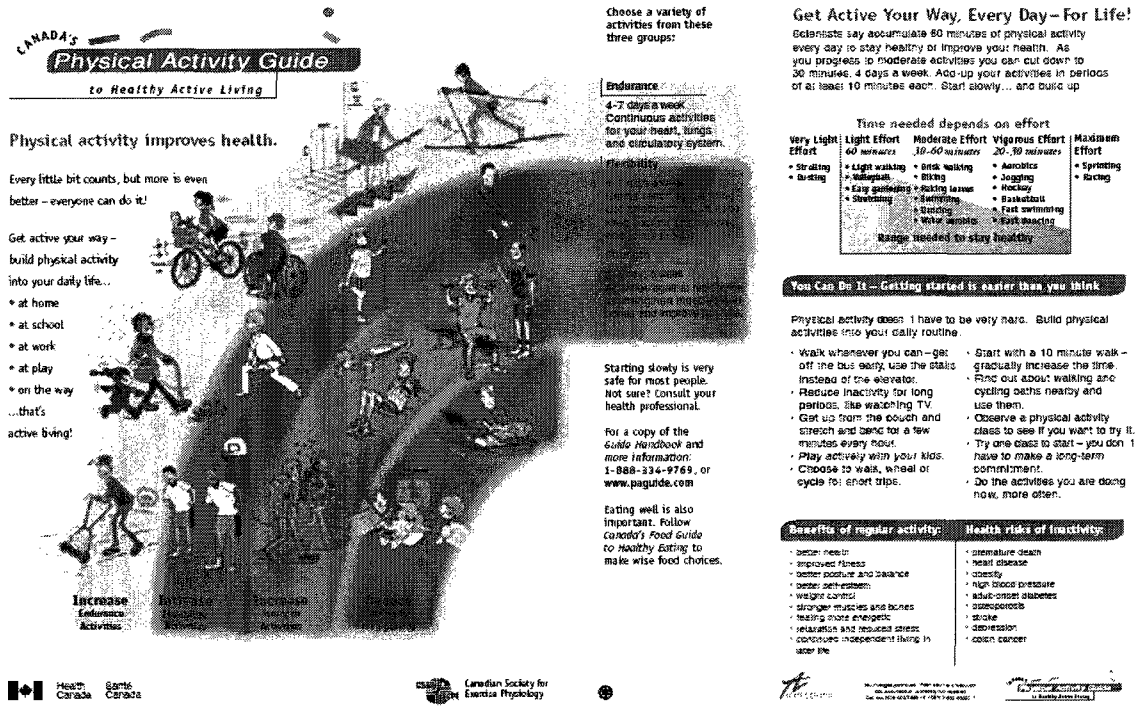
Supported by: Health Canada Santé Canada

continued on other side...

...continued from other side

PAR-Q & YOU

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)



Source: Canada's Physical Activity Guide to Healthy Active Living, Health Canada, 1998 http://www.hc-sc.gc.ca/hppb/paguide/pdf/guideEng.pdf

FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW:

The following companion forms are available for doctors' use by contacting the Canadian Society for Exercise Physiology (address below):

The **Physical Activity Readiness Medical Examination (PARmed-X)** – to be used by doctors with people who answer YES to one or more questions on the PAR-Q.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy)** – to be used by doctors with pregnant patients who wish to become more active.

References:

Arraik, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. **J. Clin. Epidemiol.** 45:4 419-428.

Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy. In: A. Quinney, L. Gauvin, T. Wall (eds.). **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health**. Champaign, IL: Human Kinetics.

PAR-Q Validation Report, British Columbia Ministry of Health, 1978.

Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). **Can. J. Spt. Sci.** 17:4 338-345.

For more information, please contact the:

Canadian Society for Exercise Physiology
202-185 Somerset Street West
Ottawa, ON K2P 0J2
Tel. 1-877-651-3755 • FAX (613) 234-3565
Online: www.csep.ca

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. N. Gledhill (2002).

Disponible en français sous le titre «Questionnaire sur l'aptitude à l'activité physique - Q-AAP (revisé 2002)».

Supported by: Health Canada Santé Canada

Pre-Testing Questions:

Complete the following checklist upon arrival of the participant.

Please check the ones that apply:

- participant has not use their inhaler (Ventolin/Bricanyl) for at least 6-8 hours
- participant has not consumed caffeine or nicotine for at least 6 hours
- participant has not consumed alcohol for at least 24 hours
- participant did not perform any heavy exercise for at least 24 hours

Please ensure that participants have brought the following:

- Ventolin or Bricanyl (rescue inhaler)
- Running shoes
- Par-Q, informed consent, and any other questionnaires that were sent previously

Has there been any increase in your symptoms in the last couple of days?

Yes No

Have you had any chest tightness, coughing or wheezing in the last 48 hours?

Yes No

Do you have a cold or bronchitis, or any other upper tract respiratory infection?

Yes No

ACT #

Asthma Control Training Study: T1

Name: _____

Fitness Test Information

Weight (kg): _____ Height (cm): _____

BMI (kg/m^2): _____ WC (cm): _____

RHR (bpm): _____ RBP (mmHg): _____

Lung Function Tests

Predicted FVC:

Pre-Bronchodilator

FEV1:	FVC:
FEV1:	FVC:
FEV1	FVC:

Pre-Exercise (15 minutes Post-Ventolin)

FEV1:	FVC:
FEV1:	FVC:
FEV1	FVC:

Post-Exercise (10 minutes)

FEV1:	FVC:
FEV1:	FVC:
FEV1	FVC:

Aerobic Fitness: *Please staple worksheet to this form!*
Absolute VO_2max:_____
Relative VO_2max:_____

Musculoskeletal Fitness:
Grip Strength Right Hand:_____ _____

Grip Strength Left Hand: _____ _____

Maximum Sit and Reach (cm): _____ _____

Vertical Jump Height (cm):_____

Demographic Information:

