UNIVERSITY OF ALBERTA

A STUDY OF FACTORS RELATED TO EMERGENCY DEPARTMENT VISITS FOR ASTHMA IN THOSE 5-50 YEARS OLD

BY
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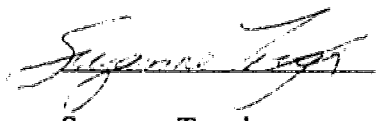

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The undersigned certify that they have read, and recommend to the Faculty of Graduate studies for acceptance, a thesis entitled, " A Study of Factors Related to Emergency Department Visits for Asthma in those 5-50 years old" submitted by Suzanne C.Tough in partial fulfilment of the requirements for the degree Doctor of Philosophy, Medical Sciences - Public Health Sciences.

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This study is dedicated to Greg, Kiersten and Jocelyn, without whose love, patience, understanding and support this educational goal would never have been attained and to Mom and Dad, my first teachers.

ABSTRACT

Asthma affects approximately 10% of the population at some time in their lives and the prevalence of asthma is increasing worldwide (1-5). In the last decade, the prevalence of asthma has increased substantially, particularly in the populations of Europe, North America and in certain parts of the southern hemisphere (Australia and New Zealand). With respect to Canada, notable increases in asthma morbidity and mortality have occurred in the Prairie Provinces (5).

In the vast majority of cases asthma can be controlled by allergen avoidance and/or appropriate medication. A visit to the emergency department (ED) for asthma may represent a breakdown in the treatment /control process. The factors that determine why one asthmatic requires emergency department treatment during an exacerbation, while others do not, remain obscure. Emergency department treatment for asthma is a significant health care expenditure and an exacerbation of asthma compromises the quality of life of asthmatics.

Rationale: In most instances asthma is a controllable disease. An ED visit represents a breakdown in control. Identification of characteristics of those with asthma who come to the ED, specifically, characteristics that distinguish them from other people with asthma, may assist in the design of interventions aimed at improving asthma control and reducing the need for this type of treatment.

Purpose: The major objective of this study was to identify the risk factors associated with an exacerbation of asthma serious enough to warrant emergency department treatment by comparing the features of those who sought treatment for asthma in the emergency department (ED cases) to a random sample of people with asthma in the same communities (RDD controls).

Methods: A comparative analysis of those who attended the ED (n=337) for asthma treatment with community asthmatics located through random digit dialling (RDD)(n=212). Participants completed a mailed questionnaire.

Analysis: Bivariate analysis of specific risk factors, followed by multivariate model development with logistic regression.

Conclusions: Bivariate analysis revealed that the ED asthmatic was more likely than the RDD asthmatic to have had asthma for less than 5 years. Logistic regression revealed that the ED asthmatic is more apt to be younger, have seen their family doctor in the last year, to use the ED more than once a year, and to report more severe disease. Differences between the ED and RDD asthmatic may relate to both asthma control and disease severity. The highest risk group appears to be the young adult with moderate to severe asthma. This group would be an appropriate target for intervention/prevention programs. Clinicians should be alert to signs of deteriorating asthma control and be willing to monitor these patients.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

CI	confidence interval
ED	Emergency department
exp B	exponential Beta
FE	Fisher's Exact test
LR	likelihood ratio
MH	Mantel Haenszel test for linear trend
n	number
OR	odds ratio
PHS	Public health sciences
RDD	Random digit dialling
SE	standard error
vs	versus
%	percent

1.0 INTRODUCTION

Asthma is the most common chronic respiratory illness in North America and in recent years its prevalence has increased internationally (1-5). Asthma affects all Canadians through increased health care costs and lost productivity. The annual cost of asthma in Canada has been estimated at 600 million dollars (5).

Asthma is an inflammatory disease characterized by exaggerated broncho-constriction in response to certain stimuli and variable airway obstruction. It is a disease of varying severity requiring different approaches to treatment. It affects people of all ages around the world and if inadequately treated can be fatal (6).

1.1 Public Health Impact

Public health has been defined as the 'promotion, protection and restoration of health by organized community action' while incorporating the principle of 'the greatest good for the greatest number' (7). To design effective public health programs therefore, the community needs an understanding of the magnitude of health related problems and their impact on the community.

Directly or indirectly asthma impacts all Canadians both socially and economically through premature death, lost productivity, compromised quality of life and significant health care expenditures. Asthma is a leading cause of absenteeism from work and school as well as a common cause of ED visits and hospitalizations (6,8).

The annual 600 million dollar cost of asthma in Canada is a reflection of direct health care costs and lost productivity (5). In 1987-88 the cost of work days lost annually in Canada due to asthma was estimated at 1 million dollars. The 300,000 days of hospitalization for asthma patients cost over 120 million dollars in 1987-88 (5). These costs are comparable to the United States where the economic cost of asthma was estimated at $6.2 billion dollars in 1990 (9).

Asthma may be controlled in the majority of cases by allergen avoidance and/or appropriate medication, hence a visit to the ED may represent a failure in the treatment/control process (Ian Mitchell, personnal communication). In 1994, the cost of treating an asthmatic in an ED was $210.00 per visit, more than double the cost of treating such patients in the doctor's office (10). In Alberta, the annual cost of acute care management of asthma is over 40 million dollars (10).

One goal of public health is to encourage the provision of the right service in the right place at the right time to the right people (7). To reduce the need for ED treatment of asthma it is important to identify characteristics of both the disease and the person that result in an ED visit. In addition it is important to identify factors that contribute to good health and minimize morbidity in those who suffer from asthma.

1.2 Epidemiology of Asthma

1.2.1 Prevalence of Asthma and Regional Variation

The most recent national estimate on the prevalence of asthma in Canada is the Canada Health Survey of 1978-1979 which reported the population prevalence as 2.4% (11). In 1988, an estimated 500,000 Canadians were reported to suffer from asthma of whom approximately 60% were less than 35 years of age (5,11-14). Data from the Manitoba Health Insurance Plan indicated that the prevalence of physician diagnosed asthma increased from 1.3% to 2.5% of the population between 1980 and 1990 (15).

In addition, in 1988 the Canadian prevalence of childhood asthma was reported at 6.0% , although regional variations were described (16,17). Canadian provincial data indicate that regional variations in the prevalence of asthma exist (16,18). For example, a cross-sectional Canadian study of 5-8 year olds revealed asthma prevalence of: 7.4% in the Maritimes, 6.4% in Saskatchewan, 5.1% in Southern Ontario, 4.2% in Central Ontario, 3.3 % in British Columbia and 3.4% in Quebec (16). Preliminary 1994 data from Alberta school children indicates that the prevalence of asthma may be as high as 10% (19). Such increases in the prevalence of asthma could result from a real increase in the incidence of the disease, an increased level of severity necessitating more physician contacts, or a change in the attitude and approach of the physician to diagnosis and treatment (15).

1.2.2 World Wide Trends in Prevalence

There is considerable variation in the world wide prevalence of childhood asthma with an average of between 4.0% and 5.0% being suggested (20,21). Britain, New Zealand, South Africa, Wales and the United States have reported increasing population prevalence of asthma over the past decade (2-4,22). A recent survey of children revealed asthma rates of: 16.8% in New Zealand; 12% in Wales; 11.5% in South Africa and 4.0% in Sweden (23,24).

The prevalence of asthma in Israel increased from 1.8% to 3.6% over a 9 year period among 17-18 year olds (25). Trends in the Finnish armed forces showed a 20-fold increase in asthma among 18 year old recruits over the past 30 years from 0.29% in 1966 to 1.79% in 1989 (26).

There are countries where the prevalence of asthma is low. Asthma prevalence has been reported to be less than 1% in Patna India, Japan, Gambia, and Papua New Guinea (21).

Increasing asthma prevalence is almost entirely accounted for by the increasing incidence of disease in those under 18 years of age (15,27-29) Additionally, some studies indicate that asthma prevalence is highest amongst males; in the population of

the developed countries; and the populations of industrialized coastal regions (25).

1.2.3 Mortality, Morbidity, and Hospitalization Rates

Since 1974, the rate of death from asthma has increased particularly in patients under 35 years of age (12). In Canada, the Alberta mortality rate for those under age 35 of 0.7 per 100,000 is almost double the Canadian rate of 0.4 (12,30).

Increased asthma death rates in the 1980s also occurred in New Zealand, Britain and the U.S. (2-4,31,32). There is convincing evidence that these increases cannot be explained on the basis of changes in diagnostic criteria or coding practices (6,32,33). Moreover, they occurred against a background of increasing use of apparently effective drugs for treatment of the symptoms of asthma (6,34).

Since 1990 the mortality rate for asthma in Canada has apparently stabilized. Hospitalization rates, however, continue to rise as evidenced by a 40.0% increase in hospital admissions /separations since 1980 (17).

International hospital admission rates for asthma, particularly in those aged 0-14 have increased as much as 6-fold between 1957 and 1981 (35). Using National Hospital Discharge Survey data for the years 1979-1987, Gergen reported that U.S. asthma hospitalizations in those 0-17 years of age increased 4.5% per annum, the increase being greatest among those 0-4 years of age (36).

Aggregate hospital discharge data do not distinguish between the admission of a new patient and the repeat admission/discharge of a single individual. It is likely, however, that both re-admission and the changing prevalence of asthma contribute to the observed increase (12,35,36). It should be noted that, changes in classifying and recording respiratory disease cannot account for this increase in hospitalization rates as the increase in asthma admissions has been noted between 1979-1987, subsequent to the implementation of ICD-9-CM (32,35,36).

1.2.4 Triggering Factors in Relation to Increased Prevalence

When an individual with asthma encounters a 'trigger' such as dust or cold air, bronchial constriction, mucus production and airway swelling may result in wheezing, breathing difficulties and an asthma exacerbation.

The increase in asthma prevalence and morbidity is unexplained. Increased recognition of asthma symptoms and a tendency to report 'wheeze' may contribute to the reported increase in the prevalence of the disease. Alternatively, however, changes in the delivery of medical care and improvements in treatment could confound estimates of prevalence and severity (28). Nevertheless, even when diagnostic drift and increased recognition are allowed for, the prevalence of asthma is still increasing (2-4,12,15,32).

The question of whether the disease has increased in both prevalence and

severity is unresolved. A study conducted in Britain comparing the prevalence of asthma between 1978 and 1991 in 7-8 year old children concluded that such prevalence had increased from 11.1% to 12.8% of the group; although, perhaps because of improved medical management, severity was not reported to show such an increase (28). A study of children aged 8-10 in Australia indicated that between 1982 and 1992 the prevalence of atopy was stable while the prevalence of airway hyper-responsiveness had increased for both a moist coastal region and a dry inland region (29) . The increased asthma prevalence varied from twofold in the coastal location to 1.4 fold in the inland site (29). A study by Peat et al. suggested that the increased bronchial responsiveness and the development of asthma in atopic children may be due to a much greater allergen load in a child's environment (29). These authors also suggested that this increase in prevalence may have reflected an increase in severity as more atopic children were diagnosed with asthma (29). Both of these studies provide evidence of a real (i.e. non-artifactual) increase in the prevalence of asthma.

The factors leading to an increase in asthma prevalence could be related to genetic predisposition, or environmental conditions such as industrial pollutants, dust mites, pets climate and diet (25,29,4,37,38-42). Evidence describing the effect of these factors on asthma will be reviewed below.

1.2.4a Hereditary Evidence

Evidence of a hereditary predisposition to develop asthma exists and familial aggregation of asthma has been noted for many years (43). Indeed, adults with severe asthma are more likely than those with milder asthma to have had a parent with a history of asthma (44). Asthma has been observed to be associated with hay fever and eczema, allergy skin test reactivity to common aeroallergens and increased serum total IgE (45-48). Family studies indicate that from 36 to 60 percent of observed variance in total IgE is explained by heredity (49).

Children of parents with asthma, hay fever or eczema are more likely than the general population to develop the same condition as their parents rather than a dissimilar allergic condition, suggesting that predisposition to atopy and asthma may be inherited as independent genetic traits (50). Infants with a parental history of asthma have a predisposition to suffer from asthma as evidenced by increased airway responsiveness to bronchial challenge soon after birth (34,41,42).

An association between asthma and atopy has been demonstrated (51-54). Atopy is the genetic predisposition toward an inappropriate IgE mediated inflammatory immune response resulting from exposure to an antigen or 'allergen' (51).The relatively high levels of IgE found in umbilical cord blood of infants suggest an inherited atopic predisposition, IgE is also elevated in those with asthma (52-54). Atopy appears to result from both genetic and environmental factors. The possibility of preventing the

development of atopic disease by manipulating environmental factors has been suggested. Environmental factors that have been suspected of contributing to the atopic response include breast feeding (55), exposure to aeroallergens in infancy, including cat dander (56), and early life respiratory infection (57). For example, reduced exposure of infants to allergens in food and in house dust was noted to lower the frequency of allergic disorders in the first years of life (53).

Evaluation of the role that ethnicity plays in asthma requires consideration of potential confounders such as access to medical care, environment, demographics and economics. Some research suggests that ethnicity may play a role in susceptibility to asthma. Very high hospital admission rates of Hispanics and African-Americans characterize specific geographic areas such as New York City (40). In addition, admission rates among Hispanics were consistently higher than among African-Americans even when socioeconomic status was controlled, and the authors suggested that genetic factors may play some role (40). The authors controlled for environment and economic status by zip code, and unfortunately could not control for cultural factors which may influence the use of medication, the attitude toward seeking care and the compliance to a medication schedule. Ethnic and cultural variables may also play a role in how and when an individual seeks medical attention and what medications (conventional or un-conventional) are used to avoid an exacerbation of asthma.

1.2.4b Environmental Evidence

The impact of the environment on the initiation and exacerbation of asthma has received widespread attention (58-60). The health effects of ground-level ozone at levels that occur in Canada have included airway hyper-reactivity, increased use of medication and increased number of visits to physicians/EDs (58,59). A 68.0 % increase in the number of pediatric asthma related emergency visits in Mexico City was related to exposure to high ozone levels for 2 consecutive days (60). Although one study found no relationship between atmospheric pollution and the prevalence of asthma (42), most such studies indicate that exposure to atmospheric pollutants triggers asthma (44, 58-64).

Motor vehicle exhaust emissions have received attention as a respiratory pollutant that has contributed to the increase in ozone. Children who lived near roads with heavy traffic were exposed to greater than normal concentrations of exhaust emission containing both fine particulate and nitrogen oxides. These children have been admitted to hospital for asthma more frequently then controls (61). The authors neglected to control for economic factors or housing conditions which could confound the relationship between the level of car exhaust and the frequency of visits to a hospital for respiratory problems. In another study, school children in an industrial town polluted by an oil fired thermoelectric power plant were found to have poorer

lung function and greater sensitivity to common aeroallergens than those in a rural control area (62). In support of the role that environmental pollutants play with respect to airway diseases, it has been recorded that in some regions of England and Wales there has been a recent decline in hospital admissions and mortality coincident with a reduction in smoke and sulphur dioxide levels (64). Furthermore in Barcelona, Spain the installation of a filter to control soybean dust seemed to prevent outbreaks of asthma caused by inhalation of such dust (63). Indications are, therefore, that living in an area with higher than normal air pollution levels may promote bronchial reactivity independent of atopy and asthma; for example, high rates of infant respiratory mortality have been noted in areas with high levels of air pollution (65).

Environmental factors have been suggested to account for low rates of childhood asthma in some developing countries; less than 1.0 % asthma prevalence in Patna India, Gambia Africa, and Papua New Guinea (21).

Because children and infants spend much time inside, domestic sources of pollution may be as important as outdoor sources as triggering factors for airway sensitivity (41). Influences in infant and fetal life such as exposure to second hand smoke and other allergens may contribute to the development of airway hyper-reactivity and asthma (66). In a study of 63 month old infants, those exposed to parental smoking demonstrated increased airway responsiveness compared to the unexposed control infants (37). Because 29 of the 33 mothers who smoked also smoked during pregnancy, these infants were also exposed to the effects of maternal smoking while in utero. This makes separating the effects of prenatal smoking from exposure to second hand smoke after birth difficult to assess, particularly since it has been recorded that babies born to smokers have diminished lung function compared with those born to non-smokers, regardless of whether the latter develop a wheezing illness (67). Measurement of urine cotinine levels in children as an indicator of exposure to cigarette smoke demonstrated that acute exacerbations of asthma increased and pulmonary function decreased with exposure to tobacco smoke (68). Unfortunately, there was no comment in this study on the relationship between asthma severity and the level of urine cotinine. In a cross-sectional analysis of 7,578 children the odds for wheezing illness was 1.36 (95% CI 1.14,1.62) for children whose mothers smoked, after controlling for potential demographic confounders (69). It seems reasonable to conclude from these studies that exposure to tobacco smoke may be linked to the development of asthma in sensitive or predisposed individuals as well as being a triggering factor for acute exacerbations of asthma.

Environmental factors have been implicated in excessive asthma admission rates where old building structures provide conditions for cockroaches, dust mites, rodents, air pollution and poor ventilation in living spaces (40). In a recent Canadian study lower socio-economic status was associated with a decreased likelihood of being sensitive to cats and trees, and an increased likelihood of sensitivity toward cockroaches and moulds (70). The authors suggested that there are differences in

exposure to different allergens by socio-economic status but there was no obvious relationship between asthma prevalence and social class (70). The relationship between environment and asthma is well supported although the precise triggering mechanisms are less clear and may be a function of a hereditary predisposition together with exposure to local environmental allergens.

Indoor pets, particularly cats, have received attention as triggering factors for asthma. In a large study of 4,353 children, cat ownership was demonstrated to parallel asthma prevalence across regions. New Zealand had reported a childhood asthma prevalence of 16.8% as compared to Wales 12.0%, South Africa 11.5% and Sweden 4.0%; cat ownership was highest in New Zealand and lowest in Sweden (23). This study also looked at the relationship between temperature and humidity and found that these factors did not account for the regional variations in asthma. As expected, the prevalence of symptoms, such as wheeze, was highest in New Zealand and lowest in Sweden (23). The authors suggest that the level of exposure of allergic children to animal antigens may be determined by assessing the local prevalence of pet ownership (23,71). However, cat ownership was not linked to individual cases of asthma and therefore the relationship between having a cat in the home and the development or exacerbation of asthma can not be determined from this study.

House dust mites have been cited as an important domestic allergen (29,38,41,72). For example 80.0% of children with asthma in the UK are allergic to the house dust mite (38,41). Over the period 1979-1989 absolute levels of house dust mite allergen were unchanged in 59 homes in the UK and the correlation, particularly in atopic children, between early exposure (5 years or less) and current wheeze (age 11) was significant (41). Asthma prevalence increased over this period suggesting that either the levels of house dust mite increased in other homes or that more children were exposed to this allergen. In addition, in both coastal and inland regions of Australia between 1982-1992 the prevalence of airway hyper-responsiveness and wheeze has doubled at the same time the numbers of house dust mites increased by 5 fold (29). The relationship between this allergen and the development or severity of asthma is not totally clear (41). A potential explanation that requires further investigation was offered by Peat et al. who suggest that either exposure to high allergen levels may have increased airway abnormalities in atopic children or new environmental factors may have altered mechanisms protective to earlier generations (29).

Another potential environmental trigger for asthma is the aeroallergen *A.alternaria*, a common mould present in grain growing regions. In the midwestern US exposure to the aeroallergen *A.alternaria* is suggested as a significant risk factor in the sudden respiratory arrest of 11 children and young adults suffering from asthma (73). Aeroallergen exposure induced unexpected, worsening symptoms of rapid respiratory decompensation and respiratory arrest within 90 minutes which resulted in 2 fatalities of 11 investigated cases (73). The control group of asthmatics had a skin test

sensitivity prevalence to *A.alternaria* of 31% compared with 91% in the case group. The importance of these results is difficult to establish given the small sample size and other factors which may confound interpretation of the results. For example, four of the cases had psychiatric symptoms or family difficulties, three did not have a regular medication regime and seven were receiving inhaled steroids at the time of respiratory arrest. Nine of the cases had required high dose prednisone at some time in the past thereby suggesting that all of these patients had experienced difficulty in controlling their asthma. Further investigation of the relationship between A. alternaria and potentially fatal asthma would be of importance to Albertans who live in grain growing regions.

1.2.4c Climate and Season

Climate and season may play a role in the exacerbation of asthma. In Ontario, for example, hospital admissions for asthma for those aged 15-34 revealed seasonal variation, being greatest in September-October with a small peak in admissions in April-May (30). In an Alberta study the risk of death from asthma was greater in summer, particularly for males (74). Countries have reported seasonal trends in asthma mortality with death rates greatest July through October in Canada, England and Wales (17,30,74,75). Factors such as weather, pollens, viral infections, house dust mites and fungal spores vary with the season and may in turn account for the seasonal variation in asthma attacks (12). For example, inhaling cold air is a trigger for bronchoconstriction in asthmatic subjects and may cause asthma in non-asthmatic subjects (76). Strenuous exercise at low temperatures which involves breathing large volumes of cold air is an explanation of persistent asthma in skiers (76).

1.2.4d Diet

The relationship between diet and the development or exacerbation of asthma has been hypothesized and is under investigation (72,77-79). Excessive ingestion of salt may exacerbate asthma symptoms and increase the need and use of inhaled steroids (78). Other researchers have noted a significant increase in bronchial reactivity to histamine in severe asthmatics when salt intake increases (79). Unfortunately, the number of participants in each of these studies is less than 15 and many more are required to confirm the observation of such increased bronchial reactivity in response to salt intake (77-79).

A relationship between the consumption of anti-oxidants and asthma has been suggested based on the observation that an increase in asthma prevalence in the UK has corresponded to a reduction in the consumption of fresh fruit and vegetables (72). The proposed mechanism by which a reduction in consumption of anti-oxidants could lead to an increase in bronchial sensitivity was linked to a reduction in host resistance

(72). The hypothesis that a reduction in the consumption of the anti-oxidants vitamin C and beta-carotene is linked to increases in asthma prevalence (72) warrants investigation utilizing large controlled trials.

Certain substances that have been associated with allergic reactions and fatal food induced anaphylaxis include nuts, shellfish and salicylate (34,80).

1.2.4e Viruses

Respiratory tract infection in early life is a potential risk factor in the development of asthma (81). Frick et al. observed that clinical and immunologic evidence of allergy in children often occurs for the first time 2 to 6 weeks after a viral upper respiratory tract infection (82).

Many young children wheeze during viral respiratory infections, but the pathogenesis of these episodes and their relation to the development of asthma later in life are not well understood (43). Most wheezing resolves by six years of age, however in many infants wheezing episodes are probably related to a predisposition to asthma (43). Children with persistent wheeze were more likely to have atopy and to have mothers with asthma than children with transient wheezing (43). In infants with lower respiratory tract infections in the first six months of life the frequency of persistent wheezing up to seven or eight years of age was found to be directly related to the level of respiratory syncytial virus (83).

Asthma symptoms and reduction in peak flow have been shown to be associated with colds and respiratory viruses (74,84,85). In adults with asthma almost 90% of colds were associated with asthma symptoms (84). In a longitudinal study of 138 asthmatic adults it was noted that respiratory pathogens were implicated in almost half of severe asthma exacerbations (84). Nearly 30% of adults with confirmed chlamydia pneumonia viral infection subsequently developed bronchial asthma compared to 7% of sero-negative patients, suggesting further research may be warranted on the relationship between viral respiratory (re)infection and the development of asthma (85).

1.2.5 Summary of the Epidemiology of Asthma

From the evidence gathered to date, it is apparent that more research is required to determine the etiologic components of asthma. The increased prevalence of asthma may be a manifestation of an increase in sensitisation among children to inhaled allergens such as those present in house dust, cat fur and grass pollen. The short period over which the increases in asthma and other allergic diseases have occurred and been measured suggests that environmental influences play a greater role than a change in genetic susceptibility in explaining the increased prevalence among young people. The epidemiology of asthma is changing and it is apparent that asthma

is a serious problem. Further study is necessary to determine whether protecting children from early exposure to allergens would prevent the later development of bronchial hyperreactivity, airway inflammation and the onset of asthma.

The potential public health impact of increased asthma prevalence in young people is substantial in terms of treatment costs, lost productivity and compromised quality of life. Given the rise in asthma prevalence it is reasonable to expect that our health care system will also experience increased use and costs. In this regard, therefore, to limit expenditures resulting from inappropriate asthma management, leading to unnecessary use of the emergency department, the profile of the emergency department asthmatic must be described. Appropriate programs can then be designed to promote optimal asthma control for these individuals.

1.3 Pathogenesis of Bronchial Asthma

The symptoms of asthma reflect changes in the airways. Bronchial hyper-responsiveness (BHR) is a key feature of asthma and is an exaggerated bronchoconstrictor response to different stimuli. This hyperresponsiveness has been associated with inflammation of the airways (13). The inflammation, which is often chronic, results in swelling of the bronchial walls and narrowing of the air passages. Blockage of the airway through increased production and secretion of mucus occurs when the airways are exposed to a triggering agent (13,86). Increased bronchial responsiveness can be triggered by many agents including allergens, ozone, industrial chemicals, virus infections, and animal dander (87).

Several different cell types produce mediators which contribute to BHR including mast cells, macrophages, eosinophils, epithelial cells and platelets (13). Altered autonomic nervous control may also contribute to airway inflammation and bronchoconstriction (13,88,89).

1.3.1 The Asthma Exacerbation

In an acute asthma exacerbation, wheezing, shortness of breath, chest tightness and coughing occur. As the attack progresses anxiety and fear often set in while breathing becomes laboured, rapid and shallow. As the exacerbation worsens the victim may show signs of agitation, fatigue, and confusion (90).

In mild attacks narrowing of the airways may be due only to a bronchospasm and may be treated with a beta agonist bronchodilator such as Salbutamol. In more severe attacks edema and mucous plugging occurs and more rigorous treatment is required. At this stage, if the patient does not receive proper treatment their respiratory muscles become exhausted and carbon dioxide levels in the blood will rise. During this event hospital treatment becomes urgent to prevent a fatality (90).

In 50% of asthmatics there will only be an 'early asthmatic response' with rapid

onset of airflow limitation which can be reversed promptly by inhalation of a bronchodilator. The remaining 50% of asthmatics will experience a dual response whereby there is a 'late asthmatic response' defined by progressive onset of airflow limitation 3-4 hours after resolution of the 'early asthmatic response'. This response reaches its peak 8-12 hours after the initial exposure and does not respond well to bronchodilators suggesting that this is a problem of inflammation (91).

In summary, asthma was previously thought of as a disease of bronchoconstriction. The current understanding of asthma as an inflammatory disease has changed the approach to treatment and has encouraged review of methods for controlling the disease.

1.4 Asthma Management

1.4.1 Diagnosis

The symptoms of asthma which include wheeze, breathlessness, chest tightness, cough and sputum can be misinterpreted as bronchitis and/or respiratory tract infection (92-95); raising concern about under-diagnosis. The episodic nature of asthma makes the diagnosis difficult as evidenced by the degree of disparity among clinicians and the absence of a gold standard for the diagnosis of asthma (96).

Different symptoms at different ages, diverse manners in which symptoms present and the varying triggers of asthma lead to a wide spectrum of patterns in individuals which complicates the diagnosis of asthma (97). This difficulty is magnified in the case of children because of the overlap of symptoms of asthma with those of related respiratory disorders and because of the limitations of available diagnostic tools (94). The clinical features of asthma are varied, both between and within patients and problems or delays in diagnosis can result (98). Furthermore, the diagnosis of asthma can be overlooked in children who present without the classical symptom of wheeze but with chronic symptoms, such as cough (98). Knowledge of all the patterns of asthma is helpful for an accurate diagnosis (98).

The diagnosis of asthma is indicated when the symptoms are provoked by allergens, cold air and/or exercise (92). The diagnosis of asthma and classification of disease severity are usually based on signs and symptoms (wheeze, cough, and chest tightness) as well as the response to therapy monitored in the clinic and/or with simple tests of lung function (95).

1.4.2 Treatment

Asthma management and treatment is normally provided in a primary care setting and guidelines are provided to promote a standardized approach to assessment

and treatment (77-79). Most guidelines encourage a partnership between patient and caregiver, including a written action plan with a guide for patient self-management. The action plan provides information to the patient as to what to do as asthma control deteriorates, how and when to increase medication, when to contact the doctor and when to go to the hospital.

Traditionally the primary objective of asthma treatment has been the control and prevention of severe exacerbations (93,99). Underlying airway inflammation and bronchoconstriction must therefore be controlled for effective treatment. Included in the guidelines are the following suggestions; the mild asthmatic can initially be encouraged to avoid triggers including allergens, occupational irritants and cigarette smoke. Treatment of an attack includes inhaled bronchodilators (beta-agonists) with or without cromoglycate, which stops the release of histamine, taken before stimuli and perhaps low-dose inhaled steroids. In more severe cases high-dose inhaled steroids are recommended in combination with ingested bronchodilators and/or prednisone. Theophylline, a sustained action beta-agonist, or inhaled ipratropium bromide, which relaxes the smooth muscle, may help to reduce symptoms in some of the more severe cases (93). Some of the medications can be technically difficult to take and initial instruction from qualified health professionals can improve technique resulting in improved delivery of the medication to the lungs.

An action plan for the asthmatic should contain information on identification of symptoms that imply poor control (such as nocturnal asthma or using more than a maximum recommended dose of bronchodialator) and how to respond. Episodes of broncho-constriction can be monitored by tracking the peak expiratory flow rate using a peak flow meter. Because up to 60% of adults are poor at self determining their airflow, it has been suggested that action plans be based on peak flow monitoring (100). When the treatment regime for best control has been defined, follow-up should occur thereafter at 6-12 month intervals (92).

Typically, asthma can best be controlled by trigger avoidance together with appropriate medication and disease monitoring. Good control means the asthmatic has no persisting symptoms, can function without a restricted lifestyle, without experiencing shortness of breath on exertion and without sleeping difficulties. Furthermore they avoid the onset of severe attacks (93,99).

1.4.3 Bronchodilator Therapy

Bronchodilators such as beta 2-agonists work to relieve asthma symptoms by relaxing contracted bronchial smooth muscle (91). Some of the more common bronchodilator medications include Ventolin, Berotec, Bricanyl, and Beta-agonist. Recently, the regular use of beta 2-agonists has come under scrutiny (101-105). The regular use of bronchodilators has been associated with deterioration of asthma control. For example, regular treatment with terbutaline (Bricanyl) reduced the ability of a beta

2-agonist to protect against histamine-induced bronchoconstriction (101,102). In a double blind placebo controlled randomised cross-over study by Sears et al. the regular use of a beta 2-agonist was followed by rebound bronchial responsiveness; the authors recommended use of a such medication for symptom relief only (101). Beta 2-agonists increase bronchial hyper-responsiveness which may be exacerbated by airways inflammation (82-84). Excessive use of inhaled beta 2-agonist bronchodilators has been associated with an increased risk of fatal and near-fatal asthma (106).

The long acting beta 2-agonists such as salmeterol have been used to control allergen induced asthma (107,108). They reportedly reduce mucosal swelling and airway inflammation, and may protect against the late-phase asthmatic response and corresponding leucocyte recruitment (107,108). The number of participants in each of these studies is less then 15, which limits the power of the results. In another study, patients (n=457) treated for 3 months with regular salmeterol experienced fewer exacerbations of asthma compared with patients treated with symptomatic salbutamol (109); this is in contrast to those results reported by Sears (101). Both long acting and regular beta 2-agonists however, may contribute to a deterioration in asthma control as subjects may be able to tolerate higher exposures to allergens thereby blunting the early asthmatic response while fuelling the inflammatory changes in the airways (101). The chronic regular use of asthma medication therefore, could be a major factor in ED visits for asthma and requires further study.

1.4.4 Fenoterol

Fenoterol, which was marketed at a higher dose than the other beta-agonists, has been demonstrated to cause more adverse effects than salbutamol or terbutaline (106,110,111). It may contribute to deteriorating asthma control by suppressing the early response and enabling a greater exposure to an allergen. The tendency for asthmatics to try to regain control of their asthma before seeking medical attention can lead to overuse of medication. This overuse does not necessarily enable the victim to regain control of their asthma and may delay appropriate treatment (33,112,113).

1.4.5 Steroid Therapy

Inhaled steroids suppress the airway inflammation which characterizes the asthmatic lung (91). Some of the more common inhaled steroids include Azmacort, Becloforte, Beclovent and Pulmicort. Inhaled steroids have been demonstrated to reduce both the number of inflammatory cells and epithelial damage (114,115). They do not reduce the thickness of the epithelial basement membrane (114,115). Inhaled corticosteroids also reportedly decrease (but do not eliminate), persistent bronchial hyper-responsiveness possibly by damping a late allergic reaction (103,105).

Steroids suppress the inflammatory response and are important for successful

asthma control. When oral steroids are taken, however, the risk of osteoporosis increases (116). "Steroid sparing" drugs such as methotrexate may reduce the requirement for systemic steroids such as prednisone, however they may compromise liver function in some patients (116).

1.4.6 Sodium Cromoglycate Therapy

In most children after an exposure to an allergen sodium cromoglycate (SCG) (ie. Intal, Tilde) stabilizes mast-cell induced acute bronchospasm (117). It has been demonstrated that SCG in combination with salbutamol does not control airway hyperreactivity as well as beclomethasone dipropionate (BDP, anti-inflammatory corticosteroid) in combination with salbutamol (117).

1.4.7 Peak Flow Monitoring

An objective measure of asthma severity should allow for more effective management of asthma. One such measure is the degree of airway obstruction reflected by the rate of forced expiration with a flow meter. The results from a peak flow meter are designed to indicate when patients should adjust their drug treatment. Without such a meter many patients are not able to adequately perceive their degree of airway obstruction. In one study up to 60.0% (152/255) of asthmatics could not discriminate between levels of high and low peak air flow (100). Many asthmatics spontaneously adjust their activity to accommodate a deteriorating air flow and fail to realize the increasing severity of the condition (100). Such poor perception of airflow obstruction may lead to under-treatment of an asthma exacerbation thereby placing themselves at risk for an emergency department visit.

Currently, asthma victims have use of a mini-flow meter as a means of measuring their peak flow rate. Unfortunately, mini-flow meters have been reported to overestimate flow rates in the range of 200-400 L/m, a range commonly encountered in pediatric practice. For example, the results of a study of 12 boys who did peak expiratory flow monitoring twice daily for 3 months using 4 different brands of meters indicated that less than half of the important reductions in lung function detected by a spirometer were detected by the four different mini-flow meters (118). The relationship between changes in lung function as measured by the spirometer and those changes measured by the mini-flow meter was poor; none of the mini-flow meters detected all episodes of clinically important deterioration in lung function. Also, all mini-flow meters showed a false reduction in peak expiratory flow. The authors concluded that accurate tracking of lung function in children with asthma may not be possible with mini-flow meters (118).

In light of the opportunity for treatment decisions to be made by individual asthmatics on the basis of peak flow results these instruments must be as reliable as

possible. Further study is required, therefore, to assess which patient populations would most benefit from the use of such instruments. In addition, the strengths and limitations on the use of peak flow meters for pediatric populations must be described through research in larger populations.

In summary, the widespread use of inexpensive accurate peak flow meters may be helpful as a means of monitoring asthma control in outpatients, particularly those with persistent bronchial hyper-responsiveness, and those with poor perception of lung function. Further research, particularly in the pediatric population, on the strengths and limitations of mini-flow meters is necessary (100).

1.4.8 Outpatient Services

Outpatient services, or specifically, community management of the asthmatic includes a program that provides for improved diagnosis, timely adjusting of treatment, improved education and effective monitoring or the patients condition (119,80). The goal of community management is optimal control of asthma where the patient and clinician are jointly responsible for asthma management (120,121).

1.4.9 Other Approaches

Non-conventional approaches to asthma management include acupuncture, yoga, biofeedback and herbal treatments.

Studies of non-conventional therapy specific to asthma have been performed. One such study examined the effects of yoga breathing on asthma control. In a small (n=18) placebo controlled study of mild asthmatics, there was a statistically significant increase in the dose of histamine needed to provoke a 20% reduction in forced expiratory volume in one second (FEV1) during enforced pranayama* breathing but no such response occurred with the placebo device (122). In a controlled trial of real and simulated acupuncture for management of chronic asthma in 25 moderate to severe asthmatics, Tashkin et al. failed to demonstrate any significant effect (123).

*pranayama breathing=controlled inspiration-expiration at a 2:4 ratio. Inspiration lasts for 2 counts, expiration for 4 counts.

1.4.10 Education and Self Management

Education programs have been designed for the asthmatic to learn about the basic nature of the disease, to identify triggers and allergens that induce airway constriction and ultimately to encourage healthy lifestyle patterns, including medication regimes. Self management is the goal of asthma education programs (121,124-127).

Education programs encourage the asthmatic to take an active role in disease

management because proactive responses to early signs of asthma, such as the avoidance of triggers and appropriate medication, often prevent acute attacks. The asthmatic should recognize when deterioration in control requires medical intervention. In the event of an acute attack, management involves efforts to stay calm and rest, maintain adequate hydration and seek assistance as necessary (121).

Asthma education programs have demonstrated positive changes in knowledge, attitude and self efficacy which were apparently maintained on follow up (124,128). If asthma knowledge and beliefs impact on ED visits then an eduction program which addresses sufficient knowledge about asthma, referrals and skill for self management, and patient oriented problem solving should improve asthma management. The goal of such programs is to empower the patient to prevent and manage an attack and when healthy, to carry on with age and gender appropriate activities (127).

1.4.11 Quality of Life Factors

Quality of life is a goal of long term asthma treatment and it envisions an unrestricted life free of symptoms, severe attacks, and serious side effects of drug treatment. Factors defining quality of life are specific to the individual and are related to their age, gender, previous health history and lifestyle.

Questionnaires have been designed to measure quality of life for adult and pediatric asthmatics (128,129,130). The Asthma Quality of Life questionnaire (AQLQ) is designed for all adult patients and contains items along four domains: activity limitation, symptoms, emotional function and environmental stimuli. It is sensitive to small within subject changes and, although time consuming to administer, can be used in a clinical trial (129). It could be included in asthma evaluations to capture the component of the condition that is most important to the patient. The AQLQ is able to detect changes in quality of life that represent a difference to the individual for both improvement and deterioration in asthma control (128,129). The AQLQ has been shown to be capable of detecting differences between improved and stable subjects (131).

The impact of asthma on a child may reflect both the distress caused by the symptoms and the inconvenience caused by the treatment (132). This distress may not be adequately assessed by an adult and the development of child-centred approaches are indicated (130), as is the need for a disease specific instrument.

Factors that may influence a parent's quality of life when a child has asthma include an over dependence on physicians, over involvement with the child, organization of the family around the child's condition, sibling resentment, manipulative behaviour of the child, family hopelessness, helplessness and frustration (133) . Improved quality of life is an important goal of asthma education programs.

1.4.12 Summary of Asthma Management

The current approach to the management of asthma incorporates a partnership between the physician and the patient. Pharmaceutical developments combined with an increased understanding of the pathophysiology of asthma influence asthma therapy and management. Some of the medications can be technically difficult for young people to take. This may impact on both compliance to taking medication and the delivery of the drug to the target organ for those who comply to the medication schedule. Ideal management of asthma incorporates effective use of medication, both inhaled steroids and bronchodilators, and attention to self-management approaches that minimize illness and enhance quality of life.

1.5 Emergency Department and Hospital Management

Emergency treatment is required when as exacerbation of asthma can not be controlled by prescribed use of asthma medication. The objective of ED treatment is to immediately reverse the airway obstruction.

Emergency department treatment of asthma may include oxygen and a nebulized inhalation treatment with a bronchodilator and sometimes theophylline to relax the smooth muscle in the airway. This inhalation treatment is repeated until the patient is comfortable. In a study of emergency department management of acute asthma it was reported that 92 of 99 received inhaled bronchodilator therapy, 16 received anticholinergic agents to relax smooth muscle, three received theophylline and corticosteroids were given to 27 patients (134). Pulmonary function tests may be used as criteria for patient discharge from the emergency department, however, these tests may fail to identify those patients who suffer relapse (135).

If a patient fails to respond to emergency treatment, hospitalization, even in the intensive care unit (ICU) may be required (119). Standard treatment of status asthmaticus in the ICU may consist of aerosolized beta-agonists, intravenous aminophylline, prednisone and supplemental oxygen.

To prevent a relapse after the patient is discharged injectable or oral steroids may be prescribed (119). Seventy-one patients were followed-up post discharge, 26 sought further medical attention, indicating sub-optimal emergency department management (134).

It is noted that, despite the life threatening nature of this condition, less than half of all asthma fatalities occur in a hospital (9,136-140). Indeed, the risk of sudden death is seriously increased when emergency treatment is delayed or inadequate, including insufficient or nonexistent use of corticosteroids (3,4,113,136-140).

1.5.1 Risk Factors for Re-Admission to Hospital

The asthmatic may be safely discharged from the ED before the obstruction is completely reversed (119). Resolution of the inflammation may take days or even weeks and requires ongoing treatment and a follow-up examination by a family doctor or a specialist (119). In a descriptive study of 1034 children admitted to hospital for asthma, Mitchell et al. noted that 33% were re-admitted within six months and 51% within 2 years (141). Factors that significantly increased re-admission were female gender, under 5 years of age, frequency of previous admissions, and the use of inpatient intravenous treatment. Inpatient treatment with theophylline was associated with decreased re-admission rate. Factors which did not predict re-admission included ethnicity, respiratory and pulse rate at initial visit, medical team, prescribed prophylactic treatment, type of follow up examination or the use of action plans. Forty percent of those admitted had not had a previous admission for asthma. Although prescribed medication had little effect on the propensity for readmission, the degree of compliance to prescribed medication was not assessed (141).

Our understanding of the asthmatic who is admitted to hospital for asthma provides a reasonable starting point for research into factors that predict an ED visit. However, the majority of those seen in the ED for asthma are not admitted to hospital and an understanding of risk factors for an ED visit is incomplete.

1.6 Patient Characteristics

1.6.1 Characteristics of the Outpatient Asthmatic

Many asthmatics receive treatment for their asthma from a respiratory specialist in an outpatient clinic. Referral to an outpatient clinic may occur either after an ED visit or if the patient's response to personal treatment is unsuccessful (91). In a descriptive study of outpatients Bailey et al. noted that the adult asthmatic who receives outpatient care in a clinic setting was typically female (66.4%) and that the most common co-morbidity was hypertension (22%). Most outpatients took 2-3 medications, 35% received more than one course of steroids per year (142). Severity of asthma dictated the use of continuous theophylline and the use of more than one course of steroids. Less than half of the patients adhered to the recommended medication regimen and only about 1 patient in 6 used an inhaler correctly. Airflow obstruction, fatigue, irritability and panicky reactions to asthma attacks were common (142). Patients with milder degrees of this disease tended to be diagnosed more recently.

No relationship has been found between asthma severity and education level, number of children, employment status, smoking status or exposure to passive smoking. Nearly half of the study patients had visited an emergency department, had

been hospitalized or had done both for a respiratory problem within the previous year. All forms of health care were used more by patients with more severe asthma (142). A limitation of this research to date is the inability to discern whether these characteristics differ from the pool of asthmatics who do not attend outpatient clinics and whether the differences between the two groups impact on asthma management.

1.6.2 Characteristics of the potentially fatal asthmatic

Some asthmatics are at greater risk of dying from asthma than others. The potentially fatal asthmatic has been described as one who may present at hospital in respiratory arrest and has had a long history of the disease, previous life-threatening attacks or hospitalizations, delays in obtaining medical care and sudden onset of a rapidly progressive crisis (140). The authors concluded that under-treatment in these young to middle aged individuals was a potential contributor to the increase in mortality from asthma. Patients who have had multiple hospitalizations, ICU admissions and longer lengths of hospital stay have also been noted as more likely to die from asthma (143). Additional diagnostic indicators for potentially fatal asthma (PFA) include: intubation for respiratory arrest/respiratory failure, acute respiratory acidosis without intubation and hospitalization for status asthmaticus (143). Of those hospitalized for asthma about 4% are admitted to the ICU, 70% of these are women, most are under 30 years of age (144,145). Analyses of asthma deaths indicate that the majority could have been prevented by improved treatment, greater compliance by the patient to medication and better attention by the patient to deteriorating control of asthma (113,146).

In a study of adult patients with asthma admitted to hospital the most common event that triggered an exacerbation warranting emergency hospital care was an upper respiratory tract infection (86). The duration of asthma symptoms prior to hospitalization of the victim was between 2.3 and 4.6 days (86).

Patients experiencing difficulty controlling their asthma as well as those who experience a near fatal event can be helped through rigorous assessment and follow up (147). Those who have difficulty controlling their asthma may be at risk of a near fatal attack and may require long term prednisone to remain functional. Factors that contributed to difficulty controlling asthma include gastroesophageal reflux, failure to use prescribed inhaled corticosteroids, poor compliance with medication regimes, exposure to environmental stimuli, poor inhaler technique and having a co-morbid condition such as COPD (147). Gastroesophageal reflux disease (GERD) was the most common factor that contributed to making patients' asthma difficult to control. GERD may theoretically worsen asthma by the mechanisms of aspiration, or stimulation of esophageal receptors which may lead to reflex bronchoconstriction or increased bronchial hyperreactivity. Reversing the symptoms and frequency of difficult-to-control asthma required a commitment to detail and perseverance by both patient and

physician to establish a treatment program including use of inhaled corticosteroids and treatment of gastroesophageal reflux (147). The results of this study are encouraging for the difficult-to-manage asthma patient. However, since the study relied on intensive medical management and frequent visit to the doctor the potential for misinterpretation of the results exists. It is difficult to separate or account for the effect that constant medical attention may have had on improving asthma control compared to the results from the same program but with less intensive medical attention.

1.6.3 Patient Compliance and Physician Interaction

The importance of patient compliance to asthma medication should be intuitive but appears to be poorly understood by both asthmatic and clinician (1136). It has been repeatedly documented that asthmatics avoid medical care until they are in extremis; perhaps indicating a lack of parental and patient understanding of the potential lethality of asthma (80,136,139,148). Sly has commented that "it is difficult to avoid the conclusion that many doctors fail to grasp the vital importance of decisive drug therapy in severe asthma" (3). For those with chronic diseases such as hypertension, diabetes, and asthma, medication compliance rates generally reveal that 1/3 of patients comply adequately, 1/3 have variable compliance and 1/3 are non compliant (149). Strategies for improved compliance must include educating both the clinician and the patient (149) .

Poor patient compliance and lifestyle factors may increase the risk of asthma morbidity and death (2,147,150-152). In a retrospective study of 108 asthma fatalities, 39% of asthmatics were non-compliant (either by overuse or insufficient use of an inhaler), a rate similar to that reported by others but less than some reported noncompliance rates ranging to 78% (74,113,139,153).

Many beta 2-agonist bronchodilators are prescribed for use as required according to activity and current health. In a study of 88 asthmatic inpatients only 33% appropriately used their "as required" drugs; 20% overused them, 20% underused them and 27% used them in an erratic and arbitrary fashion. This suggests that patient education should be directed to the use of "as required" prescriptions and increased attention be given to compliance/knowledge of appropriate medication schedules (152).

Patients often find medical regimens complicated, inconvenient, embarrassing or expensive. Particularly for chronic disorders, the short-term disadvantages appear to outweigh the long-term advantages. Non attendance at appointments and lack (or loss) of responsiveness to a usually adequate dose of treatment often identifies a non-complier. Questioning the patient in a non-threatening, non-judgemental manner typically reveals the degree of compliance (154).

1.6.4 Psychological and Social Factors in Asthma

The effect of psychological and social factors on the development and exacerbation of asthma has been discussed in the literature (155-158). Two issues seem to be defined in the literature and are of note:

1. Respiratory symptoms are not exclusive to the asthmatic population.
2. Psychopathology of itself is not caused by asthma (155-158).

To determine the influence of psychological status on respiratory symptoms, 600 healthy (non asthma) individuals completed the American Thoracic Society respiratory symptom questionnaire and the Psychiatric Symptom Index (PSI) (159,160). A relationship was found between respiratory symptoms and the SI subscales of anxiety, anger, depression and cognitive disturbance. Population studies using respiratory symptoms as indicators of pathophysiology may be biased because subgroups with psychopathology are more likely to report respiratory symptoms (155).

Pre-existing psychology needs to be accounted for in interpreting psychological scales in asthmatics. Asthmatics may be no more likely than the 'normal' population to suffer psychopathology (157). Asthmatics show no increased prevalence of neurotic personality disorders compared to the general population, and the extent of neurotic personality disorder is unrelated to the severity of bronchial asthma (158). However, asthmatics with severe disease may be more prone to depression (161). The group of variables that best explained poor respiratory function in 51 adults with asthma included age, duration of asthma, FEV1, severity as judged by a physician and Minnesota multiphasic personality inventory-depression score (MMPI-Depression) (161). Although this study relied on 17 variables to explain 68.5% of the variance between 51 patients the authors suggested that the relationship between depression and asthma severity was authentic. It remains to be determined if those seen in the ED are more depressed than others with asthma.