Age: _____ **Sex:** *Please circle the one that applies* M F

Marital Status: *Please circle the one that best applies*

a) Married or common law
b) Single (never married)
c) Divorced, separated or widowed

Education: *Please check the one that best applies to you*

a) No high school diploma
b) High School diploma or equivalent
c) College or Apprenticeship
d) University degree
e) Professional Degree (e.g. Lawyer, doctor)
f) Post Graduate Degree
g) Other: Please Specify _____

Income: *Please check the one that best applies to you*

a) Less than 15,000 per year
b) 15,000-29,999 per year
c) 30,000-49,000 per year
d) 50,000-79,000 per year
e) More than 80,000 per year

Ethnicity: *Please check the one that best applies to you*

a) Caucasian
b) Eastern European
c) South-East Asian
d) Asian
e) African
f) Other: Please Specify:_____

Smoking Status: *Please check the one that best applies to you*

a) Never smoked
b) Smoked occasionally in the past
c) Smoked less than 1 pack per week in the past
d) Smoked more than 1 pack per week in the past
e) Currently smoke less than 1 pack per week
f) Currently smoke more than 1 pack per week

Asthma and Health Related Information:

Please check the one that best applies to you

On a scale of 1 to 5, what level of asthma control do you believe you have?

a) Total Control
b) Well Controlled
c) Moderate Control
d) Low Control
e) Poor Control

In general how would you rate your overall health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

In general how would you rate your mental health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

General Asthma Questionnaire

Please complete the following table:

Question	Yes	No	Other
Do you **currently** have asthma as diagnosed by a physician?			
How old were you when this was first diagnosed?			Age:
Are you currently taking medication for your asthma?			
Is one of the medications a daily preventive inhaler?			Name Medication:
Is one of the medications an emergency inhaler that is to be used as needed?			Name Medication:
How often do you use the as needed medication on average per week?			Number of times per week:
Do you have any allergies?			Allergic To: 1) 2) 3) 4)

Please ensure the following forms have been completed:

1) Informed Consent
2) Par-Q
3) General Asthma Questionnaire
4) Asthma Control Questionnaire
5) Asthma Quality of Life Questionnaire
6) Physical Activity Recall
7) Healthy Physical Activity and Participation Questionnaire

☐ I have ensured that all the paper work for this client's file is complete.

_____ _____

Name of Fitness Appraiser Today's Date

Signature of Fitness Appraiser

ACT #

Asthma Control Training Study: T2

Name: _____

Fitness Test Information

Weight (kg): _____ Height (cm): _____

BMI (kg/m^2): _____ WC (cm): _____

RHR (bpm): _____ RBP (mm/Hg): _____

Lung Function Tests

Predicted FVC:

Pre-Bronchodilator

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Pre-Exercise (15 minutes Post-Ventolin)

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Post-Exercise (10 minutes)

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Aerobic Fitness: *Please staple worksheet to this form!*

Absolute VO_2max:_____

Relative VO_2max:_____

Musculoskeletal Fitness:
Grip Strength Right Hand:_____ _____

Grip Strength Left Hand: _____

_____

Maximum Sit and Reach (cm): _____

Vertical Jump Height (inches): _____

Asthma and Health Related Information:

1. What level of asthma control did you have PRIOR to beginning this three month exercise program?

a) Total Control
b) Well Controlled
c) Moderate Control
d) Low Control
e) Poor Control

2. What level of asthma control do you believe you CURRENTLY have?

a) Total Control
b) Well Controlled
c) Moderate Control
d) Low Control
e) Poor Control

3. In general how would you rate your overall health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

4. In general how would you rate your mental health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

4. How many times per week do you use your preventive medication? _____

5. How many times per week do you use your rescue medication? _____

6. Have you noticed a change in your medication use over the past three months

Yes No

If Yes, has it: Increased Decreased

7. Do you experience asthma symptoms (chest tightening, wheeze, coughing etc) during exercise?

Yes No

If Yes:
(i) Has the SEVERITY of asthma during exercise decreased over the last 3 months?

Yes No Stayed the same

(ii) Has the FREQUENCY of asthma during exercise decreased over the last 3 months?

Yes No Stayed the same

8. Have you noticed a change in the FREQUENCY of your asthma symptoms since you began this program?

Yes No

If Yes, has it: Improved Become worse

9. Have you noticed a change in the SEVERITY of your asthma symptoms since you began this program?

Yes No

If Yes, has it: Improved Become worse

10. I was inactive before I began this program because (please check all that apply)

- ☐ I avoided exercise because it aggravates my asthma
- ☐ I assumed exercise would worsen my asthma
- ☐ I did not want to exercise because I require my medication before exercise, and I wanted to minimize my medication use
- ☐ I had no time
- ☐ I was not familiar with the equipment available in the fitness centre
- ☐ I wanted a personal trainer but could not afford one
- ☐ I did not have access to fitness facilities
- ☐ Other: please specify _____

ACT #

Asthma Control Training Study: T3

Name: _____

Fitness Test Information

Weight (kg): _____ Height (cm): _____

BMI (kg/m^2): _____ WC (cm): _____

RHR (bpm): _____ RBP (mm/Hg): _____

Lung Function Tests

Predicted FVC:

Pre-Bronchodilator

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Pre-Exercise (15 minutes Post-Ventolin)

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Post-Exercise (10 minutes)

FEV1:	FVC:
FEV1:	FVC:
FEV1/FVC:	Predicted FVC/FVC:

Aerobic Fitness: *Please staple worksheet to this form!*

Absolute VO_2max:_____

Relative VO_2max:_____

Musculoskeletal Fitness:
Grip Strength Right Hand:_____ _____

Grip Strength Left Hand: _____ _____

Maximum Sit and Reach (cm): _____ _____

Vertical Jump Height (inches): _____ _____

Asthma and Health Related Information:

1. What level of asthma control did you have **PRIOR** to beginning this **SIX** month exercise program?

a) Total Control
b) Well Controlled
c) Moderate Control
d) Low Control
e) Poor Control

2. What level of asthma control do you believe you **CURRENTLY** have?

a) Total Control
b) Well Controlled
c) Moderate Control
d) Low Control
e) Poor Control

3. In general how would you rate your overall health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

4. In general how would you rate your mental health:

a) Excellent
b) Very Good
c) Good
d) Fair
e) Poor

4. How many times per week do you use your preventive medication? _____

5. How many times per week do you use your rescue medication? _____

6. Have you noticed a change in your medication use over the past **THREE** months

Yes No

If Yes, has it: Increased Decreased

7. Do you experience asthma symptoms (chest tightening, wheeze, coughing etc) during exercise?

Yes No

If Yes:
(i) Has the SEVERITY of asthma during exercise decreased over the last **THREE** months?

Yes No Stayed the same

(ii) Has the FREQUENCY of asthma during exercise decreased over the last **THREE** months?

Yes No Stayed the same

8. Have you noticed a change in the FREQUENCY of your asthma symptoms over the last **THREE** months?

Yes No

If Yes, has it: Improved Become worse

9. Have you noticed a change in the SEVERITY of your asthma symptoms over the last **THREE** months?

Yes No

If Yes, has it: Improved Become worse

Exercise Induced Asthma Knowledge

Which of the following asthma facts were you aware of ***BEFORE*** you began this program?

1. Exercise is a trigger for asthma
2. Exercise-induced asthma is more likely to occur after exercise, not during exercise
3. Using your rescue inhaler prior to exercise can prevent the onset of exercise induced asthma
4. A proper warm up can prevent the onset of exercise induced asthma
5. Increasing your aerobic fitness decreases the risk of exercise-induced asthma symptoms
6. Using your controller medication (as prescribed) can help prevent exercise-induced asthma symptoms
7. Exercise-induced asthma is more likely to occur in a cold dry environment compared to a warm humid environment
8. Breathing in through your nose will decrease the risk of exercise-induced asthma symptoms compared to breathing in from your mouth
9. Regardless of how severe your asthma is, you are less likely to have exercise-induced asthma symptoms if your asthma is well controlled
10. For up to a few hours after you have had exercise induced asthma symptoms, repeating the same amount of exercise will not lead to exercise-induced asthma symptoms again (i.e. there is a refractory period)

Which of the following asthma facts did you ***LEARN*** as a result of participation in this program?

1. Exercise is a trigger for asthma
2. Exercise-induced asthma is more likely to occur after exercise, not during exercise
3. Using your rescue inhaler prior to exercise can prevent the onset of exercise induced asthma
4. A proper warm up can prevent the onset of exercise induced asthma
5. Increasing your aerobic fitness decreases the risk of exercise-induced asthma symptoms
6. Using your controller medication (as prescribed) can help prevent exercise-induced asthma symptoms
7. Exercise-induced asthma is more likely to occur in a cold dry environment compared to a warm humid environment
8. Breathing in through your nose will decrease the risk of exercise-induced asthma symptoms compared to breathing in from your mouth
9. Regardless of how severe your asthma is, you are less likely to have exercise-induced asthma symptoms if your asthma is well controlled

10. For up to a few hours after you have had exercise induced asthma symptoms, repeating the same amount of exercise will not lead to exercise-induced asthma symptoms again (i.e. there is a refractory period)

Which of the following facts were ***IMPORTANT*** for you to know in order to feel confident exercising at moderate-high intensities?

1. Exercise is a trigger for asthma
2. Exercise-induced asthma is more likely to occur after exercise, not during exercise
3. Using your rescue inhaler prior to exercise can prevent the onset of exercise induced asthma
4. A proper warm up can prevent the onset of exercise induced asthma
5. Increasing your aerobic fitness decreases the risk of exercise-induced asthma symptoms
6. Using your controller medication (as prescribed) can help prevent exercise-induced asthma symptoms
7. Exercise-induced asthma is more likely to occur in a cold dry environment compared to a warm humid environment
8. Breathing in through your nose will decrease the risk of exercise-induced asthma symptoms compared to breathing in from your mouth
9. Regardless of how severe your asthma is, you are less likely to have exercise-induced asthma symptoms if your asthma is well controlled
10. For up to a few hours after you have had exercise induced asthma symptoms, repeating the same amount of exercise will not lead to exercise-induced asthma symptoms again (i.e. there is a refractory period)

Recommendation from Physicians and Healthcare Workers:

1. Has a physician ever encouraged you to exercise?
    a. YES
    b. NO

2. Has a physician ever discussed exercise and asthma with you?
    a. YES
    b. NO

3. Has any other health-care worker (other than people from this program) ever discussed exercise-induced asthma with you?
    a. YES
    b. NO

4. Have you ever asked a physician or health care worker for advice with exercise?
    a. YES
    b. NO

5. If you answered YES to question 2, 3 or 4 please briefly explain what advice was given to you with regards to exercise and asthma:

Questions regarding this program:

1. In point form, briefly explain the impact that adopting an exercise program of this nature has had on you (both overall and specific to your asthma)
    -
    -
    -
    -
    -
    -

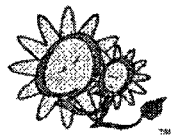
2. Do you believe that regular exercise has led to a change in your asthma? In what way?
    -
    -
    -

SEVEN DAY PHYSICAL ACTIVITY RECALL

Day of Week	Intensity	Type of Activity	Hours spent doing the activity	Total Hours of Activity
Monday	Low intensity			
	Moderate intensity			
	High intensity			
Tuesday	Low intensity			
	Moderate intensity			
	High intensity			
Wednesday	Low intensity			
	Moderate intensity			
	High intensity			
Thursday	Low intensity			
	Moderate intensity			
	High intensity			
Friday	Low intensity			
	Moderate intensity			
	High intensity			
Saturday	Low intensity			
	Moderate intensity			
	High intensity			
Sunday	Low intensity			

	Moderate intensity			
	High intensity			
Total				

ASTHMA CONTROL QUESTIONNAIRE



For further information:

Elizabeth Juniper, MCSP, MSc
Professor
20 Marcuse Fields,
Bosham, West Sussex,
PO18 8NA, UK.
Tel: + 44(0) 1243 572124 Fax: +
44(0) 1243 573680 E:mail:
juniper@qoltech.co.uk Web:
www.qoltech.co.uk

C:\My Documents\WordPerfect\Wpdocs\Qolq\Namerica\AControl\Ascosna2K1.wpd DECEMBER 2002

DATE

Please answer questions 1 - 6.

Circle the number of the response that best describes how you have been during the past week.

1 . On average, during the past week, how often were you woken by your asthma during the night?

o Never
1 Hardly ever
2 A few times
3 Several times
4 Many times
5 A great many times
6 Unable to sleep because of asthma

2. On average, during the past week, how bad were your asthma symptoms when you woke up in the morning?

o No symptoms
1 Very mild symptoms
2 Mild symptoms
3 Moderate symptoms 4 Quite severe symptoms 5 Severe symptoms
6 Very severe symptoms

3. In general, during the past week, how limited were you in your activities because of your asthma?

o Not limited at all
1 Very slightly limited 2 Slightly limited
3 Moderately limited 4 Very limited
5 Extremely limited 6 Totally limited

4. In general, during the past week, how much shortness of breath did you experience because of your asthma?

o None
1 A very little
2 A little
3 A moderate amount 4 Quite a lot
5 A great deal
6 A very great deal

DATE

5. In general, during the past week, how much of the time did you wheeze?

o Not at all
1 Hardly any of the time
2 A little of the time
3 A moderate amount of the time 4 A lot of the time
5 Most of the time
6 All the time

6. On average, durir:,g the past week, how many puffs/inhalations of shortacting bronchodilator (eg. Ventolin/ Bricanyl) have you used each day?

(If you are not sure how to answer this question, please ask for help)

o None
1 1 - 2 puffs/inhalations most days 2 3 - 4 puffs/inhalations most days 3 5 - 8 puffs/inhalations most days
4 9 - 1 2 puffs/inhalations most days
5 13 - 1 6 puffs/inhalations most days
6 More than 1 6 puffs/inhalations most days

To be completed by a member of the clinic staff

7. FEV 1 pre-bronchodilator: .....

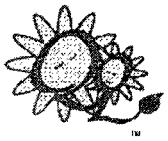
FEV, predicted: .....

FEV, % predicted: ..... (Record actual values on the dotted lines and score the FEV, % predicted in the next column)

o > 95 % predicted 1 95 - 90 %
2 89 - 80%
3 79 - 70 %
4 69 - 60%
5 59 - 50%
6 < 50% predicted

MINI ASTHMA QUALITY OF LIFE QUESTIONNAIRE (MiniAQLQ)

SELF-ADMINISTERED



For further information:

Professor Elizabeth Juniper, MCSP, MSc 20 Marcuse
Fields,
Bosham. West Sussex,
PO 18 8NA. UK
Tel: +44(0)1243572124
Fax: +44(0) 1243 573680
E-mail: juniper@qoltech.co.uk
Web: wWw.qoltech.co.uk

Development and validation
supported by
GLAXO WELLCOME. INC.

MINI ASTHMA QUALITY OF LIFE QUESTIONNAIRE PATIENT ID

SELF-ADMINISTERED DATE

Please complete all questions by circling the number that best describes how you have been during the last 2 weeks as a result of your asthma.

IN GENERAL, HOW MUCH OF THE TIME DURING THE LAST 2 WEEKS DID YOU:

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	Hardly Any of the Time	None of the Time
1. Feel SHORT OF BREATH as a result of your asthma?	1	2	3	4	5	6	7
2. Feel bothered by or have to avoid DUST in the environment?	1	2	3	4	5	6	7
3. Feel FRUSTRATED as a result of your asthma?	1	2	3	4	5	6	7
4. Feel bothered by COUGHING?	1	2	3	4	5	6	7
5. Feel AFRAID OF NOT HAVING YOUR ASTHMA MEDICATION AVAilABLE?	1	2	3	4	5	6	7
6. Experience a feeling of CHEST TIGHTNESS or CHEST HEAVINESS?	1	2	3	4	5	6	7
7. Feel bothered by or have to avoid CIGARETTE SMOKE in the environment?	1	2	3	4	5	6	7
8. Have DIFFICULTY GETTING A GOOD NIGHT'S SLEEP as a result of your asthma?	1	2	3	4	5	6	7
9. Feel CONCERNED ABOUT HAVING ASTHMA?	1	2	3	4	5	6	7
10. Experience a WHEEZE in your chest?	1	2	3	4	5	6	7

MINI ASTHMA QUALITY OF LIFE QUESTIONNAIRE PATIENT 10

SELF-ADMINISTERED DATE

IN GENERAL, HOW MUCH OF THE TIME DURING THE LAST 2 WEEKS DID YOU:

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	Hardly Any of the Time	None of the Time
11. Feel bothered by or have *to avoid going outside* because of WEATHER OR AIR POLLUTION?	1	2	3	4	5	6	7

HOW LIMITED HAVE YOU BEEN DURING THE LAST 2 WEEKS DOING THESE ACTIVITIES AS A RESULT OF YOUR ASTHMA?