Asthma has been thought of as a psychiatric disorder although little scientific evidence exists to suggest that this is the case (162). Various personality traits or behavioral styles have been proposed as representative of the asthmatic, however, study results are not consistent (162).

Effective control of asthma must address attitude, personality and disease severity. Although psychiatric abnormalities do not cause asthma, the patients' psychology may play a role in management of the disease. Personality, for example, may play a role in adapting and coping with the disease. Moreover, it is recognized that emotional stress can trigger an asthma attack, much like other triggering factors such as allergens or upper respiratory tract infections (74).

1.6.5 Attitude Toward Disease

Individual characteristics and attitudes influence the management of a chronic illness, in particular the compliance with medication usage (152). Kinsman administered the MMPI (Minnesota Multiphasic Personality Inventory) to 85 asthmatics of comparable disease severity to determine the nature of their noncompliance (152). Patients who under-used PRN (take as needed) medications presented little psychological distress and claimed to be better able to cope with problems in living, felt less alienated and were less introverted than other patients. Patients who under-used their PRN medication also held unrealistic attitudes about their illness and were at high risk for treatment failure. Patients who overused PRN medications were in considerable psychological distress, felt alienated, were introverted and more likely to respond to breathing difficulties in an anxious, dependent and helpless way. This patient style contributed to intensified medical treatment. Patients who used PRN medication in an arbitrary way were similar to patients who overused PRNs. They felt alienated from others, introverted, anxious, dependent, and helpless regarding breathing difficulties. Arbitrary PRN usage may have mis-lead the physician about a patients illness thereby providing the patient with less assistance than required when airway obstruction was present. The relationship between PRN use and visits to the ED for asthma treatment may be important (152,163).

The relationship between attitude toward disease and disease management may be relevant to understanding the ED asthmatic. The Asthma Opinion Survey was designed to measure attitudes related to self-management in adult outpatients which may in turn contribute to patient morbidity and mortality (164). Attitudes toward self-management varied with demographic characteristics, asthma severity, and intensity of health care utilization. Psychological characteristics related to self management were reflected in three factors; vulnerability, perceived quality of care, and recognition and control (164). If psychology and attitude characteristics distinguish the emergency department asthmatics from other asthmatics then knowledge of these factors would be essential for the design of relevant education programs.

1.7 Summary

Current research on asthma has provided some insight into potential triggers, potential benefits and harms of medication and some description of the individuals most apt to be seen in the ED or admitted to hospital. Much of our current knowledge on asthma stems from clinical or descriptive studies. Clinical studies are often limited in their generalizability by small sample sizes which include either broadly heterogeneous participants (e.g. age 16 months to 76 years)(134,143) or very select

homogeneous patient samples (e.g. all boarding school boys between the ages 6-14)(118,139). The descriptive studies often have larger sample sizes and are able to describe the characteristics of the asthmatic in relation to demographic factors and lifestyle (64,68,141). The descriptive studies common to asthma research are limited in their ability to compare and contrast the emergency department or potentially fatal asthmatic with other asthmatics or control individuals.

A comparison between the individual seen in the ED for asthma with those in the community who suffer from asthma is important to understand the relative importance of some of the risk factors that currently arise from studies that describe the ED asthmatic. As well, understanding these factors will allow education to be targeted towards areas that are amenable to change.

Excessive need for ED management for the treatment of asthma is expensive in terms of health care resources, lost productivity, and reduced quality of life. The present study describes the population of asthmatics who use the emergency department for treatment and brings to light factors that may discriminate the ED asthmatic from the general population of asthmatics. Of interest are demographic factors, lifestyle issues and feelings of vulnerability.

Results from this study will provide information on the types of individuals seen in the ED for asthma treatment in order that programs aimed at improving quality of life and asthma control can be designed. Additionally, reducing emergency department usage could reduce health care costs.

2.0 OBJECTIVE

To determine risk factors associated with an exacerbation of asthma serious enough to warrant an ED visit by comparing those who sought treatment for asthma in the emergency department, ED cases, to a random sample of people with asthma from the same communities, RDD controls (Random digit dialling).

3.0 METHODS

3.1 Design overview

An unmatched case-control study was implemented from 1992 to 1993 at the University of Alberta Hospital in Edmonton and the Lethbridge Regional Hospital in Lethbridge, Alberta. Emergency department asthma cases aged 5-50 years, identified through emergency department records, were compared to controls with asthma acquired through random digit dialling (RDD) in the two communities. Of interest were comparisons of cases and controls for age, sex, and other demographic variables, and characteristics of their disease (e.g. severity).

3.2 Ethics

The study was given ethical approval by the University of Alberta, the University of Alberta Hospital and the Lethbridge Regional Hospital. All participants were notified that the information was confidential and would not impact on quality or type of care. Parents were asked to complete questionnaires for participants aged 5-16. A copy of the study information sheet and the consent form was located at the start of the questionnaire (Appendix 7.1)

3.3 Selection of Study Hospitals

We took advantage of an ongoing ED study at the University of Alberta Hospital in Edmonton which was interested in evaluating ED treatment for asthma. The same study group was used and the objectives were expanded. The University hospital is a large tertiary care facility in the city of Edmonton (population 654, 000). The Lethbridge Regional Hospital (LRH) was selected as a complement to the University Hospital in Edmonton. LRH services the city of Lethbridge (pop 60,000) in southern Alberta and surrounding rural areas. LRH is a full service facility that treats both pediatric and adult patients. Study information was provided by letters, memos and through meetings with the emergency department staff after ethics approval was obtained at both hospitals. These meetings described the study to hospital staff and encouraged their support.

3.4 Case Identification

The cases were identified as those persons aged 5-50 seen in the emergency department for asthma at University of Alberta Hospital in Edmonton between October, 1992 and June 1993 or at the Lethbridge Regional Hospital between July, 1993 and October 1993. The age range of 5-50 was selected to minimize diagnostic difficulties, including those associated with co-morbidity such as chronic obstruction pulmonary disease. Cases were required to have sought treatment for asthma, and to have a discharge diagnosis from the emergency department for asthma. The need for a discharge diagnosis of asthma was important to reduce the chance that individuals with other respiratory disorders were included. As well, a preliminary diagnosis of bronchitis or cough might have been inaccurate after examination by the attending physician. Cases were identified from emergency department records, contacted by phone within 5 days of their visit, and invited to participate in the study by completing a mailed out questionnaire. Follow up by phone and mail was required to encourage questionnaire return.

Despite rigorous follow-up some individuals could not be located, often because they had given an incorrect address and phone number in the emergency department (detailed information in 4.1.1 and 4.2.1).

3.5 Control Recruitment

Unmatched controls between the ages of 5-50 were identified through random digit dialling (RDD). Comparison of this group with the emergency department cases permits evaluation of the objective noted above.

Numbers for random digit dialling were obtained through the Population Research Laboratory (PRL) at the University of Alberta. The PRL maintains a listing of all assigned five-digit prefixes for Alberta (i.e., the first five digits of the seven-digit telephone number). For each of the two area, Lethbridge and Edmonton, random telephone numbers were generated by first randomly selecting a five digit prefix that was in service for those areas. The last two digits were then generated randomly and added to the prefix. The numbers were not sorted according to prefix, but rather were kept random and bundled into groups of 30. The 30 numbers were exhausted before beginning a new group of numbers. When sufficient numbers of controls had been identified the RDD procedure halted.

Each number was dialled a minimum of 9 times on different days at different times before it was considered exhausted. If an individual with doctor diagnosed asthma between the ages of 5-50 lived in a home that was contacted they were asked to participate in the study by completing the same questionnaire as the ED cases. The individual was not excluded if they had visited an ED for asthma as this was considered representative of the community of those with asthma, although this may

bias results towards the null. If more than one asthmatic lived in the home then the individual with the birthday closest to the phone recruitment date was invited to participate. Only one participant per household was permitted. The questionnaire was mailed out and followed up through letter and telephone reminders. If the asthmatic did not return the questionnaire a second mail out was offered and finally, a telephone interview was attempted. Recruitment of population asthmatics through random digit dialling began in the spring of 1993.

Results of the RDD recruitment are presented in Table 3.1. Of the 6425 phone numbers exhausted 275 asthmatics were recruited (4.3%). No information on those who refused to participate is available, however non-participants are likely to be different than participants. Non-participant have been noted to be different in basic levels of motivation and attitudes towards health, for example, non-participants may be more likely to smoke (149). The effect of these differences impacts the generalizability of the results, however the refusal rate in this study was less than 1.0%, providing confidence that the sample obtained through RDD is relatively representative.

The population prevalence of asthma is these two areas was slightly different, the prevalence rate for Edmonton of 5.6%, is slightly higher than the rate of 4.8% for Lethbridge (18). The provincial crude rate of 5.4% is slightly higher than the 4.3% obtained through RDD and could represent the 'clustering' of asthma in families which would be masked given the limit of one participant per family in this study.

Table 3.1

Outcome of random digit dialling for Edmonton and Lethbridge

Outcome	Edmonton		Lethbridge		Total	
	n	%	n	%	n	%
Residential						
Asthmatic	208	3.9	67	6.1	275	4.3
Asthmatic refuse	31	0.6	3	0.2	34	0.5
No asthmatic	1882	35.3	342	31.4	224	34.6
Refusal to answer	54	1.0	5	0.4	59	0.9
Language problem	31	0.6	2	0.1	33	0.5
Child's telephone	2	0.0	0	0.0	2	0.0
Out of age range	368	6.9	163	15.0	531	8.3
Non Residential						
Fax	222	4.2	34	3.1	256	4.0
Business	942	17.7	143	13.1	1085	16.9
Others						
Not in service	1451	27.2	322	29.5	1773	27.6
No success	144	2.7	9	0.8	153	2.4
Total	5335		1090		6425	

3.6 Questionnaire

The questionnaire was designed to be completed by asthmatics who were identified either through the ED or RDD (Appendix 1).

The questionnaire was lengthy and comprehensive and dealt with asthma history, asthma severity, medication use, pets and smoking. In addition, issues of vulnerability, recognition & control of disease, and characteristics of the home environment were explored. The questionnaire took between 45-75 minutes to complete.

The questionnaire was drafted by a group of physicians, epidemiologists and asthma experts. The sections on smoking, home environment and attitude toward disease have been validated in other studies (164,165). The final format was edited by a graphic artistic with the Government of Alberta who had expertise in questionnaire design.

The questionnaire was pre-tested in a pilot study at the Foothills Hospital and Alberta Children's Hospital in Calgary. The pre-test results were used to resolve unclear wording and to determine user friendliness.

3.7 Scales Derived from Questionnaire

The questionnaire was designed to assess compliance to medication and asthma knowledge. Questions which dealt with these issues were designed with the assistance of many clinicians and researchers and they were included in the questionnaire at the design and pre test stage. Cronbach's alpha coefficient was used to measure the internal consistency between the items in the scale. Cronbach's alpha allows for the determination of the degree of association between variables and was used to assist in deriving reliable scales for measuring compliance to medication and asthma knowledge. Because items that represent the same concept should show high intercorrelations, a measure of internal consistency is useful. Inter-item reliability coefficients such as coefficient alpha depend on the consistency among the items and the number of items (166,167). A very reliable scale would have an alpha value of 0.80, indicating high intercorrelation among the variables (167). However, an alpha value that is too high may indicate redundancy among the items and judgement may be required for interpretation (167).

3.7.1 Compliance Scale

Compliance to generally recognized measures for asthma control was assessed through questions on the use of medication, smoking habits and indoor household pets. The preliminary scale was evaluated with 6 questions (see 3.7.2 or Appendix 7.1).

The relationship between the variables was assessed through using Cronbach's alpha and the highest coefficient was obtained by selecting the 3 questions related to medication use. The reliability coefficient (Cronbach's alpha) was 0.68, which is reasonably high.

The most compliant answer to the questions was arbitrarily awarded 2 points, as noted in front of the preliminary questions below. The questions shown to be most highly correlated were 25-27 and these were selected for a scale on compliance. The questions deleted did not reflect the same underlying construct and if included would have reduced the reliability. The overall mean score on the scale was 3.6 and the range was 0-6. The scores were categorized, low = 0-3 and high = 4-6. High scores indicated good compliance.

3.7.2 Preliminary questions for developing a scale on compliance

25. Please tell me which statement best describes you.
    2 I take my medications exactly as directed by the doctor
    0 I find a somewhat different dose schedule is best for me.

26. How does your dose schedule for bronchodilators differ from the schedule suggested by your doctor or pharmacist?
    2 use medication exactly as directed
    0 usually use more medication than directed
    0 usually use less medication than directed
    2 do not use the medication at all*

27. How does your dose schedule for inhaled steroids differ from the schedule suggested by your doctor or pharmacist?
    2 use medication exactly as directed
    0 usually use more medication than directed
    0 usually use less medication than directed
    2 do not use the medication at all

47. Have you seen a family doctor for your asthma in the last 12 months?
    0 no
    2 yes

67. Do you currently smoke cigarettes? (former smoker categorized as non-smoker for this comparison)
    2 no
    0 yes

105. Do you currently live with a pet in the house? (modified, derived from question 105 in Appendix 1).
    2 no
    0 yes

* no penalty was levied against those who had not been prescribed the medication

3.7.3 Asthma Knowledge Scale

Knowledge about asthma was assessed by questions on how medications work, use of antibiotics for the control of asthma and the potential lethality of asthma. A scale was developed from 5 questions, of which 4 were selected after the reliability analysis (see 3.7.4 or Appendix 1). The resulting Cronbach's alpha was 0.57 suggesting satisfactory reliability. The final scale included questions on how corticosteroids and bronchodilators work, the use of antibiotics to control asthma and the potential lethality of asthma. Question 110 on whether or not asthma could be cured did not correlate with the other questions and was excluded from the final scale. Each correct response was awarded 2 points,as indicated in front of the statement below, high scores reflected an understanding of asthma.

The final components of the scale: questions 107, 108, 109, 111, generated the highest alpha coefficient. The overall mean score on the scale was 4.6, the range was 0-8. The variable was broken down into three groups by score; low = 0-4, moderate = 5,6 high = 7,8.

3.7.4 Preliminary questions for developing a scale on asthma knowledge

107. How do you think bronchodilators work?
    2 relax the muscles in the airways
    0 decrease inflammation
    1 relax muscles in airway and decrease inflammation
    0 don't know
108. How do you think corticosteroids work?
    0 relax the muscles in the airways
    2 decrease inflammation
    0 relax muscles in airway and decrease inflammation
    0 don't know
109. Do you think antibiotics control asthma?
    2 no
    0 yes
110. Do you believe that asthma can be cured
    2 no
    0 yes
111. Do you believe that some asthmatics are at a greater risk of dying of asthma than other asthmatics?
    0 no
    2 yes

3.8 Recognition& Control and Vulnerability

The Asthma Opinion Survey is a 18 question 5 point Likert scale that was designed and validated by James Richard and addresses issues of 'vulnerability', and 'recognition & control' and 'quality of care' (Appendix 1, question 113) (164). Twelve questions relating to the first two constructs, 'vulnerability' and 'recognition & control' were evaluated. The variables were scored as per the original questionnaire, high scores indicating the presence of the factor (164). Questions related to the area of vulnerability included issues of general and specific vulnerability, pain-fear, personal impact and social impact. Six questions related to vulnerability for a maximum score of 30. The overall distribution of scores for vulnerability was 6-28, mean score was 14.7 and the variable was dichotomized into high and low at a score of <=15.

As defined by Richard' recognition of airway obstruction and sense of control were considered a single construct 'recognition & control'. Six question were related to recognition & control for a maximum score of 30. The overall distribution of scores for recognition & control was 7-30, the mean score was 22.4 and the variable was dichotomized at <=20.

Analysis of the recognition & control variable was limited to those over 15 years, and to those over 19 years for scores on vulnerability to exclude proxy response.

3.9 Sample Size

This case-control study examined the association of several variables with emergency department visits for asthma. The projected feasible sample size was set at 165 cases and 165 controls. This would have resulted in detectable odds ratios near 2.0 with alpha = 0.05 (two sided), and beta of 0.20 (power 80.0%). In fact, 337 cases and 212 RDD controls were recruited resulting in detectable odds ratios between 1.66 and 1.87. Calculation of adequacy of sample size was based on four variables whose prevalence amongst the control group in a pilot study varied widely (Table 3.2). A post hoc power calculation was completed when the final sample sizes were established for Lethbridge and Edmonton (Table 3.3)

Table 3.2 Calculation of adequacy of sample size

Variable	Expected prevalence in asthma controls	Lowest detectable odds ratio 165 per group	Lowest detectable odds ratio 337 cases, 212 controls
Smoking	17%	2.15	1.87
Food Allergies	25%	2.00	1.74
Antihistamines	31%	1.95	1.70
Eczema	45%	1.90	1.66

Table 3.3 Post Hoc Power Calculation

Variable	Expected prevalence in asthma controls	Lethbridge Lowest detectable odds ratio 175 cases 51 controls	Edmonton Lowest detectable odds ratio 122 cases, 161 controls
Smoking	17%	3.00	2.35
Food Allergies	25%	2.70	2.15
Antihistamines	31%	2.60	2.10
Eczema	45%	2.55	2.00

Data Management and Analysis

Questionnaires were reviewed manually for consistency and appropriate codes prior to data entry. All data were entered twice into SPSS-DE and discrepancies resolved (174). The data were edited, checked for appropriate codes and outliers, and for normality of the distributions of continuous variables.

Initial exploratory univariate and bivariate analyses examined case-control differences using odds ratios and comparisons of means. To estimate the magnitude of the association between the exposure and the disease the odds ratio was calculated according to the formula ad/bc (Table 3.4).

When there was a gradient in the data the Mantel Haenszel test for linear trend was used. Multivariate analysis was accomplished using unconditional logistic regression. Epi info 6.0 (168) was used for determining the odds ratios and confidence intervals (Cornfield method) in the stratified analysis. When cell sizes were small and in all stratified and Lethbridge analyses Fisher's Exact test was used. SPSS/PC for Windows was used for crosstabs and logistic regression (174).

Table 3.4

Two by two table for the calculation of odds ratios

		Disease	
		yes	**no**
Exposure yes		a	b
Exposure no		c	d

3.11 Justification of Self Reported Severity

There is a lack of consensus among epidemiologists and clinicians on measures of asthma severity (96). Sufficient information to establish the severity of current asthma symptoms was not available in a review of 11 published asthma questionnaires (96). The authors suggest that " in the absence of a 'gold standard' test that defines the presence or severity of asthma the 'reliability' of asthma outcome

measures must be assessed in terms of their conformity with other measures that reflect the presence or severity of asthma "(96). Hence, the relationship that self report of asthma severity had with other potential measures of asthma severity, including use of inhaled steroids, health care utilization and increased use of asthma medication was determined (3.11.1). Use of inhaled steroids was considered to be marker for asthma severity and was also compared to the other indicators of severity (Table 3.3). As well, the internal consistency of the self report of asthma severity was assessed by comparing it to a number of factors known to be associated with asthma severity such as use of inhaled steroids. The results presented in Table 3.3 suggest that there is internal consistency between self report and use of inhaled steroids. These findings concur with published findings indicating that objective markers of asthma severity generally correlate with self report (169).

The relationships between markers of severity and self report were found to be the same for both the ED case and RDD control groups suggesting self report of severity was not a marker of something else such as health care utilization (Table 3.4).

3.11.1 Questions for assessing self-reported severity

The questions selected as other markers of disease severity included (see also Appendix 1) :

12. In a week when you are not having problems with your asthma, how often do you have symptoms such as coughing, wheezing or chest tightness?

1=not at all
2=only with exercise
3=1-2 times week
4=3-4 times a week
5=5 or more times per week

14. In the last 12 months did you need to go to the emergency room for your asthma?

1= no
2= yes ___ how many times?

15. In the last 12 months did you need to increase you medication(s) to control your asthma?

1= no
2= yes

24.
Did you use an inhaled steroids in the last month ?

1= none
2= occasionally

3= every day

Did you use an inhaled steroids in the last 12 months?

1= none

2= occasionally

3= every day

Did you use a bronchodilator last month?

1= none

2= occasionally

3= every day

50. Have you ever needed to go to the ED to get help for your asthma?

1= no

2= yes

Table 3.5

Self reported severity and its relationship to markers of severity

		Self reported severity						
		Mild		Moderate		Severe		MH linear
		n	%	n	%	n	%	association
Variable								
Symptom frequency	**none****	107	61.5	113	49.8	23	38.3	22.95
	1-4/week	58	33.3	84	37.0	18	30.0	p=0.000001
	5 +/week	9	5.2	30	13.2	19	31.7	
Inhaled steroid last year	**none**	93	61.2	81	36.7	10	16.4	62.13
	occasional	46	30.3	74	33.5	17	27.9	p=0.000001
	daily	13	8.6	66	29.9	34	55.7	
Inhaled steroid last month	**none**	77	64.7	77	37.4	8	12.9	58.42
	occasional	23	19.3	39	18.9	12	19.4	p=0.00001
	daily	19	16.0	90	43.7	42	67.7	
Use beta-agonist last month	**none**	21	17.1	18	8.5	1	1.6	70.76
	occasional	78	63.4	87	40.8	6	9.7	p=0.000001
	daily	24	19.5	108	50.7	55	88.7	
Need to increase medication last year	**no**	137	69.5	80	33.5	6	9.1	93.65
	yes	60	30.5	159	66.5	60	90.9	p=0.000001
Use of ED in last year	**no**	107	54.0	78	32.4	6	9.1	48.24
	yes	91	46.0	163	67.6	60	90.9	p=0.000001
Ever to ED for asthma	**no**	68	34.3	32	13.3	3	4.5	38.83
	yes	130	65.7	209	86.7	63	95.5	p=0.000001

** no symptoms or symptoms only with exercise

Table 3.6

Self reported severity and its relationship to markers of severity; stratified on case/control (ED/RDD) status

ED cases

		Self reported severity						
		Mild		Moderate		Severe		MH linear
Variable		n	%	n	%	n	%	association
Symptom frequency	none**	50	61.7	76	51.4	20	40.8	12.55
	1-4/week	28	34.6	50	33.8	15	30.6	p=0.0004
	5 +/week	3	3.7	22	14.9	14	28.6	
Inhaled steroid last year	none	34	44.7	45	31.9	7	14.9	27.10
	occasional	32	42.1	52	36.9	11	23.4	p=0.000001
	daily	10	13.2	44	31.2	29	61.7	
Inhaled steroid last month	none	32	50.8	46	32.9	6	12.2	27.28
	occasional	15	23.8	28	20.0	6	12.2	p=0.000001
	daily	16	25.4	66	47.1	37	75.5	
Use beta-agonist last month	none	7	10.4	7	4.7	1	2.0	40.12
	occasional	42	62.7	56	37.8	4	8.2	p=0.000001
	daily	18	26.9	85	57.4	44	89.8	
Need to increase medication last year	no	52	59.1	42	27.3	4	7.8	42.30
	yes	36	40.9	112	72.7	47	92.2	p=0.000001
Use of ED in last year^^	no	61	69.3	71	45.8	10	20.0	49.26
	yes	27	30.7	84	54.2	40	80.0	p=0.000001

** no symptoms or symptoms only with exercise

^^ excluding the index visit

Table 3.7 **Self reported severity and its relationship to markers of severity; stratified on case/control (ED/RDD) status**

RDD controls

Self reported severity

Variable		Mild n	Mild %	Moderate n	Moderate %	Severe n	Severe %	MH linear association
Symptom frequency	**none****	57	61.3	37	46.8	3	27.3	10.65
	1-4/week	30	32.3	34	43.0	3	27.3	p=0.001
	5 +/week	6	6.5	8	10.1	5	45.5	
Inhaled steroid last year	**none**	59	77.6	36	45.0	3	21.4	27.42
	occasional	14	18.4	22	27.5	6	42.9	p=0.000001
	daily	3	3.9	22	27.5	5	35.7	
Inhaled steroid last month	**none**	45	80.4	31	47.0	2	15.4	23.66
	occasional	8	14.3	11	16.7	6	46.2	p=0.000001
	daily	3	5.4	24	36.4	5	38.5	
Use beta-agonist last month	**none**	14	25.0	11	16.9	0	0.0	21.58
	occasional	36	64.3	31	47.7	2	15.4	p=0.000001
	daily	6	10.7	23	35.4	11	84.6	
Need to increase medication last year	**no**	85	78.0	38	44.7	2	13.3	36.33
	yes	24	22.0	47	55.3	13	86.7	p=0.000001
Use of ED in last year	**no**	103	93.6	71	82.6	5	33.3	28.51
	yes	7	6.4	15	17.4	10	66.7	p=0.000001
Ever to ED for asthma	**no**	67	60.9	32	37.2	3	20.0	15.84
	yes	43	39.1	54	62.8	12	80.0	p=0.00007

** no symptoms or symptoms only with exercise

Conclusion

Self report of asthma severity regardless of group membership relates to a variety of asthma measures that reflect disease severity and was a reasonable way to categorize disease severity in individuals with asthma.