	Totally Limited	Extremely Limited	Very Limited	Moderate Limitation	Some Limitation	A Little Limitation	Not at all Limited
12. STRENUOUS ACTIVITIES (such as hurrying, exercising, running up stairs, sports)	1	2	3	4	5	6	7
13. MODERA TE ACTIVITIES (such as walking, housework, gardening, shopping, climbing stairs)	1	2	3	4	5	6	7
14. SOCIAL ACTIVITIES (such as talking, playing with pets/children, visiting friends/relatives)	1	2	3	4	5	6	7
15. WORK-RELATED ACTIVITIES * (tasks you have to do at work)	1	2	3	4	5	6	7

*If you are not employed or self-employed, these should be tasks you have to do most days.

DOMAIN CODE:
Symptoms: 1,4, 6,8, 10
Activity Limitation: 12, 13, 14, 15 Emotional
Function: 3, 5, 9 Environmental Stimuli: 2,
7, 11

The Healthy Physical Activity Participation Questionnaire

A. Answer the following questions

Frequency
Over a typical 7-day period (1 week), how many times do you engage in physical activity that is sufficiently prolonged and intense to cause sweating and a rapid heart beat?

☐ At least three times

☐ Normally once or twice

☐ Rarely or never

Intensity
When you engage in physical activity, do you have the impression that you:

☐ Make an intense effort

☐ Make a moderate effort

☐ Make a light effort

Perceived Fitness
In a general fashion, would you say that your current physical fitness is:

☐ Very good

☐ Good

☐ Average

☐ Poor

☐ Very poor

B. Circle your score below for each answer and total your score

Item	Male	Female	Male	Female	Male	Female
Frequency	Rarely or never		Normally once or twice		At least 3 times	
	0	0	2	3	3	5
Intensity	Light effort		Moderate Effort		Intense Effort	
	0	0	1	2	3	3
Perceived Fitness	Very poor or poor		Average		Good or very good	
	0	0	3	1	5	3

Total score: _____

C. Determine the health benefits of your physical activity based on your total score

Total score	*Health Benefit*
9 - 11	Excellent
6 - 8	Very good
4-5	Good
1 - 3	Fair
0	Needs improvement

Source: The Canadian Physical Activity, Fitness & Lifestyle Approach: CSEP-Health & Fitness Program's Health-Related Appraisal and Counselling Strategy, 3rd Edition © 2003. Reproduced with permission of the Canadian Society for Exercise Physiology.

Twelve Week Training Program

(Supervised Group)

This section includes the weekly programs for your clients. All exercises must be followed as prescribed. If your client has a previous injury or some physical restriction and is unable to perform any of the outlined exercises, please contact Shilpa to come up with a suitable alternative.

The worksheets provided must be filled in completely and submitted along with the weekly logs submitted by your clients.

The mode of aerobic exercise can be chosen by the client, however, ensure that the same machine is not used for every session. Vary between the treadmill, bike, elliptical, steppers, and rowing machines as best possible. If the gym is busy and you are unable to get a machine for 35 minutes, the client can warm up on another piece of equipment. Be sure to make note of the change on your sheet.
Please make note of whether the client has used their Ventolin (rescue medication) within 2 hours of the exercise session in the Asthma symptoms column. You can also add any other asthma symptoms they may experience during the session.

All clients must wear heart rate monitors during the aerobic portion of the exercise session. You will be given the HR max of your client, and will be expected to calculate the HR range they are supposed to work within. HR monitors can be picked up and dropped off in 116 or 117 Bethune College. Please make arrangements with Shilpa in advance should you require HR monitors for early morning or evening sessions.

Be sure to calculate the target HR zone for your client for that session. If the exercise is too easy, and the client is interested in exercising harder, increase the workload to +10-15bpm. Remember to write down the highest HR and RPE every 5 minutes.

Strength training should be performed at the end of the aerobic session. Only one set needs to be performed with the client. This set must go to fatigue. Please write down the number of reps it took to achieve fatigue. Each repetition should take 3seconds in the contraction phase, and 3 seconds in the relaxation phase. Ensure proper breathing technique: exhale on contraction.

Client Logs: The weekly logs are to be collected from your clients on the first session of each week. Please go through the columns with your client so that they understand how to fill them in properly.

Pre-Training Session

Please complete the following questionnaires with your client prior to commencing any exercise:

1) Identifying barriers to exercise
2) Goal Setting worksheet
3) Physical activity beyond personal training
4) Self Contract

Take this first session to get to know your client and their needs. It is important to understand what motivates your client so that they adhere to their exercise program.

Physical Activity Beyond Personal Training

Remember, there are many activities you can do outside of the your personal training sessions, and outside of the gym. List at least 3 activities you would like to incorporate into your weekly schedule that involve physical work. These activities can range from walking, to gardening, to heavy house-work etc.

1.

2.

3.

You can also use the great outdoors as an alternative to the gym. List 3 activities you would like to take up or add to you schedule. These could range from biking, to golfing, to hiking.

1.

2.

3.

If you are more of an indoors person, you can always exercise at home or at the gym without your trainer. List some exercises that you would be able to do at home or the gym on your own that you would like to add to your weekly schedule.

1.

2.

3.

Session 2: Cardio Portion Target HR 65-70% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 1: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Chest Press using Smith Machine			
Tricep Extensions using pulley			
Shoulder press with dumbbells			
Partial Curl-ups			
Stretch: Quads, hams, calves, chest, and triceps			

Date:
Client's Signature:

Session 2: Cardio Portion Target HR 65-70% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 2: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Lat pull down with machine			
Bicep curls with dumbbell			
Rear Deltoids on machine			
Supermans (max of 15 per side)			
Stretch: Quads, hams, calves, back, and biceps			

Date:
Client's Signature:

Session 3: Cardio Portion Target HR 65-70% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 3: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Ball Squats against wall			
Sitting Hamstring Curl machine			
Calf raises on step			
Curls ups on stability ball			
Stretch: Quads, hams, and calves			

Date:
Client's Signature:

Session 1: Cardio Portion Target HR 70-75% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 1: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Pec Fly with dumbbells			
Tricep Dips on bench			
Lateral shoulder (arm) raises			
Sitting Tucks			
Stretch: Quads, hams, calves, chest, and triceps			

Date:
Client's Signature:

Session 2: Cardio Portion Target HR 70-75% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 2: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Graviton (assisted lat pull)			
Seated Row			
Alternating Hammer Curls			
Back and leg raises on BOSU			
Stretch: Quads, hams, calves, back, and biceps			

Date:
Client's Signature:

Session 3: Cardio Portion Target HR 70-75% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 3: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Leg Press on machine			
Lying down Hamstring Curl			
Side Leg Raises			
Sit ups with medicine ball			
Stretch: Quads, hams, and calves			

Date:
Client's Signature:

Session 1: Cardio Portion Target HR 75-80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 1: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Push-Ups			
Skull Thrashers (triceps with bar)			
Alternating shoulder press			
Curl ups on the BOSU			
Stretch: Quads, hams, calves, chest, and triceps			

Date:
Client's Signature:

Session 2: Cardio Portion Target HR 75-80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 2: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Lat Pull down with machine			
Bent Over Row (one side at a time)			
Bicep curls with bar			
Oblique planks			
Stretch: Quads, hams, calves, back, and biceps			

Date:
Client's Signature:

Session 3: Cardio Portion Target HR 75-80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 3: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Walking Lunges			
Hamstring curls on Stability ball			
Hip abductors using machine			
Snow angels			
Stretch: Quads, hams, and calves			

Date:
Client's Signature:

Session 1: Cardio Portion Target HR 80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 1: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Chest Press with bar (free weight)			
Tricep Pull with cables			
Forward shoulder raise dumbbells			
Planks (2 reps)			
Stretch: Quads, hams, calves, chest, and triceps			

Date:
Client's Signature:

Session 2: Cardio Portion Target HR 80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 2: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Bent Over Row with bar			
Seated Row			
External rotators with dumbbell			
Side bends with dumbbell			
Stretch: Quads, hams, calves, back, and biceps			

Date:
Client's Signature:

Session 3: Cardio Portion Target HR 80% max:

Mode of Exercise	Time (minutes)	Heart Rate	RPE	Asthma Symptoms
	5			
	10			
	15			
	20			
	25			
	30			
	35			

Session 3: Strength and Flexibility Training

Type of Exercise	Reps to Fatigue	RPE	Asthma Symptoms
Single Leg Ball Squats			
Good Mornings			
Hip Adductor machine			
Bridges			
Stretch: Quads, hams, and calves			

Date:
Client's Signature:

Week #: 1
Date:
Client's Signature:

WEEKLY LOG

Day of the week	Type of Activity	Time Spent on Activity	Average RPE or HR during activity	Asthma symptoms during exercise (Y/N)	Description of asthma symptoms if experienced	Used medication prior to or during exercise session	Number of times used Ventolin (rescue) medication
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							
Saturday							
Sunday							

RATING OF PERCEIVED EXERTION

How does the exercise feel?	Numerical Rating
	6
Very, very light	7
	8
Very light	9
	10
Fairly light	11
	12
Somewhat hard	13
	14
Hard	15
	16
Very hard	17
	18
Very, very hard	19
	20

SAMPLE UNSUPERVISED EXERCISE PROGRAM

NOTE: ALL PICTURES HAVE BEEN DELETED DUE TO COPYRIGHT ISSUES

Week 1-3

For the first three weeks of the program the main goal is to form a HABIT. That means you want to incorporate exercise sessions into your weekly schedule on at least 5 days!

To begin with, we want to ease your body into this new lifestyle. If you push yourself too hard at the beginning, you may hurt yourself. So take your time with your workouts, and take plenty of time to stretch at the end of each session.

Cardio Portion:

You should do cardio exercises everyday! To begin with you will be working at a lower intensity.
Your target heart rate is: 130-142

This is a range of 13-15 on the Rating of Perceived Exertion scale.
Remember, if this feels too easy, you can exercise at a higher intensity. Just remember not to push yourself too far in the first week.

Your goal should be to do at least 30 minutes of cardio per day. Below are two cardio programs you can use. They can be done on any cardio equipment, but remember that it may be easier to get your heart rate up higher on some machines compared to others. For example, it may feel easier to exercise in your target heart rate zone on the treadmill than on the bike.

Since one of you preferred activities is squash, I would recommend playing with yourself once per week instead of doing cardio on a machine. This will allow you to increase your endurance and refresh your squash skills over the next few weeks. In a month of so, you'll be ready to start playing against a friend or join the squash ladder at Tait. You can book a court with the front desk by calling (416)736-5182.

As well, try working out at the Track and Field Centre. It is free for York students, and does have some weight machines and free weights. Jog one lap and walk one lap of the track for a workout. Or do half laps to start with. Try and do that for 20-30 minutes. Once you're ready for a higher intensity, we can get you sprinting!

Strength Training Portion:

Try and do each strength training workout once per week over the next three weeks. Do 2-3 sets for each exercise. Be sure to choose a weight (I have made some suggestions) that completely fatigues your muscle with 15-20 repetitions. If you are unsure of how to do a certain exercise, ask someone at the front desk of Tait to help you! That's what they are there for.