4.0 RESULTS

As the project was undertaken at two sites the results of the study from each site will be presented independently, first the results from Edmonton and then the results from Lethbridge.

The first section for each site discusses the representativeness of the respondents. The non-respondents were compared to the respondents for demographics to determine the possibility of non-response bias.

The second section for each site compares the ED group to the RDD group. The groups were characterized and compared based on demographics, asthma severity, education, home environment, medication use, compliance to preventive measures, asthma knowledge, and vulnerability. To increase power the complete ED group were compared with the complete RDD group for variables unlikely to be affected by location, such as gestational age. The most salient case-control differences were noted.

The analysis was initially completed separately for Edmonton and Lethbridge. The statistical significance of the results will be described as follows:

for 2 * 2 tables the chi square test was used

for 2 * 3 and 2* n tables the chi square test for trend was always used when the independent variable implied a gradient, and the 'p' value was noted when significant.

The stratum specific odds ratios were calculated using Epi Info 6.0 by comparing the strata back to the baseline (168). Fisher's Exact test was used for the stratified analysis, this was particularly important when the cell sizes were small, as in the Lethbridge data.

Logistic regression was used to evaluate confounding and interaction between independent variables and to develop a parsimonious model that would distinguish the cases from the controls. Site of data collection was controlled in the regression.

4.1 Edmonton Emergency Department and RDD

4.1.1 Response and response characteristics of ED participants

Of a potential 162 ED participants, 122 (75.3%) completed questionnaires, there were no gender differences in completion rates (Table 4. 1), nor were there differences in participation rates across age groups (Table 4.2). Of the forty that did not participate, half were lost to follow up, the remaining half initially agreed to participate but despite follow up, did not return questionnaires.

Table 4.1

Comparison of responders and non-responders by gender for Edmonton ED

	Male		Female	
	n	%	n	%
Responders	60	78.9	62	72.1
Non-responders	16	21.0	24	27.9
Total	76	100	86	100

Chi-square 1.02 p=0.315

Table 4.2

Comparison of responders and non-responders by age group for Edmonton ED

Age group	**5-14**		**15-29**		**30+**	
	n	%	n	%	n	%
Responders	46	78.0	50	70.4	24	80.0
Non-responders	13	22.0	21	29.6	6	20.0
Total	59	100	71	100	30	100

Chi square 1.47 p=0.48

note: missing age data on 2 responders

4.1.2 Response and response characteristics of RDD participants

Of the 208 asthmatics obtained through RDD who agreed to participate, 161(77.0%) returned completed questionnaires. There were no differences in participation rates across gender or age groups (Table 4.3, Table 4.4). All those who participated had received a diagnosis of physician diagnosed asthma. No information was available from 31 RDD contacts who admitted to having asthma but refused to participate or to provide information on age or gender. An overall response rate of 161/239 (67.0%) would be accurate if all of the 31 who did not provide any information met the study criteria of physician diagnosed asthma and were between the ages 5-50.

Table 4.3

Comparison of responders and non-responders by gender for Edmonton RDD

	Male		Female	
	n	%	n	%
Responders	81	77.9	80	77.7
Non-responders	23	22.1	24	22.3
Total	104	100	104	100

chi square 0.04 p=0.839

Table 4.4

Comparison of responders and non-responders by age group for Edmonton RDD

Age group	5-14		15-29		30+	
	n	%	n	%	n	%
Responders	49	80.3	62	84.9	50	82.0
Non responders	12	19.7	12	15.1	11	18.0
Total	61	100	74	100	61	100

chi square 0.24 p=0.889
note: missing age data on 12 non-responders

We concluded that responders and non-responders for both ED and RDD were comparable by age and gender which supports representativeness of the sample.

4.1.3 Age and gender comparisons for Edmonton ED and RDD participants

In both the ED and RDD groups there were more males than females in the 5-14 age group and the opposite was seen in the older age groups ($p<=0.01$). This may reflect what is generally described, there are more young males than young females diagnosed with asthma (148). However there was no significant difference in the age distribution among males or among females between the ED and RDD groups (Table 4.5). Eighty six percent of the ED group and 88.8% of the RDD group were Caucasian .

Table 4.5

Comparison of age and gender distribution between ED and RDD participants for Edmonton

Age	Male				Female			
	ED		RDD		ED		RDD	
	n	%	n	%	n	%	n	%
5-14	30	47.6	33	40.7	16	27.1	16	20.0
15-29	16	25.4	30	37.0	30	50.8	32	40.0
30+	17	27.0	18	22.2	13	22.0	32	40.0
Total	63	100	81	100*	59	100	80	100.0

4.1.4 Background Characteristics

Of those in the ED group 37.7% were between the ages of 5-14 compared with 30.0% of the RDD group, as well, 24.6% of the ED group were age 30 or over compared with 31.1% of the RDD control group (not significant). Over 90% of the sample resided within city limits. There were significant differences in the amount of education completed by those age 25 or over. Those in the RDD group had completed more years of education then those in the ED group ($p<=0.05$) (Table 4.6). The cut off of 25 years was used to minimize problems associated with participants who were still in school.

Table 4.6

Comparison of background characteristics of ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Age Group						
5-14	46	37.7	49	30.0	1.00	
15-29	46	37.7	64	39.8	0.77	0.44,1.33
30+	30	24.6	50	31.1	0.83	0.46,1.51
Urban						
yes	113	92.6	155	96.9	0.41	0.11,1.37
no	9	7.4	5	3.1		
Education- over age 25						
grade 1-11	9	24.3	6	9.2	1.00	
grade 12 graduate	6	16.2	9	13.8	0.44	0.10,1.92
attend post secondary	6	16.2	14	21.5	0.29	0.07,1.17
finish post secondary	16	43.2	36	55.4#	0.30	0.09,0.97

* chi square (trend if appropriate) $p<=0.01$
# chi square (trend if appropriate) $p<=0.05$

4.1.5 Duration of Asthma Symptoms before Diagnosis

Those in the ED case group did not differ from those in the RDD group as to duration of symptoms of asthma before a clinical diagnosis was made (Table 4.7).

Table 4.7

Comparison of duration of asthma symptoms before diagnosis between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Duration of symptoms before diagnosis						
<1 month	20	21.1	16	14.4	1.00	
1-6 months	24	25.3	25	22.5	0.77	0.32,1.82
7-12 months	7	7.4	13	11.7	0.43	0.14,1.33
1 year or more	44	46.3	57	51.4	0.62	0.29,1.33

chi square not significant

4.1.6 Self Reported Asthma Severity and Frequency of Asthma Symptoms

All participants were asked about how severe their asthma was, mild was defined as interfering infrequently with normal lifestyle, moderate as occasional interference and severe as seriously interfering with a normal lifestyle.The comparison of self reported asthma severity revealed that those in the ED group were more likely than those in the RDD group to report having moderate or severe asthma (p<=0.01) (Table 4.8). There were no differences between ED and RDD participants with regard to frequency of asthma symptoms. There were no gender differences in symptom frequency or self report of severity between the ED and RDD groups (data not shown).

Table 4.8

Comparison of self reported asthma severity and frequency of asthma symptoms between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Self reported severity						
mild	20	16.0	85	51.0	1.00	
moderate	76	62.0	65	40.0	4.97	2.76,8.96
severe	26	21.0	13	8.0^	8.5	3.73,19.39
Symptom frequency						
none	30	25.0	43	30.7	1.00	
with exercise only	36	30.0	32	22.9	1.61	0.83,3.14
1-2 times/week	27	22.5	36	25.7	1.08	0.34,2.13
3-4 times/week	9	7.5	14	10.0	0.92	0.35,2.4
5 or more times week	18	15.0	15	10.7	1.72	0.75,3.94

^ chi square trend p<=0.001

4.1.7 Health Care Utilization and Medication Changes in the Past 12 Months

Deteriorating asthma control which could result in an ED visit for asthma may be evidenced by changes in medication or visits to health care providers. Seventy-five percent of those in the ED group increased their medication in the last 12 months compared with 40% of the RDD group ($p<=0.001$). Unscheduled visits to the doctor for asthma were made by 89.3% of the ED group, compared to 42.9% of the RDD group($p<=0.001$). Within the last 12 months 41% of the ED group compared with 22% of the RDD group had visited an asthma specialist ($p=0.001$)(Table 4.9). Only 23 (14.3%) individuals from the RDD group required ED treatment in the last 12 months for their asthma.

Some of these issues, such as increased medication in the last 12 months and frequency of ED visits were evaluated in the context of asessing the strength of self reported severity as a marker of disease severity, regardless of ED or RDD status. The data are presented here in the context of distinguishing between the ED and RDD asthmatic.

Table 4.9

Comparison of health care utilization and medication changes between ED case and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Increase medication in last 12 months						
yes	91	75.0	66	40.0	4.37	2.56,7.14
no	30	25.0	95	60.0^		
Saw family doctor for asthma in last 12 months						
yes	93	76.0	87	55.0	2.63	1.55,4.41
no	29	24.0	71	45.0^		
Unscheduled visit to the doctor for asthma in last 12 months						
yes	108	89.3	69	42.3	11.1	5.76,21.32
no	13	10.8	92	57.1^		
Frequency of ED visits in the last 12 months						
none/index only@	52	43.0	138	85.7	1.00	
1 times	30	24.8	13	8.1	6.12	2.97,12.64**
2-3 times	33	27.3	6	3.7	14.6	5.78,36.86
4-6 times	4	3.3	3	1.9	3.54	0.77,16.35
7 or more	2	1.7	1	0.6^	5.31	0.47,59.78

@no visit or only the visit where the ED asthmatic was recruited
^ chi square(trend if appropriate) p<=0.001
** Fisher's Exact test

4.1.8 Asthma Management Characteristics

Those who are seen in the ED may have different strategies for managing their asthma then those in the RDD group. Two strategies to monitor and improve asthma management include use of an action plan and/or a peak flow meter. Of those in the ED group 27% used a peak flow meter compared with 11% of the RDD group ($p<=0.01$), however use of action plans was almost evenly distributed between the groups (Table 4.10). The finding that those in the ED group are more likely to use a specialist and a peak flow meter may also reflect asthma severity, which in itself may be predictive of an ED visit. The finding that use of an action plan did not differ between the ED and RDD group may suggest that this tool was not advocated by health care professionals. It is likely that the questions related to use of a specialist and whether or not a respiratory doctor prescribes asthma medication measure the same thing.

Table 4.10

Comparison of several asthma management characteristics for ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Use of specialist						
yes	50	41.0	35	22.0	2.46	1.47,4.17
no	72	59.0	124	78.0*		
Use of action plan						
yes	16	13.2	17	10.8	1.25	0.57,2.75
no	105	86.8	140	89.2		
Use of peak flow meter						
yes	33	27.0	18	11.4	2.88	1.47,5.70
no	89	73.0	140	88.6*		
Respiratory doctor prescribes medicine						
yes	29	59.2	24	16.3	7.43	3.42,16.29
no	20	40.8	123	83.7*		

* chi square $p<=0.01$

4.1.9 Asthma Medication

Frequency and type of medication may distinguish between the ED and RDD asthmatics. Beta agonist bronchodilators were used 97.3% of the ED group and by 91.4% of the RDD group in the preceding year, however those in the ED group were more likely to use a beta agonist daily whereas those in the RDD group were more likely to report occasional use. Preparations containing theophylline, also a bronchodilator, were rarely used by the RDD group but were used by 40.4% of the ED group on either a daily or occasional basis (p=0.001). Anti-inflammatory medication, such as inhaled steroids, were used occasionally or daily by 68.7% of the ED group compared with 41.7% of the RDD group (p=0.001). Steroid tablets were used occasionally or daily by 59% of the ED group compared with 11.6% of the RDD group (Table 11).

Table 4.11

A comparison of asthma medication used in the last 12 months for Edmonton ED and RDD

	ED		RDD		OR	CI
	n	%	n	%		
Beta agonist						
none	3	2.7	11	8.6	1.00	
occasionally	50	45.5	83	64.8	2.21	.59,8.30
every day	57	51.8	34	26.6^	6.15	1.6,23.6
Bronchodilator + Theophylline						
none	51	58.6	114	89.1	1.00	
occasionally	14	16.1	6	4.7	5.22	1.9,14.35
every day	22	25.3	8	6.3^	6.15	2.57,14.73
Inhaled steroids						
none	31	31.3	74	58.3	1.00	
occasionally	33	33.3	31	24.4	2.54	1.33,4.84
every day	35	35.4	22	17.3^	3.8	1.9,7.48
Steroid Tablets						
none	39	41.1	114	88.4	1.00	
occasionally	47	49.5	15	11.6	9.16	4.16,18.18
every day	9	9.5	0	0.0^	26.31	3.23,214.35

^ chi square(trend if appropriate) p<=0.001

4.1.10 Compliance, Knowledge, Recognition & Control

Compliance, knowledge, and recognition & control were assessed as discussed in the methods section. Compliance refers to the participants' assessment of their use of medication compared with physician advice. Compliance for the whole group and for those 15 years of age and older was similar between groups (Table 4.12). Smoking was significantly more common among the RDD group. Of the 64 ED participants that kept indoor pets, 27 were dogs and 28 were cats, the remainder were birds or small mammals like hamsters. Of the 81 RDD participants that kept indoor pets 37 were dogs and 39 were cats, the remainder kept birds or small mammals.

Knowledge reflects the participants' general understanding of how asthma medications work and whether antibiotics control asthma. Asthma knowledge was assessed for those participants age 15 or over. Those in the ED group were more apt to score 50% or more compared to those in the ED group ($p=0.02$) (Table 4.12).

Recognition and control refers to the participants' ability to assess when an asthma exacerbation is beginning and what they can do to control the worsening asthma. Most participants in both the ED and RDD group scored above 21/30 on recognition and control of asthma.

Table 4.12

A comparison of compliance, knowledge, recognition&control between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Compliance-all ages						
Low	42	38.9	68	42.2	0.87	0.53,1.43
High	66	61.1	93	57.8		
Compliance (aged 15 and over only)						
Low (0-3)	31	38.3	34	35.4	1.13	0.61,2.09
High (4-6)	50	61.7	62	64.6		
Smoking (aged 15 and over only)						
non smoker	94	93.1	55	49.1	1.00	
former	1	1.0	26	23.2	0.02	0.00,0.17
current	6	5.9	31	27.7*	0.11	0.04,0.29
Indoor pets						
current indoor pet	64	39.5	81	50.3	0.65	0.41,1.00
no indoor pet	98	60.5	80	49.7#		
Knowledge (aged 15 and over only)						
low (0-4)	26	37.7	45	51.1	1.00	
moderate (5-6)	23	33.3	31	35.2	1.28	0.62,2.65
good (7-8)	20	29.0	12	13.6#	2.88	1.22,6.84
Recognition and control (aged 15 and over only)						
low (0-20)	18	24.7	26	29.9	0.77	0.38,1.55
high (21-30)	55	75.3	61	70.1		

* chi square p<=0.01
# chi square p<=0.05

4.1.11 Home Environment

To evaluate the role the current home environment plays in distinguishing between the ED and RDD asthmatic some comparisons were made between the two groups. There were no linear trends in age of home. Those in the ED group were less likely to have found mold on a surface (other than food) than those in the RDD group (p=0.01). This may suggest that those in the ED group were more vigilant about minimizing their exposure to mold, a known allergen. There were no differences in use of a humidifier between the groups (Table 4.13). Other comparison that were made and found not to differ between the groups include frequency of changing a furnace filter, renovating or changing a carpet in the past 12 months, type of heating, use of a wood fire place and use of a kerosene heater (data not shown).

Table 4.13

A comparison of the home environment between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Home Built						
before 1960	28	27.2	23	16.3	1.00	
1961-1970	18	17.5	27	19.1	.55	0.24,1.23
1971-1980	31	30.1	49	34.8	.52	0.26,1.06
1981+	26	25.2	42	29.8	.51	0.24,1.06
Mold found on surface						
yes	16	21.6	56	39.7	0.42	0.21,0.80
no	58	78.4	85	60.3*		
Use a humidifier						
yes	6	24.0	25	18.1	1.43	0.46,4.31
no	19	76.0	113	81.9		

* chi square p<=0.01

4.1.12 Triggering Factors for Asthma

Many substance have been reported to trigger asthma (34). In the following three tables common triggering factors have been reported and data presented on differences between the ED and RDD participants (Table 4.14, 4.15,4.16). In most instances the ED participants were not distinguished from the RDD participants on the basis of triggering factors. The ED asthmatics were more likely to report sensitivity to cold air, colds and flu, drugs, and stress (Table 4.14, 4.16).

Table 4.14

A comparison of some triggering factors for asthma between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Cold air triggers asthma						
yes	85	69.7	82	51.3	2.19	1.29,3.7
no	37	30.3	78	48.8*		
Colds, flu trigger asthma						
yes	106	86.9	110	68.3	3.07	1.59,6.01
no	16	13.1	51	31.7^		
Physical activities trigger asthma						
yes	96	78.7	110	68.3	1.71	0.96,3.07
no	26	21.3	51	31.7		
Drugs trigger asthma						
yes	23	18.9	15	9.4	2.26	1.07,4.82
no	99	81.1	146	90.6#		
Foods trigger asthma						
yes	31	25.4	36	22.4	1.18	0.66,2.13
no	91	74.6	125	77.6		

^ chi square p<=0.001
* chi square p<=0.01
# chi square p<=0.05

Table 4.15

A comparison of common allergens which may trigger asthma between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
House dust triggers asthma						
yes	84	68.9	106	65.8	1.15	0.67,1.96
no	38	31.1	55	34.2		
Perfume, fumes trigger asthma						
yes	52	42.6	50	31.1	1.65	0.98,2.77
no	70	57.4	111	68.9		
Molds trigger asthma						
yes	70	57.4	74	46.8	1.53	0.92,2.53
no	52	42.6	84	53.2		
Other dusts trigger asthma						
yes	71	58.2	84	52.8	1.24	0.75,2.06
no	51	41.8	75	47.2		
Animals trigger asthma						
yes	78	63.9	96	59.6	1.20	0.72,2.10
no	44	36.1	65	40.4		
Pollens trigger asthma						
yes	86	70.5	100	62.9	1.41	0.83,2.41
no	36	29.5	59	37.1		
Cigarette smoke triggers asthma						
yes	93	76.2	117	72.7	1.21	0.68,2.15
no	29	23.8	44	27.3		

Table 4.16

A comparison of emotional triggering factors between ED cases and RDD controls for Edmonton

	ED		RDD		OR	CI
	n	%	n	%		
Stress triggers asthma						
yes	59	48.4	52	32.5	1.96	1.16,3.26
no	63	51.6	108	67.5*		
Depression triggers asthma						
yes	18	14.8	21	13.0	1.15	0.56,2.39
no	104	85.2	140	87.0		
Excitement triggers asthma						
yes	42	34.4	46	28.6	1.31	0.77,2.25
no	80	65.6	115	71.4		

* chi square $p<=0.01$

4.2 Lethbridge Emergency Department and RDD

Those in the Lethbridge ED group were compared to those in the Lethbridge RDD group for distinguishing characteristics, however, because of the small numbers in the RDD group Fisher's Exact (FE) test was used for all stratified analysis.

4.2.1 Response and Response Characteristics of ED Participants

Of a potential 228 ED participants 175 (76.8%) completed questionnaires, there were no gender differences in completion rates (Table 4.17), nor were there differences in participation rates across age groups (Table 4.18).

Table 4.17

Comparison of responders and non-responders by gender for Lethbridge ED

	Male		Female	
	n	%	n	%
Responder	86	78.2	89	75.4
Non-responder	24	21.8	29	24.6
Total	110	100	118	100

chi square 0.28 p=0.598,

Table 4.18

Comparison of responders and non-responders by age group for Lethbridge ED

	5-14		15-29		30+	
	n	%	n	%	n	%
Responder	76	81.7	70	71.4	29	78.4
Non responder	17	18.3	28	28.6	8	22.2
Total	93	100	98	100	37	100

chi square 2.87 p=0.238

4.2.2 Response and Response Characteristics of RDD Participants

Of 67 eligible participants obtained through RDD 51 (76.1%) completed questionnaires, there were no differences in participation rates across gender or age groups (Table 4.19,4.20). Three asthmatics refused to participate or to provide information on age or gender. An overall response rate of 51/70 (72.9%) would be accurate if the three refusals met the study criteria of physician diagnosed asthma and were between the ages of 5-50.

Table 4.19

Comparison of responders versus non responders by gender for Lethbridge RDD

	Male		Female	
	n	%	n	%
Responder	24	75.0	27	77.1
Non-responder	8	25.0	8	22.9
Total	32	100	35	100

chi square 0.28 p=0.598

Table 4.20

Comparison of responders versus non-responders by age group for Lethbridge RDD

	5-14		15-29		30+	
	n	%	n	%	n	%
Responder	16	84.2	22	75.9	11	68.8
Non-responder	3	15.8	7	24.1	5	31.2
Total	19	100	29	100	16	100

chi square 1.17 p=0.557

Age unknown for 2 participants and 3 non-responsers

Responders and non-responders were comparable by age and gender and that the relatively high response rate supports representativeness. The increase in non-response with increased age group for the RDD asthmatics is of note but difficult to interpret given the small numbers. The limiting factor in analysis and interpretation of the Lethbridge data is the small number of RDD participants recruited, although the number bank for the area was exhausted and the area was oversampled compared to Edmonton. The population density of the region limited further RDD.

4.2.3 Age and gender comparisons for Lethbridge ED and RDD participants

There were no differences in the age distribution of males' between the ED and RDD groups, nor was there a difference in age distribution of females between the ED and RDD group. However there were significant gender differences across age group for the ED (chi sq 11.11, p=0.01) group, and although not significant for the RDD group the trend was similar (chi sq 4.5, p=0.21). There were more males in the 5-14 age groups and more females above age 15 (Table 4.21).

Table 4.21

Comparison of age and gender distribution for ED vs RDD participants for Lethbridge

	Male				Female			
	ED		RDD		ED		RDD	
Age	n	%	n	%	n	%	n	%
5-14	48	55.9	11	47.8	28	31.4	5	20.0
15-29	25	29.1	9	39.1	45	50.6	13	52.0
30+	13	15.1	3	13.0	16	18.0	7	28.0
Total	86	100.0	23	100.0*	89	100.0	25	100.0

gender unknown for 3 participants

* chi square trend p<=0.01

4.2.4 Background characteristic

Of those in the ED group 44.1% were between the ages 5-14 compared with 33.3 % of the RDD group (not significant), and the odds of an ED visit decreased with increasing age. Of the ED group age 25 or over, 22.9% had not completed grade 12 compared with 6.7% of the RDD group although the numbers are small (Table 4.22). Most of the participants lived in urban centres.

Table 4.22

Comparison of background characteristics of ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Age Group						
5-14	76	43.4	16	33.3	1.00	
15-29	70	40.0	22	45.8	0.67	0.33,1.38
30-50	29	16.6	10	20.8	0.61	0.25,1.50
Education- age 25 or over						
grade 1-11	11	22.9	1	6.7	1.00	
grade 12 graduate	8	16.7	4	26.7	0.18	0.02,1.95
attend post secondary	10	20.8	4	26.7	0.23,	0.02,2.39
finish post secondary	19	39.6	6	40.0#	0.29	0.03,2.71
Urban Residence						
yes	160	92.5	43	86.0	2.0	0.67,5.82
no	13	7.5	7	14.0		

chi square trend $p<=0.05$
** Fisher's Exact test

4.2.5 Comparison of Asthma Onset and Duration of Asthma Symptoms before Diagnosis

There were no differences in age of asthma onset between the ED and RDD groups, nor were there differences in age of onset between the ED and RDD groups when stratified by severity (data not shown). Of those in the ED group 31.3 % were diagnosed with their asthma within one month of symptom onset compared with 13.9% of the RDD group (Table 4.23).