Cardio Programs

Program 1: Constant Cardio Target HR: 130-142

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	120	12
Cardio	25 minutes	130-140	14-15
Cool Down	3 minutes	<120	11

Program 2: Heart Rate Hill Climb

Intensity of Exercise	Time (minutes)	Heart Rate	RPE
Warm Up	0-5	110	10
Workout Portion	5-10	125	12
	10-15	130	13
	15-20	135	13
	20-25	135-140	14
	25-32	140-145	14-15
Cool Down	32-35	120	12

Session 1:

Type of Exercise	Weight to Lift
1) Chest Press	45 lbs
2) Tricep Extensions using pulley	30-35 lbs
3) Shoulder press with dumbbells	8 lbs each
4) Partial Curl-ups	Body Weight

Session 2:

Type of Exercise	Weight to Lift
1) Lat pull down with machine	50-55lbs
2) Bicep curls with dumbbell	15-18 lbs each
3) Rear Deltoids on machine	40-45 lbs
4) Supermans (max of 15 per side)	Body Weight

Session 3:

Type of Exercise	Weight to Lift
1) Ball Squats against wall	Body weight
2) Sitting Hamstring Curl machine	40-50 lbs
3) Calf raises on step	Body Weight
4) Curls ups on stability ball	Body Weight

CARDIO TIME ☺
(Week 4-6)

You are now in the third week of your exercise program. In these past three weeks you have had the opportunity to incorporate exercise into your daily routine.

It is now time to pick it up a notch! Now that your body is accustomed to regular exercise, you should be able to work at higher intensities. Our goal is to improve your aerobic fitness so that you can go faster and further on your next treadmill test!

For the next three weeks your goal is to do a minimum of 5-7 days of aerobic exercise at a moderate intensity or higher. That means your heart rate should be in the following range:

Heart rate: 131-151
Rating of Perceived Exertion: 13-15

You should accumulate at least 30 minutes of aerobic exercise per day. This can be done in 10 minute intervals or more. In other words, if you are crunched for time, take 10-15 minutes in the morning and 10-15 at night to get in your exercise. Another way would be to do 10 minutes of cardio before breakfast, lunch and dinner.

Remember, cardio exercises are anything that increase your heart rate and breathing rate. They can include jogging, biking, jumping up and down, running up the stairs, sports etc. Don't limit yourself! Any activity is good activity!

Don't neglect your muscular strength and endurance. Continue to do the previous workouts set-up for you as well as the additional ones below, so that you can improve your overall health and fitness as well. An increase in leg strength will increase your ability to do aerobic exercise at an even higher intensity...and for a longer time.

On days you are crunched for time, do 10 minutes of the circuits you were given at week 1. Whatever you do, don't give up! Every 10 minutes of exercise counts!!!!

The two programs outlined below are meant to be done in either 15 minute (cut the workloads in half) or 30 minutes bouts. Follow these along so that you can ensure you are working at the optimal intensity for cardiovascular and calorie burning benefits!

Program 1: Moderate Intensity Hill
This program allows you to gradually build up to a moderate intensity. It incorporates a warm up and a constant climb up to that moderate HR range.

Program 1: Moderate Intensity Hill Climb Target HR 65-75% max: 131-151

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	120	12
Base of the hill	5 minutes	130	13
Easy Climb	5 minutes	135	13+
Increase Pace	5 minutes	140	14
Moderate Hill	5 minutes	145	14+
Moderate Hill with Pace	5 minutes	150	15
Cool Down	3 minutes	<120	10

Program 2: High Intensity Intervals
This program allows you to flip between easy and very hard phases in short intervals. This allows you to recover your heart rate and breathing before your next work phase. Use this if you are short on time. Repeat the number of sprints as many times as you can! Notice, the heart rate range is very broad.

Program 2: High Intensity Intervals Target HR 65-80% max: 131-162

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	120	12
Hard	30 seconds	160	16
Easy	1 minute	135	13+
Hard	45 seconds	160	16
Easy	1 1/2 minutes	135	13+
Hard	60 seconds	155	15+
Easy	60 seconds	135	13+
Cool Down	3 minutes	<120	10

Session 1: Chest and Triceps

Type of Exercise	Weight to Lift
1) Push Ups	Body weight
2) Triceps Dips on bench (feet on floor)	Body weight
3) Rotator Cuffs	5 lbs each
4) Sitting Tucks	Body Weight

Session 2: Back and Biceps

Type of Exercise	Weight to Lift
1) Pull Ups (keep your feet on the floor)	Body Weight
2) Bicep curls with bar	20 lbs
3) Rear Deltoids on machine	5-8 lbs
4) Back raises	Body Weight: 10-15 repetitions per set

Session 3: NO Impact Leg Exercises

Type of Exercise	Weight to Lift
1) Leg Extension	60-70lbs
2) Laying Down Hamstring Curl machine: one leg at a time	20-30 lbs
3) Side Leg Raises	Body Weight
4) Sitting Tucks with dumbbell	10 lbs

Half Way Program
(Week 7-9)

You are now HALF way through the 3 month program! Time flies when you're having fun ;)

You should now be at a point where you are comfortable exercising at a moderate intensity for 30 minutes. Over the next 3 weeks, we want you to do longer bouts of high intensity cardio so that from week 9-12 you can do 30 minutes of continuous high intensity work.

Below are your heart rate ranges for moderate and high intensity work:
Moderate Intensity:141-152
High Intensity: 162-172

Rating of Perceived Exertion
Moderate Intensity: 14-15
High Intensity: 16-18

Below are two cardio programs for you to give a try. Don't forget to work on increasing your strength as it will help you increase your endurance!

Continue to use your previous strength training workouts as well as the circuits. The key is to increase the number of repetitions and the intensity of the work you are doing! I have also provided you with a leg workout...try and do this at least twice per week.

Program 1: Rolling Hills

This program has two peaks so that you can get up to your target intensity twice. Each hill slowly builds you up and brings you down with the same ease. Remember to warm up and cool down properly!

Program 1: Rolling Hills Target HR 80-85% max: 162-172

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	130	13
Base of Hill	2 minutes	145	15
Half Way Up	2 minutes	155	16
Steep Climb	2 minutes	165	17
Peak 1	1 minute	172+	18
Flat Road	4 minutes	160	16
Base of Hill	2 minutes	145	15
Half Way Up	2 minutes	155	16
Steep Climb	2 minutes	165	17
Peak 1	1 minute	172+	18
Flat Road	4 minutes	160	16
Race to Finish	2 minutes	165-170	17-18
Cool Down	3 minutes	<120	10

Program 2: Steady Build

This program gradually gets you to your target heart rate. Use the "course" as a guideline to what you should do and how you should feel in each interval.