Table 4.23

Comparison of asthma onset and duration of asthma symptoms before diagnosis between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Age of asthma onset						
0-5 years	83	49.0	22	44.9	1.00	
6-10 years	30	17.8	9	18.4	0.88	0.37,2.13
11-15 years	16	9.5	9	18.4	0.47	0.18,1.21
15 + years	40	23.7	9	18.4	1.18	0.50,2.79
Duration of symptoms before diagnosis						
< 1month	40	31.3	5	13.9	1.00	
1-12 months	39	30.5	16	44.4	0.30	0.10,0.91
1 year or more	49	38.3	15	41.7*	0.41	0.14,1.22

* chi square trend p<=0.01
** Fisher's Exact test

4.2.6 Self Reported Asthma Severity and Frequency of Asthma Symptoms

All participants were asked about how severe their asthma was, mild was defined as interfering infrequently with normal lifestyle, moderate as occasional interference and severe as seriously interfering with a normal lifestyle. Although more ED than RDD participants reported moderate or severe disease (p=0.02), there were no differences in the frequency of reported asthma symptoms between the groups (Table 4.24). There were no gender differences between groups for either reported symptoms or asthma severity (data not shown).

Table 4.24

Comparison of self reported asthma severity and frequency of asthma symptoms between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Severity						
mild	68	39.5	28	54.9	1.00	
moderate	79	45.9	21	41.2	1.55	0.81,2.97
severe	25	14.5	2	3.9#	5.15	1.14,23.21
Symptom frequency						
none	45	28.0	17	38.6	1.00	
exercise only	38	23.6	5	11.4	2.87	0.97,8.51
1-2 times/week	36	22.4	11	25.0	1.24	0.51,2.97
3-4 times/week	21	13.0	6	13.6	1.32	0.46,3.84
5+ times week	21	13.0	5	11.4	1.59	0.52,4.88

chi square trend p<=0.05
** Fisher's Exact test

4.2.7 Health Care Utilization and Medication Changes in the Past 12 Months

Deteriorating asthma control which could result in an ED visit for asthma may be preceded by changes in medication or visits to health care providers. In the 12 months preceding the index visit, 47.4% of the ED cases had been to the ED for asthma. Only 17.6% of the RDD group sought ED treatment for asthma in the previous 12 months (p=0.001) (Table 4.25). The ED group were more likely than the RDD group to have seen their family doctor for asthma in the last 12 months. The ED participants were more likely to have made an unscheduled visit to the doctor in the last 12 months (p=0.001).

Table 4.25

Comparison of health care utilization and medication changes between ED case and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Increase medication in last 12 months						
yes	105	60.0	18	36.7	2.58	1.28,5.24
no	70	40.0	31	63.3*		
Saw family doctor for asthma in last 12 months						
yes	134	77.5	26	52.0	3.17	1.64,6.13
no	39	22.5	24	48.0^		
Unscheduled visit to doctor in last 12 months						
yes	143	81.7	21	41.2	6.38	3.08,13.31
no	32	18.3	30	58.8*		
Frequency of ED visits						
none/index only@	92	52.6	42	82.4	1.00	
1 time	41	23.4	4	7.8	4.68	1.57,13.91
2 or more	42	24.1	5	9.8^	3.83	1.42,10.39

@ no visit or excluding the ED visit where participant was recruited

^ chi square p<=0.001
* chi square (trend if appropriate) p<=0.01
** Fisher's Exact test

4.2.8 Asthma Management Characteristics

If asthma management was different for those in the ED group compared with the RDD group then education programs designed to reduce ED visits could target medical and personal management practices. Asthma management characteristics were compared for the ED and RDD group. Although not significant those in the ED group were about twice as likely to have seen a specialist, used a peak flow meter or an action plan than the RDD participants (Table 4.26).

Table 4.26

Comparison of several asthma management characteristics for ED cases and RDD controls

	ED		RDD		OR	CI**
	n	%	n	%		
Use of specialist						
yes	37	21.4	6	12.0	2.0	0.76,6.16
no	136	78.6	44	88.0		
Use of action plan						
yes	29	16.7	5	9.8	1.84	0.65,6.43
no	145	83.3	46	90.2		
Use of peak flow meter						
yes	34	19.7	4	7.8	2.87	0.95,11.69
no	139	80.3	47	92.2#		
Respiratory doctor prescribes medication						
yes	22	12.0	5	10.9	0.81	0.30,2.27
no	146	88.0	41	89.1		

* chi square $p<=0.01$
# chi square $p<=0.05$
** Fisher's Exact test

4.2.9 Asthma Medication

The frequency and type of asthma medications used was compared between the ED case and RDD control groups. Beta agonist bronchodilators were used with similar frequency by both ED and RDD participants, and there were no differences in beta agonist use across levels of asthma severity (data not shown). Very few individuals had used theophylline preparations, 14.3% of the ED group, 4.6% of the RDD group. Of those in the ED group anti-inflammatory inhaled steroids were used by 65.7% either occasionally or daily compared to 44.2% of the RDD group ($p<=0.05$). Steroid tablets were used occasionally or daily by 37.6% of the ED group and with 18.6% of the RDD group ($p<=0.05$)(Table 4.27).

Table 4.27

Lethbridge ED vs RDD
Asthma medication use in the last 12 months

	ED		RDD		OR	CI**
	n	%	n	%		
Beta agonist						
none	9	5.4	2	4.8	1.00	
occasionally	108	64.7	33	78.6	0.73	0.15,3.53
every day	50	29.9	7	16.7	1.59	0.28,8.9
Bronchodilator +Theophylline						
none	143	85.6	41	95.3	1.00	
occasionally	14	8.4	1	2.3	4.01	0.51,31.44
every day	10	5.9	1	2.3	2.87	0.36,23.06
Inhaled Steroids						
none	57	34.1	24	55.8	1.00	
occasionally	62	37.0	11	25.6	2.37	1.07,5.28
every day	48	28.7	8	18.6#	2.53	1.04,6.14
Steroid Tablets						
none	103	62.4	35	81.4	1.00	
occasionally	59	35.8	7	16.3	2.86	1.2,6.85
every day	3	1.8	1	2.3#	1.02	0.10,10.12

chi square trend $p<=0.05$
** Fisher's Exact test

4.2.10 Compliance, Knowledge, Recognition & Control

Compliance, knowledge, recognition & control were evaluated as described in the methods section. A comparison between the ED case and RDD control groups revealed that compliance to prescribed asthma medication was similar between the groups. For those over the age of 15 there was no difference in asthma knowledge, recognition & control,and compliance between the ED and RDD participants (Table 4.28). There were no apparent differences in smoking habits. Of the 82 ED participants that had indoor pets 50 were dogs, 52 were cats (not mutually exclusive). Of the 30 in the RDD group that kept indoor pets 21 were dogs, 13 were cats. Other less common pet choices included birds and hamsters.

Table 4.28

A comparison of compliance, knowledge, recognition & control between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Compliance						
Low (0-3)	64	40.0	20	48.8	0.7	0.35,1.39
High (4-6)	96	60.0	21	51.2		
Compliance-15 years and only						
Low (0-3)	45	50.0	16	64.0	0.56	0.22,1.40
High (4-6)	45	50.0	9	36.0		
Smoking						
Non-smoker	46	46.5	16	48.5	1.00	
Former	24	24.2	10	30.3	0.83	0.33,2.12
Current	29	29.3	7	21.2	1.44	0.53,3.93
Indoor Pets						
Current indoor pet	93	53.1	30	58.8	0.79	0.40,1.56
No indoor pet	82	46.9	21	41.2		
Knowledge-15 years and over						
Low (0-4)	45	50.6	18	66.7	1.00	
Moderate (5-6)	28	31.5	6	22.2	1.87	0.66,5.27
Good (7-8)	16	18.0	3	11.1	2.13	0.55,8.22
Recognition & control-15 years and over						
Low (0-20)	28	31.1	8	30.8	1.02	0.39,2.61
High (21-30)	62	68.9	18	69.2		

** Fisher's Exact test

4.2.11 Home Environment

To evaluate the role the current home environment plays in distinguishing between the ED and RDD asthmatic some comparisons were made between the two groups. There was no relationship between age of home and membership in the ED or RDD group. There were no differences surrounding the presence of mold or use of a humidifier (Table 4.29). Other comparison that were made and found not to differ between the groups included frequency of changing a furnace filter, renovating or changing a carpet in the past 12 months, type of heating, use of a wood fire place and use of a kerosene heater (data not shown).

Table 4.29

A comparison of the home environment for ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI**
	n	%	n	%		
Home Built						
before 1960	46	30.3	14	31.8	1.00	
1961-1970	17	11.2	5	11.4	1.03	0.32,3.31
1971-1980	55	36.2	13	29.5	1.29	0.55,3.01
1981+	34	22.4	12	27.3	0.86	0.35,2.10
Mold found on surface						
yes	57	37.7	19	44.2	0.77	0.39,1.52
no	94	62.3	24	55.8		
Use a humidifier						
yes	27	16.9	9	18.0	0.92	0.38,2.31
no	133	83.1	41	82.0		

** Fisher's Exact test

4.2.12 Triggering Factors for Asthma

Many substance have been reported to trigger asthma (34). In the following three tables common triggering factors have been reported and data presented on differences between the ED and RDD participants (Table 4.30, 4.31,4.32). In most instances the ED participants weres not distinguished from the RDD participants on the basis of triggering factors.

Table 4.30

A comparison of some triggering factors for asthma between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Cold air triggers asthma						
yes	85	50.9	27	52.9	0.92	0.47,1.81
no	82	49.1	24	47.1		
Colds, flu trigger asthma						
yes	128	76.6	34	66.7	1.64	0.78,3.43
no	39	23.4	17	33.3		
Physical activities trigger asthma						
yes	127	76.0	38	74.5	1.09	0.49,2.36
no	40	24.0	13	25.5		
Drugs trigger asthma						
yes	18	10.8	1	2.0	6.08	0.79,50.0
no	148	89.2	50	98.0		
Foods trigger asthma						
yes	38	22.8	10	19.6	1.21	0.52,2.84
no	129	77.2	41	80.4		

Table 4.31

A comparison of common allergens which may trigger asthma between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
House dust triggers asthma						
yes	76	45.5	27	52.9	0.74	0.38,1.46
no	91	54.5	24	47.1		
Perfume, fumes trigger asthma						
yes	48	29.1	19	37.3	0.69	0.34,1.41
no	117	70.9	32	62.7		
Molds trigger asthma						
yes	44	26.5	16	31.4	0.79	0.38,1.66
no	122	73.5	35	68.6		
Other dusts trigger asthma						
yes	87	52.4	30	58.8	0.77	0.39,1.52
no	79	47.6	21	41.2		
Animals trigger asthma						
yes	102	61.4	31	60.8	1.03	0.51,2.05
no	31	60.8	20	39.2		
Pollens trigger asthma						
yes	94	56.6	32	62.7	0.78	0.39,1.55
no	72	43.4	19	37.3		
Cigarette smoke triggers asthma						
yes	103	61.7	32	62.7	0.96	0.48,1.91
no	64	38.3	19	37.3		

Table 4.32

A comparison of emotional triggering factors between ED cases and RDD controls for Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Stress triggers asthma						
yes	53	31.9	14	27.5	1.24	0.59,2.64
no	113	68.1	37	72.5		
Depression triggers asthma						
yes	19	11.4	4	7.8	1.51	0.47,6.39
no	148	88.6	47	92.2		
Excitement triggers asthma						
yes	47	28.3	12	23.5	1.28	0.59,2.85
no	119	71.7	39	76.5		

4.3 Comparison of Data Patterns between Edmonton and Lethbridge

The data were collected at two sites and comparing between sites may provide insight to the potential generalizability of the results. Some of the salient features of the data were compared to determine homogeneity of the results.The pattern in the odds ratios was reviewed to determine it there was similarity between the cities. The results were considered to be homogeneous if the confidence intervals overlapped. Formal tests of homogeneity were not applied. If trends in the results were similar then the data could be pooled for some analysis. The differences in sample size was considered in interpreting the data.

4.3.1 Age group and duration of symptoms before diagnosis

The age distribution of participants in both Edmonton and Lethbridge is similar, the patterns and relative magnitudes of the odds ratios was similar and an interaction between age and city was not evident. The relationship between time to diagnose asthma from onset of symptoms and membership in the ED or RDD group is slightly different for Edmonton and Lethbridge. Of those in Lethbridge 55.5% of the ED group compared with 50.0% of the RDD group were diagnosed within 6 month of symptoms, whereas of those in Edmonton 46.4% of the ED group compared with 36.1% of the RDD group were diagnosed within 6 months of symptoms (Table 4.33). However the trend is in the same direction for both sites, the odds of an ED visit are reduced with increasing duration of symptoms prior to diagnosis, and an interaction between city and duration of symptoms before diagnosis is not apparent.

Table 4.33

Comparison of age group and duration of asthma symptoms before diagnosis between Edmonton and Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Edmonton						
Age Group						
5-14	46	37.7	49	30.0	1.00	
15-29	46	37.7	64	39.8	0.77	0.44,1.33
30+	30	24.6	50	31.1	0.83	0.46,1.51
Lethbridge						
Age group						
5-14	76	43.4	16	33.3	1.00	
15-29	70	40.0	22	45.8	0.67	0.33,1.38**
30-50	29	16.6	10	20.8	0.61	0.25,1.50
Edmonton						
Duration of symptoms before diagnosis						
< 1 month	20	21.1	16	14.4	1.00	
1-6 months	24	25.3	25	22.5	0.77	0.32,1.82
7-12 months	7	7.4	13	11.7	0.43	0.14,1.33
1 year or more	44	46.3	57	51.4	0.62	0.29,1.33
Lethbridge						
Duration of symptoms before diag.						
< 1 month	40	31.3	5	13.9	1.00	
1-6 months	31	24.2	13	36.1	0.30	0.10,0.93**
7-12 months	8	6.3	3	8.3	0.33	0.07,1.68
1 year or more	49	38.3	15	41.7*	0.41	0.14,1.22

* chi square (trend if appropriate) p<=0.01

** Fisher's Exact test

4.3.2 Asthma Severity and Health Care Utilization

Regional variation in asthma mortality have been reported and may be related to local asthma severity (74). Health care utilization may also be a reflection of local disease severity, or local understanding of when to seek ED (or other) treatment. For both Edmonton and Lethbridge the ED asthmatic was more likely than the RDD asthmatic to report more severe asthma, however overall 30.0% of those in Edmonton reported having severe asthma compared with 18.4% of those in Lethbridge. The pattern of the odds ratios was similar between the cities, however the magnitude of the odds ratios was greater for Edmonton. The wide confidence intervals for Lethbridge reflect the instability of the estimate as a reflection of the sample size. The pattern of the odds ratios between health care utilization, in terms of visits to the family doctor and ED visits for asthma, was similar between cities. In both cities the ED asthmatics were characterized by more severe disease, and more frequent use of both the family doctor and ED in the preceding 12 months (Table 4.34).

Table 4.34

Comparison of asthma severity and health care utilization between Edmonton and Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Edmonton						
Severity						
mild	20	16.0	85	51.0	1.00	
moderate	76	62.0	65	40.0	4.97	2.76,8.96
severe	26	21.0	13	8.0*	8.50	3.73,19.39
Lethbridge						
Severity						
mild	68	39.5	28	54.9	1.00	
moderate	79	45.9	21	41.2	1.55	0.81,2.97**
severe	25	14.5	2	3.9#	5.15	1.14,23.21
Edmonton						
Saw family doctor for asthma in last 12 months						
yes	93	76.0	87	55.0	2.63	1.55,4.41
no	29	24.0	71	45.0*		
Lethbridge						
Saw family doctor for asthma in last 12 months						
yes	134	77.5	26	52.0	3.17	1.64,6.13
no	39	22.5	24	48.0^		

** Fisher's Exact test

Table 4.34 continued

Comparison of asthma severity and health care utilization between Edmonton and Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Edmonton						
Frequency of ED visits						
non/index only	52	43.0	138	85.7	1.00	
1 time	30	24.8	13	8.1	6.12	2.97,12.64
2-3 times	33	27.3	6	3.7	14.6	5.78,36.86
4-6 times	4	3.3	3	1.9	3.54	0.77,16.35
7 or more times	2	1.7	1	0.6*	5.31	0.47,59.78
Lethbridge						
Frequency of ED visits						
non/index only	92	52.6	42	82.4	1.00	
1 time	41	23.4	4	7.8	4.68	1.57,13.91**
2-3 times	25	14.3	5	9.8	2.28	0.82,6.38
4-6 times	5	2.9	0	0.0	2.28	0.26,20.15
7 or more times	12	6.9	0	0.0*	5.48	0.69,43.52

^chi square (trend if appropriate) p<=0.001
* chi square (trend if appropriate) p<=0.01
# chi square (trend if appropriate) p<=0.05
** Fisher's Exact test

4.3.3 Medication Use

If medication practices were distinctly different between the ED and RDD groups then reducing ED visits for asthma may be linked to prescription habits and compliance to medical advice. Almost all of the participants were using beta agonists, more of those in the Edmonton group used a beta agonist daily, whereas more of those in Lethbridge reported occasional use. The finding that those in the Edmonton group reported more severe asthma and those in the Lethbridge group reported moderate asthma could explain this finding. In both sites those in the ED group were more likely to use inhaled steroids.

Table 4.35

Comparison of medication use between Edmonton and Lethbridge

	ED		RDD		OR	CI
	n	%	n	%		
Edmonton						
Beta agonist						
none	3	2.7	11	8.6	1.00	
occasionally	50	45.5	83	64.8	2.21	0.59,8.30
every day	57	51.8	34	26.6^	6.15	1.6,23.6
Lethbridge						
Beta agonist						
none	9	5.4	2	4.8	1.00	
occasionally	108	64.7	33	78.6	0.73	0.15,3.53**
every day	50	29.9	7	16.7	1.59	0.28,8.9
Edmonton						
Inhaled steroids						
none	31	31.3	74	58.3	1.00	
occasionally	33	33.3	31	24.4	2.54	1.33,4.84
every day	35	35.4	22	17.3*	3.8	1.9,7.48
Lethbridge						
Inhaled Steroids						
none	57	34.1	24	55.8	1.00	
occasionally	62	37.0	11	25.6	2.37	1.07,5.28**
every day	48	28.7	8	18.6#	2.53	1.04,6.14

^chi square trend p<=0.001
* chi square trend p<=0.01
# chi square trend p<=0.05
** Fisher's Exact test

4.4 Complete Group

Pooling the data from Lethbridge and Edmonton increases the sample size and the power of the analyses. Issues unlikely to be related to region, such as gestational age may be discussed within the context of the larger group. The pattern in the odds ratios was reviewed to determine it there was homogeneity in the results and therefore between the cities. The results were considered to be homogeneous if the confidence intervals overlapped. Formal tests of homogeneity were not applied. If trends in the results were similar then the data was pooled for some analysis. The pooled data is presented in this section. Although Lethbridge is much smaller than Edmonton both were urban centres with local universities and community colleges. The samples were similar in age and gender distribution.

4.4.1 Age and Residence

There were no differences in location of residence (within a city on not), 92.5% of the ED group lived within city limits, 94.3% of the RDD group lived within city limits.

There were no gender differences between the groups, 51.9% of the ED group was female, 50.5% of the RDD group was female (data not shown). The ED group was slightly younger than the RDD group, 40.3% of the ED group compared with 31.0% or the RDD group was in the 5-14 age group (Table 4.36).

Table 4.36

Comparison of the ED and RDD asthmatic for age, residence and asthma onset

	ED		RDD		OR	CI
	n	%	n	%		
Urban/rural						
urban	273	92.5	198	94.3	0.75	0.34,1.64
rural	22	7.5	12	5.7		
Age group						
5-14	135	40.3	65	31.0	1.00	
15-29	141	42.1	84	40.0	0.81	0.54,1.21
30+	59	17.6	61	29.0*	0.47	0.29,0.74

* chi square trend p<=0.01

4.4.2 Asthma Onset

Of those in the ED group 51.6% had asthma symptoms for less than 6 months before diagnosis compared with 40.2% of RDD asthmatics. Of those in the ED group 48.4% had asthma by the age of 5 years, compared with 33.9% of those in the RDD group. Although not all of the confidence intervals are significant, there was a significant trend toward earlier onset asthma in the ED group. The fluctuating odds ratios over the strata reflect the small cell sizes in some stratum. Of those in the ED group 9.9% had asthma for 1 year or less compared with 2.0% of the RDD group ($p<=0.01$). Of the ED group 44.5% had asthma for 5 years or less compared with 29.0% of the RDD group. The ED asthmatics were characterized by the development of symptoms resulting in a diagnosis of asthma within 6 months and by early onset, recently diagnosed disease. Three of the ED asthmatics had not been previously diagnosed with asthma (data not shown) before their visit to the ED. Note that these comparisons have not been adjusted for age differences.

Table 4.37

Comparison of the ED and RDD asthmatic for duration of symptoms before diagnosis, age of onset, and duration of disease

	ED		RDD		OR	CI
	n	%	n	%		
Duration of asthma symptoms before diagnosis (months)						
< 1	60	26.9	21	14.3	1.00	
1-6	55	24.7	38	25.9	0.51	0.27,0.97
7-12	15	6.7	16	10.9	0.33	0.14,0.78
1 year or more	93	41.7	72	48.9*	0.45	0.25,0.81
Age of asthma onset (years)						
< 2	42	21.6	31	15.0	1.00	
2 - 4	52	26.8	39	18.9	0.98	0.53,1.83
5-9	32	16.5	40	19.4	0.59	0.31,1.14
10-14	19	9.8	37	18.0	0.38	0.18,0.78
15-19	21	10.8	14	6.8	1.11	0.49,2.51
20-24	9	4.6	20	9.7	0.33	0.13,0.83
25-29	7	3.6	13	6.3	0.40	0.14,1.11
30-50	12	6.2	12	5.8^	0.74	0.29,1.86
Duration of asthma (years)						
< 1	19	9.9	4	2.0	1.00	
1-4	66	34.6	55	27.0	0.25	0.08,0.79
5 -9	40	20.9	64	31.4	0.13	0.04,0.41
10 -14	19	9.9	29	14.2	0.14	0.04,0.47
15 -50	47	24.6	52	25.5^	0.19	0.06,0.60

^chi square trend p<=0.001

* chi square trend p<=0.01

4.4.3 Self Reported Asthma Severity

Results of the site specific analyses suggested that those in the ED group were more likely to report more severe asthma, in merging the data sets the trend remains, of those in the ED group 17.3% reported their asthma as severe compared to 7.1% of the RDD group (Table 4.37).

Table 4.37

Comparison of the ED and RDD asthmatic for self reported asthma severity

	ED		RDD		OR	CI
	n	%	n	%		
Severity						
mild	88	29.9	110	52.1	1.00	
moderate	155	52.7	86	40.8	2.25	1.53,3.31
severe	51	17.3	15	7.1*	4.25	2.24,8.06

* chi square trend if appropriate p<=0.01

4.4.4 Gestational Age, Childhood Illnesses and Co-morbidity

Premature birth increases the risk of pulmonary problems (137), however there were no differences in gestational age between the ED and RDD participants; about 80% of both groups were full term. Location of delivery was not important as high risk deliveries may be more common in larger urban centres. There were no differences between the ED and RDD asthmatics concerning the frequency of serious chest illnesses before age 2, bronchitis or pneumonia, or removal of tonsils.

There were no differences in co-morbidity (co-existing medical conditions such as arthritis, mental retardation, cerebral palsy, diabetes, hearing impairment) between the ED and RDD groups, controlling for asthma severity did not alter this relationship (data not shown) (Table 4.39).

Table 4.39

Comparisons of the ED and RDD asthmatic for gestational age, childhood illnesses and co-morbidity

	ED		RDD		OR	CI
	n	%	n	%		
Full term baby						
yes	226	85.3	148	83.1	1.14	0.65,1.98
no	39	14.7	29	16.9		
Serious chest illness before 1 year of age						
yes	73	29.6	42	26.8	1.15	0.72,1.84
no	174	70.4	115	73.2		
Bronchitis or pneumonia before age 16						
yes	183	72.3	114	66.7	1.31	0.84,2.03
no	70	27.7	57	33.3		
Tonsils removed						
yes	75	26.7	49	26.6	1.00	0.65,1.52
no	206	73.3	135	73.4		
Co-morbidity						
yes	42	21.5	48	22.6	0.94	0.57, 1.54
no	153	78.5	164	77.4		

4.4.5 Home Environment

Those in the ED group were significantly more likely to reside in a home built before 1960 (p=0.002). There were no obvious differences between the ED and RDD groups with regard to remodelling, refurnishing or re-carpeting a room in the last 12 months (Table 4.40). Nor were differences between the ED and RDD group noted for type of home heating (77% ED, 67% RDD had forced air), frequency of cleaning a furnace filter or use of a wood burning fire place, type of cooking stove, or the presence of mold or mildew (data not shown).

Table 4.40

Comparison of the ED and RDD asthmatic on age of home and recent renovations

	ED		RDD		OR	CI
	n	%	n	%		
Age of Home						
before 1960	74	29.0	37	20.0	1.00	
1961-1970	35	13.7	32	17.3	0.55	0.29,1.02
1971-1980	86	33.7	62	24.3	0.69	0.42,1.16
1981-present	60	23.5	54	29.2*	0.56	0.32,0.95
Home renovation in last 12 months						
yes	98	35.0	63	34.4	0.98	0.66,1.44
no	182	65.0	120	65.6		

* chi square (trend if appropriate) p<=0.01

4.4.6 Seasonal Variation in Asthma

The participants were asked whether their asthma was worse at certain times during the year and during which seasons their asthma was worse. Responses to the seasonal questions were not mutually exclusive. Participants from both the ED and RDD group reported seasonal variation in their asthma. Spring and fall were reported to be the most troublesome seasons for participants (Table 4.41)

Table 4.41

Comparison of ED and RDD asthmatic for seasonal variation in asthma

	ED		RDD		OR	CI
	n	%	n	%		
A time of year when asthma is worse						
yes	220	75.6	168	79.2	1.23	0.81,1.89
no	71	24.4	44	20.8		
Season exacerbates asthma				not mutually exclusive		
winter	87	48.1	46	27.5		
spring	143	73.7	120	71.9		
summer	57	38.0	31	18.6		
fall	106	59.2	80	47.9		

4.4.7 Previous Allergic, Atopic and Asthmatic Experiences

Those seen in the ED may have more severe allergic responses that require medical attention however, there were no differences between the ED and RDD asthmatic in the likelihood of having food allergies or ezcema. There was no difference between the groups with respect to ever having a life threatening allergic reaction. Significantly more of the RDD group had used antihistamines in the preceeding month. CPR was required for asthma treatment for 20 (6.8%) ED participants compared to 3 (1.5%) from the RDD group, this difference was significant although the confidence interval is very wide (Table 4.42).

Table 4.42

Comparison between the ED and RDD asthmatic for previous allergic and asthmatic experiences

	ED		RDD		OR	CI
	n	%	n	%		
Do you or have you ever had food allergies						
yes	99	44.6	73	50.0	0.80	0.52,1.25
no	123	55.4	73	50.0		
Do you or have you ever had eczema						
yes	70	44.6	62	42.2	1.10	0.68,1.78
no	87	55.4	85	57.8		
Have you ever had a life threatening allergic reaction						
yes	65	21.9	46	21.9	1.0	0.64,1.57
no	232	78.1	164	78.1		
Have you used antihistamines in last month						
yes	71	21.1	84	39.6	0.41	0.27,0.61
no	266	78.9	128	60.4^		
Have you ever had CPR						
yes	20	6.8	3	1.5	4.9	1.42,26.05
no	272	93.2	200	98.5#		

^chi square p<=0.001
chi square p<=0.05

4.4.8 Aspirin Avoidance

ASA can cause broncho-constriction in about 4% of asthmatics and could trigger an ED visit (92). However, in terms of being informed about avoiding aspirin or ASA no difference was found between the ED and RDD asthmatics (Table 4.43).

Table 4.43

Comparison between the ED and RDD asthmatics for aspirin avoidance

	ED		RDD		OR	CI
	n	%	n	%		
Have you been told to avoid Aspirin/ASA						
yes	181	61.1	122	57.8	1.15	0.79,1.67
no	115	38.9	89	42.2		

4.4.9 Prescription Medication

If an asthmatic delayed filling a prescription and subsequently required medication during the evening or night-time then ED treatment may be sought. We did not find any difference between the ED and RDD asthmatics in terms of delaying to fill a prescription because of the cost. In both groups, slightly over 20.0% of asthmatics had delayed filling a prescription (Table 4.44).

Table 4.44

Comparison between the ED and RDD asthmatic for likelihood of not filling a prescription due to cost

	ED		RDD		OR	CI
	n	%	n	%		
Have you ever delayed filling a prescription due to cost						
yes	69	23.3	45	22.1	0.93	0.61,1.43
no	227	76.7	159	77.9		

4.4.10 Education

The age of 25 is a reasonable cut off point to establish the impact of education as it allows enough time to attend and/or complete post secondary education. More RDD than ED participants had attended or completed post secondary education. Seventy- five percent of those in the RDD group had attended or completed post secondary education compared to 60% of the ED group (Table 4.45).

Table 4.45

Comparison between the ED and RDD asthmatic for education

	ED		RDD		OR	CI
	n	%	n	%		
Education- those 25 years or older						
grade 1-11	20	23.5	7	8.8	1.00	
grade 12 graduate	14	16.5	13	16.3	0.38	0.12,1.18
attend post secondary	16	18.8	18	22.5	0.31	0.10,0.93
finish post secondary	35	41.2	42	52.5*	0.29	0.11,0.77

^chi square (trend if appropriate) p<=0.001
* chi square (trend if appropriate) p<=0.01
# chi square (trend if appropriate) p<=0.05

Because health could impact on the ability to complete education, the relationship between education and disease severity was evaluated. After stratifying for asthma severity the difference in the amount of education completed for those in the ED vs RDD group was significant only for those with moderate disease (Table 40). Because of the small numbers in some of the cells this data needs to be interpretted with caution, the wide confidence intervals reflect the instability of these estimates.

Table 4.46

Comparison between the ED and RDD asthmatic for level of education, stratified by severity

	ED		RDD		OR	CI
Education	**n**	**%**	**n**	**%**		
Severe						
grade 1-12	11	55.0	3	50.0	1.22	0.13,11.45
attend or complete ps**	9	45.0	3	50.0		
Moderate						
grade 1-12	17	42.5	7	33.3	1.48	0.43,5.16
attend or complete ps**	23	57.5	14	66.7^		
Mild						
grade 1-12	5	20.8	10	20.8	1.00	0.23,3.79
attend or complete ps**	19	79.2	38	79.2		

** post secondary education

^chi square (trend if appropriate) p<=0.001

4.11 Lifestyle

In the site analysis Edmonton and Lethbridge differed on issues of smoking and keeping indoor pets. Of those in Edmonton, more RDD participants smoked and kept indoor pets, whereas no such difference was noted for Lethbridge. To clarify the relationship between pets and smoking and to determine if keeping indoor pets and smoking were moderated by disease severity a stratified analysis was completed. When stratified by severity there were no differences in the likelihood of keeping a pet between the ED and RDD participant. Those with severe asthma who were seen in the ED were more likely to be non-smokers than the RDD participantsalthough the numbers are small (Table 4.47).

Table 4.47

Comparison between the ED and RDD asthmatic for indoor pet and smoking, stratified by severity

	ED		RDD		OR	CI
Indoor Pets	**n**	**%**	**n**	**%**		
Severe						
current pet	21	41.2	5	33.3	1.40	0.37,5.98
no pet	30	58.8	10	66.7		
Moderate						
current pet	84	54.2	43	50.0	1.18	0.67,2.08
no pet	71	45.8	43	50.0		
Mild						
current pet	50	56.8	62	56.4	1.02	0.56,1.87
no pet	38	43.2	48	43.6		
Smoking for those aged 15 or over						
Severe	**n**	**%**	**n**	**%**		
current smoker	4	11.1	3	37.5	1.00	
ex smoker	5	13.9	3	37.5	1.25	0.16,9.92
non smoker	27	75.0	2	25.0	10.13	1.27,80.61
Moderate						
current smoker	18	20.7	13	25.0	1.00	
ex smoker	11	12.6	16	30.8	0.50	0.17,1.42
non smoker	58	66.7	23	44.2	1.82	0.77,4.31
Mild						
current smoker	12	25.0	21	25.0	1.00	
ex smoker	8	16.7	17	20.2	0.82	0.27,2.47
non smoker	28	58.3	46	54.8	1.07	0.45,2.49

4.4.12 Vulnerability

To evaluate how scores on vulnerability were related to membership in the ED or RDD group and to disease severity a stratified analysis was completed. Vulnerability scores were established as discussed in the methods section. Those who were seen in the ED with severe and moderate disease tended to score higher on feelings of vulnerability than their RDD counterparts However those with mild disease who were in the ED tended to feel less vulnerable than their RDD counterparts (Table 41). The small numbers within the groups in the stratified analysis suggest that these results be interpreted with caution and perhaps the area of vulnerability and its impact on disease warrants further study.

Table 4.48

Comparison of the ED and RDD asthmatic for feelings of vulnerability; stratified by severity

Age 20 +	**ED**		**RDD**		**OR**	**CI**
Severe	**n**	**%**	**n**	**%**		
low vulnerability	2	8.0	2	40.0	7.69	0.77,76.4
high vulnerability	23	92.0	3	60.0		
Moderate						
low vulnerability	23	38.3	19	65.5	3.06	1.10, 8.60
high vulnerability	37	61.7	10	34.5#		
Mild						
low vulnerability	33	89.2	42	73.7	0.34	0.10,1.12
high vulnerability	4	10.8	15	26.3		
Overall						
low vulnerability	58	47.5	64	59.6	2.52	1.38,4.64
high vulnerability	64	52.5	28	30.4^		

chi square p<=0.05
^ chi square p<= 0.001

4.5 Summary of Bivariate Analysis

The results of the bivariate analysis suggest that the ED asthmatics were distinguished from the RDD asthmatics by earlier onset, and more often reported moderate to severe disease of less than 5 years duration. Those in the ED were more likely to have had their asthma diagnosed within 6 months of symptom onset and were more likely to be younger. The ED asthmatics sought care from their family doctors or specialists at both scheduled and unscheduled visits and they used the ED more frequently through the year than the RDD asthmatics. The ED asthmatics were more apt to have increased their medication and to have used more asthma medication, both bronchodilators and steroids, however the RDD asthmatics were more likely to have used antihistamines within the past month. The ED asthmatics were more likely to have required CPR in the past.

Controlling for asthma severity the ED asthmatics tended to score higher than the RDD asthmatics on measures of vulnerability. The exception was the mild asthmatic group where the trend was reversed and the RDD asthmatics scored higher on measures of vulnerability.

The ED group did not differ from the RDD group in likelihood of co-morbidity, tonsils removed, bronchitis or pneumonia, serious chest illness or full term birth. If these factors are important in may be in distinguishing asthmatics from non-asthmatics.

The home environment that the ED asthmatics lived in did not differ from the environment of the RDD asthmatics except that the ED asthmatics were slightly more likely to live in an older home.

The majority of participants in both groups reported that the spring and fall were troublesome seasons for their asthma, however more of the ED group reported that they were troubled all year around, while the RDD group was more apt to report that their asthma was most troublesome in spring and fall.

These ED participants were no more likely to comply to medication regimes, or to have different skills in recognizing and controlling their asthma. The majority of both groups filled prescriptions promptly and did not fail to fill prescriptions because of cost.

4.5.1 Differences between Edmonton and Lethbridge

Overall there were very few differences between the Edmonton and Lethbridge groups. The observation that those in Lethbridge were less likely to see a specialist could relate to the absence of specialists and alternative facilities in the city. Asthma knowledge scores did not differ between the ED and RDD group in Lethbridge perhaps reflecting that those with milder disease have less comprehensive understanding of asthma.

4.6 Logistic Regression

4.7 Model Development

The initial bivarite analysis revealed several significant differences between the ED and RDD individual with asthma, including severity, health care utilization and medication use. These independent variables were selected for evaluation in the model building process. All independent variables were coded as catergorical for ease of interpretation and informativeness, although there is some loss of precision (170). Variables were eliminated from the model building process if they did not distinguish between the groups (i.e. the variables were not statistically significant)(174) or, if because of missing data, they markedly reduced the sample size. The dependent outcome variable was ED case as compared to RDD control.

Theory should suggest what does and does not relate to the outcome of interest, therefore evaluating non-significant relationships serves to strengthen both the final model and the theory (171). To this end, some variables, such as compliance, gender and knowledge were evaluated with the expectation that they would not be significant based on the bivariate analysis.

To uncover potential confounders and interaction terms and to establish which variables might be included in the final model bivariate logistic regression was completed. Interaction terms and confounding were revealed by evaluating two independent variables in a regression equation. The selection of which variables to include and which confounders to evaluate was based on the results of the preceding chapters and the literature. The 'p' value suggests the significance of the independent variable (173,174).

The process of evaluating the variable was as follows:

Step 1

Model 1: A single independent variable was entered into the equation to evaluate its significance as a predictor variable eg. severity. The significance of the variable at $p <= 0.05$ was used to determine if the variable should be carried forward for evaluation in the final model.

Step 2

Model 2: A second independent variable was evaluated for its significance as a predictor variable by noting the p value, of this variable. The variable added at this step was also selected to evaluate for potential confounding with the initial variable. If the addition of the second variable, eg. sex, resulted in a change in the risk estimate (beta) of the initial variable, eg. severity, of more than twice the standard error (SE) from model 1 then confounding between the variables, eg. severity and sex, was suggested. The justification of the SE criterion derives from the 95.0% confidence interval around beta, which is approximately beta +/- twice the standard error. We can be 95.0% certain that the true beta value lies within this range. If the beta value changes more than that, confounding can be suggested (Dr. Sarah Rose, personnal communication). If either or both the independent variables were significant at $p<= 0.05$ they were evaluated further in the final model.

Step 3

Model 3: Lastly, the interaction between the two independent variables was assessed by multiplying the variables together and adding the interaction term, eg. sex*severity, to the model with both independent variables. The statistical significance of the interaction term at $p <= 0.05$ was then used as a criterion for evaluating interaction.

The specific impact of the independent variable on membership in the ED group can be interpreted from the 'exp B' (exponential of beta) as the increase (or decrease) in odds with the presence of this factor, with all else held constant. Independent variables that predicted membership in the ED case group, confounders and interaction terms were eligible for evaluation in creating the final multivariate model.

The likelihood ratio statistic (-2log LR) provides information on the whether the apparent association is statistically significant, and if beta differs significantly from zero, then the exponential of beta (odds ratio) differs significantly from unity (170). The improvement in fit of the model was tested by comparing differences in the log LR with differences in degrees of freedom and comparing these to critical values in the chi square table, this is noted in the ' -2log LR' column in the following tables. The significance of the LR was noted in the following tables and was determined by comparing difference the LR chi square with degrees of freedom and comparing them to the chi square table, this is noted in the column 'significant improvement p<' in the following tables.

4.7.1 Model with City and Asthma Severity

There was a significant interaction between city and asthma severity, however the effect is very small and suggests that the interaction may reasonably be omitted from the final model. Disease severity is less predictive of an ED visit for those in Lethbridge compared with those in Edmonton (Table 4.49) . Because the case group from Lethbridge was 3.4 times larger than the control group the city variable is significant, it is significant because of the structure of the study.

Table 4.49

Model with city and self reported asthma severity in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
Edmonton		0.00			1.00	689.13	0.0000
Lethbridge		1.23	0.19	0.00	3.40		
Model 2							
Lethbridge		1.72	0.22	0.00	5.58	584.56	0.0000
severity	mild	0.00			1.00		
severity	moderate	1.09	0.22	0.00	2.96		
	severe	1.81	0.35	0.00	6.11		
Model 3							
Lethbridge		2.30	0.34	0.00	9.96	578.17	0.0000
severity	moderate	1.58	0.30	0.00	4.80		
	severe	2.10	0.42	0.00	8.20		
Lethbridge*moderate		-1.13	0.45	0.01	0.32		
Lethbridge*severe		-0.47	0.88	0.56	0.63		

Dependent variable coding RDD=0, ED=1

Model Interpretation

This and subsequent models can be interpretted as follows using Model 3;

Logistic regression equation;

log odds of disease = $Bo + B_1X_1 + B_2X_2 + B_3X_1X_2$

= constant + B_1 location + B_2 severity + B_3 location *severity

Example: if you have moderate disease and live in Edmonton the equation would be;

log odds = log odds of disease for moderate in Edmonton / log odds of disease for mild in Edmonton

log odds of disease= $\frac{B_0 + B_1 (0) + 1.58 (1) + B_3 (0)}{B_0 + B_1 (0)} = 1.58$

and the odds ratio = exp 1.58 = 4.80

Conclusion: those with moderate disease in Edmonton are at 4.8 times greater risk of using the ED for asthma than those with mild disease

Example: if you live in Lethbridge and have moderate disease the equation would be;

log odds of disease= log odds for moderate in Lethbridge / log odds for mild in Lethbridge

$= \frac{B_0 + 2.3 + 1.58 - 1.13}{B_0 + 2.3} = 0.45$

and the odds ratio = exp 0.45 = 1.57

Conclusion: those with moderate disease in Lethbridge are at 1.57 times greater risk of using the ED for asthma than those with mild disease.

4.7.2 Model with Gender and Age Group

The relationship between gender and age group was evaluated although there was no suggestion from the initial bivariate analysis that a relationship between these variables existed. Age group was a significant predictor of the outcome variable and should be evaluated in the final model. The gender variable was not significant and the beta coefficient for age group did not change with the addition of gender to the model suggesting that there is no confounding between the two variables. The interaction terms were non-significant. Age group and gender are independent variables \Table 4.50

Table 4.50

Model with gender and age group in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
age group	5-14	0.00			1.00	715.87	0.0047
	15-29	-0.21	0.20	0.30	0.81		
	30-50	-0.76	0.24	0.00	0.47		
Model 2							
age group	15-29	-0.25	0.21	0.24	0.78	715.24	0.0099
	30-50	-0.80	0.24	0.00	0.45		
gender	male	0.00			1.00		
	female	-0.15	0.19	0.43	0.87		
Model 3							
age group	15-29	-0.35	0.28	0.21	0.71	711.54	0.0101
	30-50	-0.38	0.35	0.27	0.68		
gender	female	0.27	0.32	0.39	1.31		
15-29*female		0.12	0.42	0.77	1.13		
30-50*female		-0.75	0.49	0.13	0.47		

Dependent variable coding RDD=0, ED=1

4.7.3 Model with Gender and Asthma Severity

To better understand the role of gender in discriminating between the ED and RDD asthmatic the relationship between self reported severity and gender was assessed. Gender was not a significant predictor of an ED visit. With the addition of severity to the model gender remained non-significant, severity was highly significant. The interaction terms were non-significant suggesting that for a given level of severity there is no difference in gender, gender could be excluded from the final model (Table 4.51

Table 4.51

Model with gender and asthma severity in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
sex	male	0.00			1.00	732.25	0.7395
	female	0.06	0.18	0.74	1.06		
Model 2							
sex	female	0.04	0.17	0.82	1.04	656.79	0.0000
severity	mild	0.00			1.00		
	moderate	0.81	0.20	0.00	2.25		
	severe	1.45	0.33	0.00	4.26		
Model 3							
sex	female	0.05	0.27	0.85	1.06	655.02	0.0000
severity	moderate	0.75	0.28	0.01	2.11		
	severe	1.83	0.49	0.00	6.21		
moderate*female		0.13	0.39	0.74	1.14		
severe*female		-0.74	0.66	0.27	0.48		

Dependent variable coding RDD=0, ED=1

4.7.4 Model with Asthma Severity and Emergency Department Use

Many asthmatics (63.7%) in the study either did not use the emergency department at all or used it once per year or less. Many of the ED asthmatics recruited to the study may have had only the single index visit for asthma in the preceding 12 months. The relationship between repeated use of the ED and severity was evaluated. Asthma severity was a significant predictor of an ED visit. The inclusion of ED use to the model revealed some confounding with severity. With the addition of ED use to the model the impact of severity, particularly for those with severe disease, is somewhat diminished. Both disease severity and ED use contribute to the equation and their main effects should be evaluated in the final model (Table 4.52.

Table 4.52

Model with asthma severity and Emergency Department use in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
severity	mild	0.00			1.00	656.84	0.0000
	moderate	0.81	0.19	0.00	2.25		
	severe	1.45	0.33	0.00	4.25		
Model 2							
severity	moderate	0.52	0.20	0.01	1.67	603.74	0.0000
	severe	0.56	0.37	0.13	1.75		
ER use	none^	0.00			1.00		
	1or more	1.62	0.24	0.00	5.07		
Model 3							
severity	moderate	0.52	0.23	0.02	1.69	601.24	0.0000
	severe	1.22	0.57	0.03	3.38		
ER use	1 or more	1.87	0.45	0.00	6.51		
ER use * moderate		-0.15	0.56	0.79	0.86		
ER use *severe		-1.18	0.79	0.14	0.31		

^ excluding index visit to ED

Dependent variable coding RDD=0, ED=1

4.7.5 Model with Asthma Severity and Visiting the Family Doctor for Asthma in the Last 12 Months

The effect that visiting the family doctor for asthma in the preceding 12 months had on distinguishing between the ED and RDD asthmatic was evaluated in conjunction with self reported disease severity. The main effects of both independent variables was significant and as noted in Model 3 there was a significant interaction between asthma severity and visiting the family doctor for asthma. Those with mild disease who saw their family doctor were at increased risk of an ED visit. Those with moderate asthma were more likely to use the ED than those with mild asthma and those with severe asthma were much morelikely to use the ED than those with mild disease, all other variables held constant. In the final model both the main effect of severity and visiting the family doctor as well as the interaction between asthma severity and visiting the family doctor will be evaluated (Table 4.53).

Table 4.53

Model with self reported severity and visiting the family doctor in the last 12 months in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
severity	mild	0.00			1.00	656.84	0.0000
	moderate	0.81	0.19	0.00	2.25		
	severe	1.45	0.33	0.00	4.25		
Model 2							
severity	moderate	0.64	0.21	0.00	1.90	628.13	0.0000
	severe	1.27	0.33	0.00	3.57		
saw doctor	no	0.00			1.00		
	yes	0.89	0.21	0.00	2.43		
Model 3							
severity	moderate	1.17	0.36	0.00	3.22	618.61	0.0000
	severe	2.89	0.79	0.00	17.92		
saw doctor		1.45	0.31	0.00	4.28		
saw dr * moderate		-0.85	0.44	0.06	0.43		
saw dr * severe		-2.25	0.88	0.01	0.11		

Dependent variable coding RDD=0, ED=1

Model Interpretation

Given the significant interaction term the interpretation will be expanded.
Logistic regression equation;

log odds of disease = $Bo + B_1X_1 + B_2X_2 + B_3X_1X_2$
= constant + B_1 severity + B_2 saw fam dr. + B_3 severity* saw fam dr

	Saw Family Doctor	
Severity	**no**	**yes**
mild	= Bo	Bo + 1.45 X_2
moderate	= Bo + 1.17 X_1	Bo + 1.17X_1 + 1.45 X_2 -0.85 X_3
severe	= Bo + 2.89 X_1	Bo + 2.89X_1 + 1.45 X_2- 2.25 X_3

To interpret the effect of disease severity among those who had seen their family doctor in the last 12 months the equation can be evaluated as follows;

OR (mod/mild)= exp (1.17-0.85)= exp (0.32) ; OR=1.38

OR (severe/ mild) = exp (2.89-2.25) = exp (0.64); OR=1.90

To interpret the effect of seeing the family doctor anong those with different levels of asthma severity the equation can be evaluated as follows;

Mild asthma;
OR (saw fam dr yes/ saw fam dr no)= exp (1.45); OR 4.26

Moderate asthma;
OR (saw fam dr yes/ saw fam dr no)= exp (1.45- 0.85); OR 1.82

Severe asthma;
OR (saw fam dr yes/ saw fam dr no)= exp (1.45- 2.25); OR 0.45

Conclusion: For those who had seen their family doctor in the last 12 months those with moderate and severe disease were more likely to seek ED treatment. Furthermore, of those with mild and moderate asthma those who see their doctor are more likely to use the ED than those with mild or moderate asthma who don't. Of those with severe asthma those who see their family doctor may be at less risk of an ED visit than those who do not. This may suggest that those with severe asthma may be able to reduce their ED use if they see their family doctor frequently.