Target HR 70-85% max:	141-172

Program 2: Steady Build

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	130	13
Pick up the effort	5 minutes	145	14
Start to challenge yourself	5 minutes	150	15
Heavy Breathing	5 minutes	155	16
Intense!	5 minutes	160	16
Target Intensity	5 minutes	165	17
Target Intensity Plus	5 minutes	170+	17-18
Cool Down	3 minutes	<12	10

Strength Training

It is probably becoming more apparent to you that when working at higher intensities it isn't your lungs and heart that hurt, but rather your legs. Below is a great leg workout that can be done in the comfort of your home. A couple of sets of these exercises followed by a day of rest and recovery will prepare you for a high intensity workout. Don't neglect the upper body though, do a few push ups and pulls ups as well.

Quadriceps Exercises: Choose one to two of these per session

1) Step Ups: Do this exercise without any weights the first few times, your body weight is a sufficient load. Be sure to do at least 10 repetitions per leg!

2) Static Lunge: Again, start without any additional weight for this exercise. Be sure that the bench/step isn't too high by ensuring that your front leg forms a 90degree angle when you lunge.

3) Ball Squats: These squats can be done without a ball as well. Just slide your back up and down the wall instead. Again, remember not to let your legs pass the 90degree angle mark. If these feel too easy, add some weight or do one leg at a time!

Hamstring Exercises: Do at least one of these per session. The hamstrings are important for high intensity work, especially sprints!

1) Single Leg Ball Extensions: When doing this exercise pull the ball towards you using the back of your leg. If you do not have a stability ball, you can use a basketball or a towel on a slippery surface. Remember not to overextend your back!

2) Bridges: For this exercise always push through your heels. To make it a bit more difficult, do one leg at a time. Hold the up and down position for at least 10 seconds at a time and repeat till you feel the burn in the back of your legs.

Calf Exercises: Do at least one of the exercises per session.

1) Stair Calf Raises: hold on to a railing for support. You can do this exercise with both legs, or one at a time. Try and use the full range of motion of your calf/heel.

2) Seated Calf Raise: This can be done with or without weight on your lap. Again remember to use the full range of motion of your ankle joint.

Other Leg Exercises: Here are a couple of other exercises for smaller leg muscles. Do at least one of these per session.

1) Gluts Raises aka Buttock Raises: Do one leg at a time, and keep your abs nice and tight. Make sure you don't hyperextend your back!

2) Abductors: Here again, do one leg at a time. Try not to extend your leg up too high. Keep your body grounded on the floor!

3) Adductors: If you don't have a stability ball you can use pillows or cushions instead. Be sure to keep your core (abs and back) nice and tight.

Maintaining Flexibility

When we become regularly active our muscles tend to lose some of their pliability. It is therefore important to stretch at the end of each exercise session so that we can maintain our flexibility.

Attached are some basic stretches that you should incorporate at the end of each workout. If at all possible, try to join a yoga class, or do a yoga video a couple of times per week. Never overdo a stretch! A stretch should be somewhat uncomfortable, but never painful. If its painful, pull back a little. Try to exhale as you stretch.

If there is a particular body part that you think needs some extra work, let me know, and I can recommend some additional stretches.

Hold each stretch for at least 20-30 seconds!

The Final Three Weeks!
(Week 10-12)

You are in the last three weeks of this twelve week program. You should now be comfortable and confident at higher intensities of exercise. The goal this week is to increase the duration of time you are able to spend at a high intensity. Remember: The ultimate goal of this program is 30 minutes of continuous high intensity cardio!
Your heart range for this 30 minutes should be between: 162-172 which is the equivalent of a Rating of Perceived Exertion of 16-18.

At this point I would like to introduce you to plyometrics. This type of training involves hops and jumps to give you an intense workout geared at increasing your muscular power thereby increasing your ability to do high intensity cardio.
With this type of training it is essential to warm up for at least 5 minutes. Once you warm up you are ready to do the following workout. Try to do this workout twice a week in addition to your cardio workouts. Start with one set and aim for three! Make sure you take the time to stretch after this workout.

Jumping squats: This is a basic squat with no weights with an added jump.
When you reach the deepest part of the squat you jump up, and straight away land into the deepest part of the squat again. Try to do 10 repetitions continuously.

Lateral Jumps: With a bit of a bend in your knees and hands on your hips, hop laterally. Try and do this 12-16 times continuously.

Box Jumps: In one continuous motion, jump up on a box (or stair), step down immediately and jump up again. Try to do this 10-25 times.

Depth Jumps: Jump from a height (stairs or box) and upon landing on the floor immediately jump up again. Try to repeat this 10 times.

Rock and Roll: Get into a semi-squat position, keep your core tight and rock back and forth on your feet. Try to take a larger step to make it more intense!

The Plyo Push Up: This is an intense upper body exercise and the only one I am prescribing, so give it a try! You can try the first one which is less intense than the second.
1) start from the kneeling position and fall to the floor, immediately push yourself back up to the starting position. Try to do at least 10-12 of these continuously.
2) instead of starting on your knees, start in a push up position and push up with a bounce. Remember to be soft on those elbows!

Cardio Workout: Steady Heart Rate

This program gets you into your target heart rate range and keeps you there. Alternate between easy and intense if you're getting tired!

162-172

Target HR 80-85% max:

Course	Timeline	Heart Rate	Rating of Perceived Exertion
Warm Up	2 minutes	140	14
Get into the zone	5 minutes	160	16
Get intense	5 minutes	165	17
Push yourself	5 minutes	170	18
Drop down	5 minutes	160	16
Get intense	5 minutes	165	17
Push yourself	5 minutes	170	18
Cool Down	3 minutes	<120	10