4.7.6 Model with Asthma Severity and use of Theophylline

It may be that those who take more medication are more apt to report more severe asthma. The potential for confounding between self reported asthma severity and medication use exists and needs to be described. Severity is an significant independent risk factor for membership in the ED group. The addition of theophylline to severity (model 2) reduced the risk estimate for severity suggesting some confounding between the variables. There was no interaction between severity and theophylline use (Table 4.54). Unfortunately, there were missing data from 82 participants for the theophylline variable limiting the ability to assess its effect. The number of cases included in the analysis was reduced from 505 to 423. Both independent variables should be evaluated in a final model.

Table 4.54

Model with severity and use of theophylline in the last 12 months in distinguishing between ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement
Model 1							
severity	mild	0.00			1.00	656.84	0.0000
	moderate	0.81	0.19	0.00	2.25		
	severe	1.45	0.33	0.00	4.25		
Model 2							
severity	moderate	0.43	0.22	0.05	1.53	547.86	0.0001
	severe	0.86	0.35	0.01	2.37		
theophylline^	none	0.00			1.00		
	occasional	1.06	0.44	0.02	2.88		
	daily	0.83	0.40	0.04	2.30		
Model 3							
severity	moderate	0.44	0.23	0.05	1.56	543.39	0.0006
	severe	1.11	0.41	0.01	3.03		
theophylline	occasional	1.37	0.82	0.10	3.92		
	daily	5.31	9.55	0.58	202.06		
occasional*	moderate	0.25	1.13	0.83	1.28		
occasional*severe		-1.51	1.13	0.18	0.22		
daily*moderate		-4.59	9.56	0.63	0.01		
daily*severe		-4.69	9.59	0.62	0.01		

^ theophylline in the last 12 months

Dependent variable coding RDD=0, ED=1

4.7.7 Model with Between Asthma Severity and use of Inhaled Steroids

As mentioned, the relationship between medication use and self reported asthma severity required description. The significance of severity as an independent predicator for an ED visit was reduced with the addition of inhaled steroid use to the equation. This suggests some confounding between the variables and both independent variables should be considered in evaluating the final model (Table 4.55). Unfortunately inclusion of inhaled steroid variable reduced the number of cases included in the analysis from 505 to 434 limiting interpretation of this variable.

Table 4.55

Model with severity and use of inhaled steroids in the last 12 months in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
severity	mild	0.00			1.00	656.85	0.0000
	moderate	0.81	0.19	0.00	2.25		
	severe	1.45	0.33	0.00	4.25		
Model 2							
severity	moderate	0.27	0.23	0.23	1.31	525.36	0.0000
	severe	0.32	0.38	0.40	1.38		
steroid	none	0.00			1.00		
tablet	occasional	1.52	0.27	0.00	4.57		
	daily	2.37	1.06	0.02	10.74		
Model 3							
severity	moderate	0.15	0.24	0.53	1.17	521.29	0.0000
	severe	0.47	0.50	0.34	1.60		
steroid	occasional	1.07	0.51	0.04	2.92		
tablet	daily	5.88	8.42	0.48	358.25		
moderate*occasional		0.86	0.65	0.18	2.36		
moderate*daily		-4.27	8.49	0.61	0.01		
severe*occasional		-0.04	0.81	0.96	0.96		
severe*daily-redundant							

Dependent variable coding RDD=0, ED=1

4.7.8 Model with Between Asthma Severity and Compliance

The relationship between asthma severity and compliance to medication was assessed in those 264 participants age 20 years or over. Severity remains a significant predictor of membership in the ED or RDD group however compliance was not significant in the equation and does not need to be evaluated in a final model. There was no confounding or interaction between severity and compliance (Table 4.56).

Table 4.56

Model with asthma severity and compliance in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
severity	mild	0.00			1.00	303.23	0.0000
	moderate	1.15	0.29	0.00	3.15		
	severe	2.06	0.49	0.00	7.85		
Model 2							
severity	moderate	1.17	0.31	0.00	3.23	275.27	0.0000
	severe	2.05	0.51	0.00	7.79		
compliance	<50%	0.00			1.00		
	>51%	0.21	0.29	0.47	1.24		
Model 3							
severity	moderate	1.75	0.47	0.00	5.76	268.21	0.0000
	severe	1.61	0.67	0.02	5.04		
compliance		0.61	0.46	0.18	1.84		
moderate*>50%		-1.13	0.63	0.07	0.32		
severe* >50%		1.51	1.26	0.23	4.53		

Dependent variable coding RDD=0, ED=1
n=264, age 20 or over

4.7.9 Model with Between Asthma Severity and Knowledge of Asthma

The relationship between asthma severity and knowledge about the disease was assessed in those 264 participants age 20 or over. There was no relationship between severity and knowledge, furthermore asthma knowledge was not a predictor of membership in the ED group (Table 4.57).

Table 4.57

Model with severity and asthma knowledge in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
severity	mild	0.00			1.00	303.24	0.0000
	moderate	1.15	0.29	0.00	3.15		
	severe	2.06	0.49	0.00	7.85		
Model 2							
severity	moderate	1.17	0.32	0.00	3.21	256.99	0.0000
	severe	1.90	0.54	0.00	6.67		
knowledge	<50%	0.00			1.00		
	>51%	0.23	0.30	0.45	1.25		
Model 3							
severity	moderate	1.24	0.45	0.00	3.44	256.91	0.0002
	severe	1.79	0.85	0.04	6.03		
knowledge>51%		-0.44	0.54	0.41	0.64		
moderate*>50%		-0.14	0.63	0.83	0.87		
severe* >50%		0.15	1.10	0.89	1.16		

Dependent variable coding RDD=0, ED=1
n=264, age 20 or over

4.7.10 Model with Between Compliance and Asthma Knowledge

The relationship between compliance and knowledge was evaluated for the 264 participants age 20 or over through logistic regression. Neither compliance nor knowledge were predictive of an ED visit for asthma, nor was there any confounding or interaction between the two variables (Table 4.58).

Table 4.58

Model with between compliance and knowledge in distinguishing between the ED case and RDD control

Variable		Beta	SE(B)	p	exp B	-2log LR	significant improvement p<
Model 1							
compliance	0-50%	0.00			1.00	304.53	0.9755
	51-100%	-0.00	0.27	0.97	0.58		
Model 2							
compliance		-0.03	0.30	0.91	0.97	254.74	0.3433
knowledge	0-50%	0.00			1.00		
	51-100%	0.46	0.30	0.15	1.53		
Model 3							
compliance		0.48	0.44	0.27	1.61	252.15	0.1931
knowledge		0.95	0.45	0.03	2.59		
compliance*knowledge		-0.97	0.61	0.11	0.38		

Dependent variable coding RDD=0, ED=1
n=264, age 20 or over

4.7.11 Conclusions from preliminary logistic regression

Independent variables that discriminate between the ED and RDD asthmatic should be evaluated in the model building process. These independent variables include; city, severity, age group, emergency room use, a visit to the family doctor within the last 12 months, theophylline and inhaled steroids. Potential interaction terms include severity * a visit to the family doctor in the last 12 months.

Additional variables that may be potentially important and merit further investigation in other studies include vulnerability and education. Given the sample size and the desire for a parsimonious clinically relevant model these variables were not evaluated in the final model.

4.8 Development of a Multivariate Model that Distinguishes Between the ED asthmatic and the RDD asthmatic

The variables in the univariate logistic regression that were significantly different between the ED and RDD group were evaluated in a model building process to determine the most parsimonious and clinically useful model that would distinguish between the ED and the RDD asthmatics.

The model was developed with all participants, including those in the RDD group who had had and emergency department visit for asthma in the past. It was developed in an investigator driven fashion in consultation with Dr. Sarah Rose.

The model was built up by adding variables to the prediction equation one at a time. All significant variables were tested in the equation and all significant interaction terms were included (as were their main effects regardless of significance).

The model was then tested using forward selection and we came up with the same model. In forward selection the first variable considered for entry into the equation is the one with the largest correlation with the dependent variable. Once one variable is entered the statistics for variables no in the equation are used to select the next one. The variable with the largest partial correlation is the next candidate. The procedure stops when there are no other variables that meet the entry criteria. Once the model was derived the analysis was replicated excluding those in the RDD group who had had an emergency department visit for asthma, with the result that the OR were further removed from 1.

When sex was added to the final model there was no evidence of a significant effect of sex. In addition there was no evidence of any two-way interactions between sex and the variables included in the model.

All other potential two-way interactions were tested and only one found to be significant. The interaction between age group and use of the ED was included in the model. The was no evidence of any other two way interactions between the variables in the model.

The likelihood ratio statistic is reported in the final table as an indication of the improvement in the fit of the model with the addition of the variable. The classification table provides a measure of the goodness of fit of the data and suggests

how well the data from both the ED and RDD groups fit the final model (174).

Use of inhaled steroids in the past 12 months was not significant when included in the final model. Theophylline was tested for inclusion in the final model and was rejected for two reasons: 1. The loss of cases available for analysis reduced the power 2. The fit of the model was compromised with the inclusion of theophylline; the fit of the model for those seen in the ED remained high (84.34%) but the fit of the model for those in the RDD group was reduced (64.85%).

4.8.1 The Multivariate Model that Distinguishes Between the ED and RDD Asthmatic

The factors that distinguished the ED asthmatics from the RDD asthmatics include: location, asthma severity, use of the ED, age group, visits to the family doctor and two interaction terms, use of ED * age group and severity* visit to family doctor. The independent contribution of each factor can be estimated from the exp B (OR), and the significance derived from the 'p' value. The individual at highest risk of an ED visit for asthma could be described as a severe asthmatic between the ages of 5-14 who has required physician and ED treatment for asthma more than once in the preceding 12 months (Table 4.59).

Table 4.59

Final model : Factors that distinguish the ED asthmatic from the RDD community asthmatic control

Variable	Beta	SE(B)	p	exp B	-2log LR	significance of improvement
Use of ED						
index or none		0.00		1.00	595.75	0.0001
1 or more	0.69	0.37	0.06	1.99		
Edmonton	0.00			1.00	533.49	0.0001
Lethbridge	1.80	0.24	0.00	6.06		
Severity						
mild	0.00			1.00	518.78	0.0006
moderate	2.07	0.88	0.02	7.94		
severe	4.53	1.78	0.01	92.95		
Visit to the family doctor in the last 12 months						
no	0.00			1.00	512.38	0.0115
yes	1.18	0.36	0.00	3.24		
Severity* visit to family doctor						
moderate*visit	-0.84	0.51	0.10	0.43	504.68	0.0213
severe*visit	-2.12	0.97	0.03	0.12		
Use of ED * age group						
1or more* 15-29	1.75	0.63	0.01	5.77	498.10	0.0373
1 or more * 30-50	1.31	0.64	0.04	3.69		
Age group						
5-14				1.00	490.52	0.0225
15-29	-0.43	0.30	0.15	0.65		
30-50	-0.97	0.36	0.00	0.38		
Dependent variable coding	RDD=0, ED=1					

Model Interpretation

The interaction between severity and seeing the family doctor in the last 12 months was elaborated on in Table 4.53. The interaction between age group and use of the ED was uncovered in evaluating the final model and will be elaborated on here.

Logistic regression equation;

log odds of disease = $Bo + B_1X_1 + B_2X_2 + B_3X_1X_2$

= constant + B_1 age group + B_2 use of ED + B_3 age group* use of ED

	Use of the ED	
Age Group	no	yes
5-14 = Bo		Bo + 0.69 X_2
15-29 = Bo -0.43 X_1		Bo-0.43X_1 + 0.69X_2 +1.75 X_3
30-50 = Bo -0.97 X_1		Bo -0.97X_1 + 0.69 X_2+1.31 X_3

To interpret the effect of age group among those who had had and ED visit for asthma in the last 12 months the equation can be evaluated as follows;

OR (15-29/ 5-14)= exp (-0.43+1.75)= exp (1.32) ; OR=3.74

OR (30-50/5-14) = exp (-0.97+1.31) = exp (0.34); OR=1.45

To interpret the effect of an ED visit among those in different age groups the equation can be evaluated as follows;

5-14;
OR (ED yes/ ED no)= exp (0.69); OR 1.99

15-29;
OR (ED yes/ ED no)= exp (0.69+1.75); OR 11.47

30-50;
OR (ED yes/ ED no)= exp (0.69+1.31); OR 7.39

Conclusion

Those aged 15-29 were most likely to report more than one visit to the ED in the last 12 months excluding the index visit. Previous use of the ED significantly increased the odds of repeat ED use among all participants.

4.8.2 Classification Table for the Final Model

The classification table suggests what percentage of the data would fit the above described model, it provides a comparison of predictions to observed outcomes (167,174). Slightly more than 71% of the RDD group would be correctly classified from the model, almost 80% of the ED group fit the model. The overall fit exceeds 75%.

4.60 Classification table for the final model

	Predicted RDD	ED	
Observed			
RDD	147	58	71.71%
ED	59	230	79.58%
		Overall	76.32%

chi square 179.96, 11 degrees of freedom, p<=0.0001

4.9 Summary

Characteristics that distinguish the ED case from the RDD control included moderate to severe asthma of early onset, short period of symptoms prior to diagnosis, and duration less than 5 years. The ED cases reported deteriorating asthma control in the months or year preceding the ED visit, described by more scheduled and unscheduled visits to the doctor, and other visits to the ED. The ED asthmatic, potentially through these contacts with health professionals, was more apt to have increased use of asthma medication in the past year and to use more medication than the RDD controls. Additionally, the ED asthmatics were likely to be under the age of 30, and often under the age of 14.

In the adult asthmatic feelings of vulnerability were more common among ED cases. Generally, those individuals who felt vulnerable were more apt to be in the ED group than those who didn't.

The ED asthmatic was not distinguished from the RDD control by gender or symptom frequency. Comparisons between the ED and RDD asthmatic for gestational age, childhood respiratory illness and co-morbidity did not reveal differences. Although the ED asthmatic were more likely to live in an older home there was no difference in the interior environment on the variables we measured. There was no difference in amount of education completed, smoking or keeping indoor pets when the group was stratified on disease severity. Although there was some suggestion that the ED asthmatics were more knowledgable about asthma, there was no difference in

compliance to medication regime, or in the ability to recognize and control asthma symptoms.

5.0 DISCUSSION

The objective of this research was to determine risk factors associated with an exacerbation of asthma serious enough to warrant an ED visit. Some issues unique to this project will be discussed, including self reporting of asthma severity and proxy response. As outlined below, the prospective case-control design has both limitations and strengths.

The results are discussed in light of current research and the implications of these results will be suggested.

In keeping with the objective of this research project the discussion focuses on the differences between the ED cases and the RDD controls and proposes areas for intervention and for further study.

5.1 Case-Control Study Design

The central feature of the case-control design is the comparison of two groups defined on the basis of disease health status. The case-control design has been found to be well suited to investigate multiple explanatory variables or potential causes of a disease or event since many risk factors can be investigated at the same time (175). In this instance the cases were identified on the basis of an ED visit for asthma (ED case) and the controls were not. Factors potentially related to an ED visit were compared for cases and controls and implications of any differences or lack of differences will now be discussed.

5.1.1 Recruitment of Cases and Controls

For accurate comparisons between the groups we required a doctor's diagnosis of asthma to increase the likelihood that both cases and controls had the same disease; asthma and not other respiratory illnesses. Only those between 5 and 50 years were chosen to reduce the likelihood that COPD was either a co-morbidity or a misdiagnosis, and to ensure that participants were old enough to have received a reliable diagnosis of asthma. The diagnosis of asthma is not easy and there is a chance that some of those in the community with respiratory problems such as recurrent wheezing or nocturnal cough may have had undiagnosed asthma. Therefore, it is more likely that these individuals who might have had mild asthma would not be included in the study. This would make the case group with more severe asthma more similar to the control group and could bias risk estimates toward the null (175).

The control group represented those who would have been identified and included as cases had they required ED treatment for asthma. It is possible, however, that in Edmonton some of the controls would have sought medical treatment at ED's other than the University of Alberta Hospital. Historically, asthma patients at the ED

at the U of A hospital have had higher hospital admission rates than the other ED's in the city (19). It is not known whether this reflects the type of asthma patients coming to this ED or treatment practices. Selection bias could have occurred because the controls were selected from Edmonton and not exclusively from the area surrounding the U of A hospital and this is a limitation of the study. However, this bias would not have been present in the Lethbridge component of the study and the results from this analysis were similar to those found in the Edmonton analysis providing some confidence in the generalizability of the results.

Given the focus of the questionnaire on issues of daily living and environmental matters there is little reason to suspect that preferential recall could explain the results, providing support for generalizability (175).

5.1.1a Evaluation of RDD as a means of control recruitment

Random digit dialling is a commonly used method of selecting control subjects for population-based case-control studies. The representativeness of control groups chosen by this method has been studied and found to be acceptable, although low response rates from RDD may lead to biased results (176). A study designed to compare information obtained from control groups identified using RDD with those selected by area sampling found similar frequencies of various population characteristics, suggesting that RDD provides representative samples and valid odds ratios for a wide range of variables of interest in human populations (177).

Appropriate RDD techniques must be adhered to in order to obtain valid information and to avoid introducing bias into the results (178). The methods used throughout this study meet the rigorous requirements of RDD methodology, including the exclusion of numbers that have been 'changed', and clarification that the number reached was the number dialled, which uncovered both misdialling and call forwarding. As well, if an answering machine was reached no information about the study was provided and the number was re-dialled at a later time. The number reached was confirmed to be residential. Criteria were established in advance concerning the selection of a participant within the residence should there have been more than one eligible (178).

RDD methodology can introduce bias because homes without telephones are excluded from potential recruitment into the study, however, in the regions sampled for this study over 98.0% of the population had a phone (Population Research Laboratory, personnal communication). This bias can be dealt with by excluding cases without telephones (179). Indeed, all cases that participated had a viable phone number, and of the few cases without phone numbers repeated attempts to contact them by mail were unsuccessful. Hence, all participants had an active number. This restricts the generalizability of the results to those with phones and consequently the results may not apply to those of very low socio-economic status.

The cases were recruited from hospital centres and the selection of appropriate controls poses more problems than for population based studies. To minimize bias introduced by recruiting controls from a broader region than cases it has been suggested that RDD be based on the telephone numbers of the cases (179). However, the cost of this procedure was prohibitive and the risk of over-matching exists.

The study would have benefitted from additional controls from the Lethbridge region, although the region was over sampled compared to Edmonton. For example we exhausted 5335 phone numbers from a population base of approximately 750,000 in Edmonton (0.66%), for Lethbridge we exhausted 1090 phone numbers from a population base of 75, 000 (1.45%).

With the rapid growth in the use of RDD for surveys response rates may be poor (179), however, we had few refusals from our target audience and our response rates were satisfactory.

The challenge of applying RDD methodology to the study of a rare disease was in contacting the target audience, those between the ages of 5-50 with asthma. It has been suggested that RDD methodology not be applied when the criteria for participation in the study excludes more than 10.0-20.0% of the sampled population (180), in our study we 42.9% of the sample were either not asthmatic or out of the age range and consequently this sampling methodology was not a particularly efficient method of recruiting controls. Further research in asthma could examine other methods of control recruitment, including pharmacies and general practitioners' offices.

In summary, although the methodology of RDD was rigorously applied in this study and bias due to mis-application of appropriate techniques was probably minimal, the appropriateness of this technique for the recruitment of controls into a study of a disease such as asthma is questionable.

5.1.2 Methods of Data Collection

5.1.2a Mailed Questionnaire

Mailed surveys are a reasonable method for data collection for a specialized sample, such as this, although responses to mailed surveys can be low (<70.0%) (166,181). The instrument for gathering information was a structured self-completed mailed questionnaire. The questionnaire was exhaustive in detail and contained validated components from the EC Respiratory Health Survey Questionnaire (165) and the Asthma Opinion Survey (164). The questionnaire was initially pilot tested and any areas found with ambiguities, complex language and inconsistencies were amended or deleted.

To minimize the risk that illiterate individuals might be excluded from the sample, all participants who did not return the questionnaire were contacted individually and encouraged to complete a telephone interview. The response rates

were adequate and similar for both the ED and RDD groups (ED=76.2%, RDD=76.3 %). Unfortunately, the number of controls recruited for the Lethbridge RDD arm of the study was substantially less than the number of cases. However, the total numbers of cases and controls were sufficient for the data analysis (337 ED, 212 RDD).

The matter of reliability and validity of self-reported data obtained by the questionnaire process has been investigated (182-184). Self report of sensitive issues on a questionnaire may not be reliable (182). However, as was the case in this study, when the information is not used for the purposes of assessing an individuals treatment and does not have any impact on clinical care, self-reporting provides usefully reliable and valid data (182).

5.1.2b Proxy Response

For ethical reasons information was obtained by proxy for those participants under age 16; in all instances the proxy was a parent or legal guardian. The literature suggests that proxy response provides reliable data (183). High levels of agreement have been found between asthmatics and close acquaintances as regards personal history, psychiatric characteristics, limitations in daily activities, asthma severity, frequency of asthma exacerbations, medication use, doctor visits and hospital services (183). Although proxy response may under-report use of medication, the data provided are still considered reliable with regard to types of medication prescribed and purchased (183,184). In fact, proxy response for those under 16 might have provided the most accurate information on childhood illnesses, asthma history, medical care and home environment. In summary, the questionnaire was comprehensive and provided an opportunity to assess lifestyle, attitude, environment, perceived severity and health care utilization.

5.1.2c Self Report of Disease Severity

Classifying the severity of an asthma condition has proven to be a problem because of the chronic and episodic nature of the disease (96,185). Scales have been developed and used to describe the severity of the acute asthma attack, to identify the need for hospitalization and to assess change in the clinical status of the asthma patient (96,185). Although physician reports have been used to classify study participants' underlying disease severity, physicians were not contacted for this study (186). As recommended, the validity of self reporting of asthma severity was determined by means of assessing its conformity with other measures that also reflect the severity of an asthma condition (96). Results from this study indicated that self-reported severity was related to a combination of factors resulting from and reflecting asthma severity such as medication use and health care utilization. Other researchers have reported that independent self-assessment of asthma severity generally correlates

with objective markers such as medication use and health care utilization (169). Given the currently available instruments, self-reported asthma severity is a reasonable method to establish health status and was considered suitable for this study.

5.1.3 Response Rates

Our response rates exceeded 70.0% for all groups with the exception of the Edmonton RDD group where the overall response rate may have been as low as 67.0%. However, the participation rate among those in the RDD group who agreed to participate was 77.0% and the rate of 67.0% was the minimum response rate that would have resulted if all of those who initially refused had met the study criteria. Unfortunately, the assumption that some of them would not have met the criteria can not be tested. Similar patterns of responses were observed for cases and controls providing some reassurance against selection bias (181).

When nonparticipation rates are high the validity of the study is threatened. The reasons for which controls chose to participate in a study are unclear, but they may be different from those of cases and participants may be more health conscious than nonparticipants (175,181). Restricting the sample to populations that yield high participation can minimize selection bias (181).

5.2 Features Distinguishing the ED Case from the RDD Control

Logistic regression techniques were used to design a model that would describe the differences between the ED cases and the RDD controls. The odds ratio (exp B) allowed measurement of the strength of the relationship between the independent and dependent variable (ED case) while controlling for other independent variables in the equation. As mentioned in the results section, the profile of the ED asthmatic was distinguished from the RDD control by having more severe disease, being younger, and making more frequent use of health care resources (both a doctor and the ED). Each of these independent variables will be discussed in more detail below.

Those seen in the ED for asthma treatment had more severe disease than the RDD asthmatic, and were more likely to have required CPR at some point (although the numbers are small). It was found that cases with moderate disease and severe disease used the ED eight and 90 times more, respectively, than cases with mild disease. This indicates that disease severity is a powerful indicator of ED usage, a finding that is supported by the literature (142,186,187).

The data also indicated that those seen in the ED were younger; 40.3% of the ED group vs 31.0% of the RDD group were less than 16 years old, and their asthma was more recently diagnosed than the RDD control. Those with an ED visit were more

likely to have asthma for 1 year or less. In approximately 52.0% of cases the individual had been diagnosed with asthma within six months of respiratory symptom onset. This presented a picture of the ED asthmatic as a young individual with acute onset of symptoms which resulted in a diagnosis of moderate to severe asthma. The rapid onset of severe symptoms may foreshadow the severity of the disease. It has been reported that the more severe the onset of asthma in childhood the less likely the child is to 'outgrow' their asthma (188-190). Furthermore, the ED asthmatic was diagnosed with asthma at a younger age than the RDD control. It has been reported that increases in asthma prevalence are primarily a result of increased prevalence in those under age 17 and our finding that the ED asthmatic is both younger and newly diagnosed is consistent with these published findings (15,27-29,191).

The association between the frequency of ED use and age indicates that younger patients are more likely to use the ED than older patients. This may result from parents/caregivers taking their children to the ED when asthma control deteriorates more readily than an adult would seek assistance for their own asthma. Parents have cited their inability to relieve their child's symptoms as a major component of the burden of the disease (192).

The observation that previous use of the ED doubled the chance of subsequent use supports findings which suggest that there is a subgroup of individuals who, because of severe asthma and/or chronic under-treatment, make multiple visits to the ED (186,187). It has been further observed that these repeat visits to the ED are not related to a lack of understanding of asthma severity by the individual, to their psychological health, or to environmental allergens (187). The need for ED use has been related to delays in treatment or from chronic under-treatment contributing to a deterioration in asthma control, and, in the extreme, death (74,113,140,146). Further research is required to determine whether under-medication is a result of patient non-compliance, physician under-prescribing, or a combination of these and as yet unidentified factors.

Visits to the family doctor were found to be more common in the ED group than the RDD group. Those with mild asthma who saw their family doctor in the previous 12 months for asthma were more likely to seek ED treatment than those who did not. Visits to the family doctor have been found to be directly related to asthma severity (187), and these visits seem to be essential in maintaining asthma control, particularly in those with severe asthma. These findings suggest that those with severe asthma who frequent their doctor may be less likely to seek ED treatment. Visits to the family doctor may reflect the asthmatic's deteriorating control over the 12 months preceding the ED visit. Deterioration in control was evidenced by increases in, amounts and types of medication used, unscheduled and scheduled visits to the family doctor or specialist, and more frequent use of the ED. Awareness of these trends by physicians and patients should prompt actions that could include lifestyle changes, alterations in medications, patients education or other interventions that could prevent

further deterioration and improve asthma control (127).

Lack of compliance to prescribed medications has been cited as an important contributor to poorly controlled disease (74,113,136,139,148). This study did not find case-control differences in compliance in either the crude analysis or after adjusting for severity.

Issues related to non-compliance have been observed across a spectrum of chronic diseases (149,193,194). The relationship between disease severity, health care utilization and medication compliance can be discussed within the context of the Health Belief Model (193,194). This model suggests that a patients' behaviour depends mainly on two variables: (1) the desire to avoid illness; and (2) the individuals' estimate of the degree of threat of the illness and of the likelihood of being able through personal action to reduce that threat (195). If a desire to avoid illness is assumed, the importance of patient education regarding the potential consequences of uncontrolled asthma and personal actions that can be taken to reduce risk becomes more obvious.

Both the ED and RDD asthmatics reported sensitivity to numerous triggering factors including colds, flu, physical activity and exposure to cigarette smoke and other allergens. As well, more ED asthmatics reported drugs, colds and stress as trigger factors for their asthma. An interesting relationship was observed between the ED and RDD asthmatics in Edmonton. The RDD asthmatics were less likely to have taken measures to control their environment as indicated by their failure to abandon smoking or give up their indoor pets, this may reflect less severe disease and an ability to cope with these environmental allergens.

The ED asthmatics scored higher than the RDD asthmatics on issues of knowledge about asthma medications. It may be that, in the same way that the ED asthmatic had acquired information about the role that medication plays in controlling the disease, they also acquired information on how the environment impacts on asthma. The RDD asthmatics may not have received this information, possibly because they had fewer contacts with health professionals. The same difference was not observed in Lethbridge and this may reflect the lower average level of severity among ED asthmatics in Lethbridge.

Participants in this study completed the Asthma Opinion Survey that was designed to address feelings of vulnerability. Richard et al. found that higher scores on vulnerability were associated with being African-American, having less education, and with having more severe asthma, including more severe symptoms (164). Our data allowed us to elaborate on Richard' initial findings concerning the relationship between disease severity, feelings of vulnerability and ED utilization. Results from our study revealed that, given comparable disease severity, the adult seen in the ED feels more vulnerable to their asthma than their RDD counterpart. Given severe disease, those in the ED group were almost 8 times more likely to score high on vulnerability than those in the RDD group, although the numbers were small; given moderate disease,

those in the ED group were 3 times more likely to score high on vulnerability than those in the RDD group. These data may suggest that those seen in the ED are a sub-group of the population of asthmatics who feel particularly vulnerable at a given level of severity. There is no evidence to indicate that those diagnosed with asthma are more anxious or depressed by nature or character (158,160,196), nor is there apparent reason to suggest that there is a psychological profile unique to asthmatics, although others may dispute this (161). The relationship between the patients' sense of vulnerability and ED usage underlines the need for education programs focused on patient empowerment (121,195).

5.3 Public Health Implications

One goal of epidemiology is to provide information to public health practitioners in order that programs can be designed to minimize illness and improve quality of life. Co-incidently, health care costs are reduced through better maintenance of health and reduced morbidity. The design of an effective education program requires knowledge about who is at risk and about factors which may be amenable to modification through intervention such as education. In this regard, therefore, some factors emerged through this work which may be of value to public health practitioners and asthma educators.

The importance of asthma education has been the subject of much discussion and research (121,127). There is consensus that all asthmatics should be taught about the nature of asthma, its inciters and inducers, treatment goals, means of achieving control and of preventing deterioration, effects of medication and side effects, compliance, measurements of peak expiratory flow rates, and the use of action plans (127). In this study 83.5% of the total sample did not use or did not have a peak flow meter and 87.4% of the sample did not have an action plan to follow when they experienced a deterioration in asthma control. This indicates that the ideals of medical management and education are not in evidence at a community level. In theory therefore, implementation of a public health initiative to encourage the use of action plans and peak flow meters should significantly reduce asthma morbidity.

Based on the present study the young, newly diagnosed asthmatics and their families should be taught to recognize and to respond to a deterioration in the control of their asthma and thereby prevent a serious exacerbation or death (113,146). It has been reported that the cost of an educational intervention in a adult population is $85.00 US per person, with a subsequent reduction in health care costs, including ED visits and hospitalizations, during the following year of $628.00 US (197). Similar results have been demonstrated by others (126).

The observation that, despite contact with a doctor, many of the ED asthmatics continued to experience a deterioration in asthma control over a 12 month period may reflect a need for professional as well as patient education (128,146). Indeed, some

studies have revealed that general practitioners measured lung function in only 50% of their patients and they instructed patients in how to use a peak flow meter in less than 10% of patients (127,198,199). This finding lead the authors to conclude that the level of knowledge by non-specialist health professionals about asthma and the attendant skills in educating patients should be improved.

Although scholastic achievement has not been related to the development of asthma (145), or to asthma severity (142), it has been documented that childhood asthma causes considerable school absenteeism (8,200). In a 25-year follow up study, educational achievement did not differ between those with 'asthma', those with 'wheeze in the presence of upper respiratory tract infections (wheeze)' or a control group without asthma (188). These data were obtained from 63% of the original 'asthma' group and 59.8% of the original 'wheeze' group. It is noteworthy that 23% of the 'asthma' group felt that respiratory problems had been detrimental to their education compared with 5% of the 'wheeze' group and none of the controls (188). Unfortunately, almost 40% of the original case group were lost to follow up and the relationship between asthma severity and educational achievement was not evaluated. The present study suggested that 46.1 % of those with more severe asthma (regardless of group membership) attended or completed college or university compared with 60.6 % of those with moderate asthma and 79.2% of those with mild asthma. This observation is consistent with high rates of school absenteeism in childhood and adolescence for those with severe disease. Programs offered to asthmatics could provide information on how educational achievement can be maintained or recovered after an absence, or repeated absences, due to asthma. This may require targeting newly diagnosed asthmatics as well as school-aged children and their parents. In this way the information can be available early enough to assist in establishing study habits that will allow the patient to cope with lost study time.

The role of 'attitude toward disease', its impact on health care utilization and strategies for teaching 'optimal coping' requires further study. The Health Belief Model (HBM) is a conceptual framework for understanding why individuals do or do not engage in health related actions and provides a model for understanding the role that vulnerability and disease severity play in asthma control (195,201). Of the 4 dimensions of the HBM the dimension of 'perceived susceptibility' suggests that individuals vary widely in their feeling of personal vulnerability to a condition. The dimension of 'perceived severity' suggests that feelings concerning the seriousness of the illness also vary from person to person (195). Other dimensions of the HBM include 'perceived benefits' (e.g., actions to reduce disease threat are feasible and efficacious) and 'perceived barriers' (e.g., actions to reduce disease are perceived as unpleasant, inconvenient or time-consuming) (195,201). Individual variation in 'perceived severity' of an acute attack may impact on appropriate management of asthma. Acknowledging feelings of vulnerability and their impact on morbidity should be included in an education program. Participants could be taught to recognize and

cope with feelings of vulnerability, thereby potentially improving asthma control.

5.4 Summary

The major importance of this study in furthering our understanding of asthma resided in our ability to compare those who sought ED treatment for asthma with those who did not. A great deal of attention has been focused on describing the high risk asthmatic in terms of those admitted to hospital and those with difficulty in controlling disease (32,39,61,64,74,139,142,144,147,150,186,187). Less attention has been paid to determining the characteristics that distinguish these individuals from other asthmatics (140,143,187). The comparison of a variety of factors between groups of asthmatics provided an opportunity to determine if there were variables that could be identified and modified so that the need for ED treatment among those at risk can be avoided.

Given the current understanding of asthma, some characteristics of the ED asthmatic may not be amenable to alteration. An appreciation of these variables, however, facilitates the design and implementation of appropriate public health initiatives. The observation that many ED users were young and recently diagnosed may indicate that ideal asthma control requires time for the individual and family to accept the disease, and time to determine the optimum methods of treatment. The initial phase of a patient learning to deal with a newly diagnosed disease provides a window of opportunity for asthma education. Such education programs designed for newly diagnosed asthmatics should improve the patients' health and reduce the need for future ED visits for asthma. In addition, although the standard components of an education program should not be overlooked, specific information on how to cope with both schooling and with feelings of vulnerability should be beneficial to the patient.

Study participants sought medical care through both scheduled and unscheduled visits to the doctor during the year preceding the ED visit. This suggests that there were (possibly missed) opportunities for patient education and re-evaluation of pharmaceutical and non-pharmaceutical management. Continuing medical education should be an important forum for the distribution of current information in this rapidly changing field.

Finally, strategies that encourage improved control of the underlying disease will require the combined efforts of clinicians, patients, caregivers, educators and researchers.

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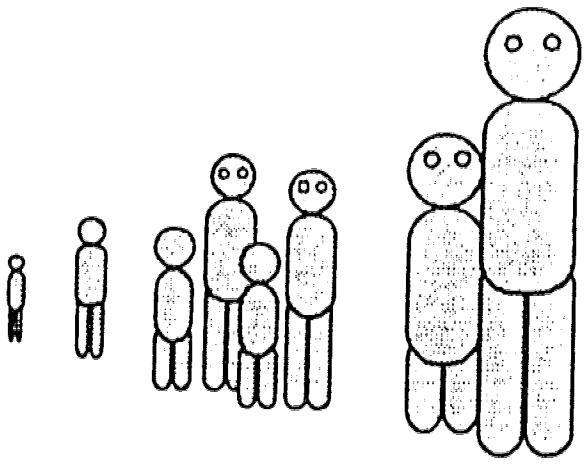
APPENDIX 7.1

Questionnaire

The Prairie
Lung
Associations

1992/95

Prairie Provinces Asthma Study



ASTHMA STUDY INFORMATION

Date

Dear Participant:

The University of Calgary and the University of Alberta in collaboration with the University of Saskatchewan and the University of Manitoba are conducting the Prairie Provinces Asthma Study. The study is funded by Health and Welfare Canada.

Please take the time to read this information carefully. It will give you the basic idea of what the research project is about and what your participation will involve. If you would like more information or detail about something mentioned here, please feel free to phone.

What is the purpose of the study?... Gathering information from many people who suffer from asthma will help us identify factors that may cause asthma to deteriorate and may cause acute attacks of asthma.

What does participating involve?... The attached questionnaire asks about your own or your child's asthma, medications, and allergies. It will take approximately 40 minutes to complete. Please help our research by completing the questionnaire.

Participation is voluntary... Participation is voluntary. You can withdraw from the study at any time. If you chose not to participate, your medical treatment will not be affected in any way.

Confidentiality... All information you make available to us is confidential and will be used exclusively for this study. Names will not be used when the information is published.

Benefits to you and to others... Results of this study will help us learn more about the causes of asthma and help us design asthma education programs for asthma suffers, medical professionals, and the public.

For further information on the study... If you have any questions about this study or would like to have further information, please contact:

Suzanne Tough
Asthma Project Coordinator
Phone: **1-800-661-5762.**

Your consent and legal rights... Your signature on the following page indicates that you understand to your satisfaction the information regarding your participation in this study and you agree to participate. This does not waive your legal rights nor release the study investigators or the involved universities from their legal and professional responsibilities. If you have any questions concerning your rights as a possible participant in this research, please contact:

Office of Medical Bioethics
Faculty of Medicine
University of Calgary
Phone: (403) 220-7990

ASTHMA STUDY CONSENT

Your signature indicates that you understand to your satisfaction the information regarding the Prairie Provinces Asthma Study and you agree to participate.

Name of Participant
please print

Name of Parent or Guardian *if participant is under the age of 18 years*
please print

Signature

if participant is under the age of 18, a parent or guardian must sign this release

Date

Address of Participant

town/city *province* *postal code*

Phone no. at work **Phone no. at home**

Name of Witness **Signature of Witness**
please print

Date

INSTRUCTIONS

Thank you for agreeing to participate in the Prairie Provinces Asthma Study.

Please help us by answering the questions on the following pages. If you do not know the answer to a question please write *"don't know"* by the question. Your truthful responses are important to help us learn more about asthma.
All of the information is confidential.

- Please use *ink*.
- Please *print* the fill-in responses.
- Select your responses with a *check* ✓ *mark*.

Upon completion of this questionnaire, please return it to:

Prairie Provinces Asthma Study
4070 Bowness Road, N.W.
Calgary, Alberta T3B 3R7

A self-addressed postage paid envelope is provided for your convenience.

GENERAL QUESTIONS

1 What is your birth date?

day *month* *year*

2 Are you?

male

female

3 What is your ethnic origin?

Caucasian (white)

North American Indian, Metis, Inuit

Oriental

East Indian

other

4 What is your highest level of education?

grades 1 - 6

grades 7 - 11

grade 12 graduate

after completing grade 12, **attended** technical school, college, or university

completed technical school, college, or university

5 Where do you live?

within city or town limits

on a farm

on an acreage

6 Did you move to this province from another province/country within the last 10 years?

no *go to question 7.*

yes *answer questions 6.1 & 6.2*

6.1 Where did you live before you moved to this province?

6.2 Did you move to help control your asthma?

no

yes

ASTHMA HISTORY

7 How old were you when your asthma was diagnosed by a doctor?

An estimate is ok

8 How long did you have asthma symptoms such as coughing, wheezing, or chest tightness before you were diagnosed with asthma?

less than 1 month

1 - 6 months

7 - 12 months

1 year or more

don't know

9 Do you have any other illnesses?

no *go to question 10.*

yes *please specify other illnesses*

ASTHMA SEVERITY

10 How would you rate the overall severity of your asthma condition?

severe: seriously interferes with normal lifestyle

moderate: occasionally interferes with normal lifestyle

mild: interferes infrequently with normal lifestyle

I am interested in when your asthma is *worse*. By *worse*, I mean when your asthma is bad enough that you need to change your daily routine, make an unscheduled visit to the doctor, or change your usual medication.

11 Is there a time of year when your asthma is **worse**?

no *go to question 12.*

yes *answer question 11.1*

11.1 When is your asthma **worse**?
Select the season(s) that apply.

winter spring summer fall

ASTHMA SEVERITY

12 In a week when you **are *not* having problems** with your asthma, how often do you have symptoms such as coughing, wheezing, or chest tightness?

not at all

1 or 2 times per week

3 or 4 times per week

5 or more days per week

symptoms only with physical activity

13 In the last 12 months did you need to make an **unscheduled visit to your doctor** for your asthma?

no

yes *how many times? An estimate is ok*

14 In the last 12 months did you need to **go to the emergency room** for your asthma?

no

yes *how many times? An estimate is ok*

15 In the last 12 months did you need to **increase your medication(s)** to control your asthma?

no

yes *how many times? An estimate is ok*

16 How often in the **past two weeks** did you wake up in the ***morning*** with asthma symptoms such as coughing, wheezing, or chest tightness?

not at all

1 to 3 morning

4 to 8 morning

9 to 13 morning

every morning

17 How often in the **past two weeks** did you wake up at ***night*** to use your asthma medications?

not at all

1 to 3 nights

4 to 8 nights

9 to 13 nights

every night

COUGH AND MUCOUS

18 Do you often feel that you have mucous or phlegm in your chest that needs to be coughed out?

no

yes

19 How frequently are you coughing *today?*

none: unaware of coughing

rare: cough now and then

occasional: less than hourly

frequent: one or more times an hour

almost constant: never free of cough or feeling free of the need to cough

20 How frequently were you coughing *last night?*

none: unaware of coughing

rare: cough in morning but I don't waken from sleep

occasional: wake a few times but I fall back asleep right away

frequent: waken many times through the night with fits of coughing

almost constant: up all night long with coughing

21 How severe were your coughing episodes on a typical day during the *past week?*

none: unaware of coughing

mild: did not interfere with usual morning or daily activity

moderate: must stop activity during coughing episode

marked: must stop activity during and for a brief period after coughing episode

severe: stop all activity for some time and am exhausted sometimes accompanied by dizziness, headache, and/or pain

22 How easy is it to cough up phlegm when you cough *today?*

none: unaware of coughing at all

easy: phlegm comes up without difficulty after only one or two coughs

somewhat difficult: most of the phlegm comes up but only after several hard coughs

very difficult: some phlegm comes up after hard coughing but there is the feeling that most is sticking down there

impossible: there is phlegm down there but no matter how hard the coughing nothing comes up

23 How much chest tightness or discomfort do you have *today?*

none: unaware of any discomfort

mild: noticeable now-and-then but is not bothersome and passes quickly; does not limit activity

moderate: noticeable during light activity such as walking one block or up one flight of stairs

marked: noticeable while washing or dressing in the morning

severe: almost constant and limits all activity; present even while resting

ASTHMA MEDICATIONS

24 **Please tell me which asthma medications or treatments you used in the *last month* and in the *last 12 months*. How often did you take the medication and what is the specific name of the medication?**

List of Medications and Treatments	How often taken in the last month?	How often taken in last 12 months?	Name of Medication *Please write down the specific name*
No Medication			
	no medication taken in last month	no medication taken in last 12 months	not applicable
Symptom Relief Medication			
beta-agonist bronchodilator: **Alupent, Berotec, Bricanyl, Bronkaid, Medihaler, Nephron, Pro-Air, Salbutamol, Ventolin**	none occasionally every day	none occasionally every day	
ipratopium bronchodilator: **Atrovent**	none occasionally every day	none occasionally every day	
bronchodilator tablets containing theophylline: **Choledyl, Phyllocontin, Quibron, Somophylline, Tedral, TheoDur, Theolair, Uniphyl**	none occasionally every day	none occasionally every day	
Preventative Medication			
inhaled steroids: **Azmacort, Becloforte, Beclovent, Bronalide, Pulmicort, Vanceril**	none occasionally every day	none occasionally every day	
steroid tablets: **Cortisone, Deltasone, Prednisone, etc.**	none occasionally every day	none occasionally every day	

ASTHMA MEDICATIONS

24 con't

List of Medications and Treatments	How often taken in the last month?	How often taken in last 12 months?	Name of Medication *Please write down the specific name*
Preventative Medication continued			
inhaled cromoglycate/ nedocromil: **Intal, Tilade**	none occasionally every day	none occasionally every day	
Zaditen tablets	none occasionally every day	none occasionally every day	
allergy shots	none occasionally regular	none occasionally regular	
herbal remedies	none occasionally every day	none occasionally every day	
naturopath remedies	none occasionally every day	none occasionally every day	
other	occasionally every day	occasionally every day	

25 Please tell me which statement best describes you:

I take my medications exactly as directed by the doctor.

I find that a somewhat different dose schedule is best for me.

26 How does your dose schedule for **bronchodilators** differ from the schedule suggested by your doctor or pharmacist?
Bronchodilators include Alupent, Atrovent, Berotec, Bricanyl, Bronkaid, Choledyl, Medihaler, Nephron, Phyllocontin, Pro-Air, Quibron, Salbutamol, Somophylline, TheoDur, Theolair, Uniphyl, and Ventolin.

use medications exactly as directed

usually use **more** medication than directed

usually use **less** medication than directed

do not use the medication at all

ASTHMA MEDICATIONS

27 How does your dose schedule for **inhaled steroids** differ from the schedule suggested by your doctor or pharmacist?
Inhaled steroids include Beclovent, Becloforte, Bronalide, Pulmicort, and Vanceril.

use medications exactly as directed

usually use ***more*** medication than directed

usually use ***less*** medication than directed

do not use the medication at all

28 How does your dose schedule for **Intal/Tilade** differ from the schedule suggested by your doctor or pharmacist?

use medications exactly as directed

usually use ***more*** medication than directed

usually use ***less*** medication than directed

do not use the medication at all

29 Have you ***ever*** needed to take steroids such as Prednisone, Deltasone or Cortisone by mouth or injection?
This does not refer to inhaled steroids such as Beclovent or to steroid creams.

no *go to question 30.*

yes *answer questions 29.1 to 29.2*

29.1 Why was the steroid prescribed?

pneumonia

recurrent asthma symptoms

bronchitis

treatment after hospital stay

other

don't know

29.2 In the **last 12 months**, did you need a "short burst" or "short course" of steroids (less than 2 weeks) or if you are on regular steroid pills, did you need a dose increase?

no

yes *how often?*

30 In the **last 12 months** have you ever run out of medication when you needed it for your asthma?

never

1 - 2 times

3 - 4 times

more than 5 times

ASTHMA MEDICATIONS

31 In the **last 12 months** have you ever delayed filling a prescription because of the cost?

no

yes

32 Do you use a peak flow monitor at least once a week?

no

yes

don't know

don't have one

33 Have you and your doctor worked out a **written action plan** to change your medication routine to help you deal with your asthma when it is worse?

no

yes

don't know

NON-ASTHMA MEDICATIONS

34 **Please tell me about *all the allergy and/or non-asthmatic medications* you have taken in the *last month* such as antihistamines, cold medications, antibiotics, Tylenol, acne medications, birth control pills, vitamins, etc.?**

No medication was taken in the last month. ***Go to guestion 35.***

What is the **brand name** or the type of medication?	**Dosage/day** taken:	**Reason** for taking medication:	Was this medication prescribed by a doctor?
			no yes
			no yes
			no yes
			no yes

continue on next page

NON-ASTHMA MEDICATIONS

34 con't

What is the **brand name** or the type of medication?	**Dosage/day** taken:	**Reason** for taking medication:	Was this medication prescribed by a doctor?
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes
			no yes

35 **Some people who have asthma have other sensitivities. Please read the list and check the most appropriate statement and tell me the age you first had this condition.**

List of Conditions	*check the most appropriate statement*				
	"I have **never** had this reaction"	"I have had this **in the past** but not now"	"I have had this in the past and now have it **occasionally**"	"I have had this in the past and now have it **frequently**"	**Age in years** when you first had this: *an estimate is ok*
eczema					
hayfever					
hives					
food allergies					
drug allergies					
other					

36 Have you *ever* been tested for allergies?

no

yes

37 Have your *ever* had a life threatening allergic reaction ?

no *go to question 38.*

yes *answer questions 37.1 to 37.2*

37.1 What was the allergic reaction to:

drugs: *specify*

fish

insect bite

peanuts

nuts (other than peanuts)

shellfish

other: *specify*

37.2 Have you *ever* been prescribed an injection of adrenalin such as Ana-Kit or EpiPen?

no

yes

ALLERGIES AND TRIGGERS

38 Have you been told to avoid Aspirin, Anacin, (ASA)?

no

yes

39 Do you avoid Aspirin, Anacin, (ASA)?

no

yes

40 Do you have a sour taste in your mouth when lying down at night to go to sleep?

no

yes

41 Do you have heartburn as often as once a week?

no

yes

42 Do spicy foods cause you to have heartburn?

no

yes

43 Do spicy foods trigger your asthma symptoms (coughing, wheezing, or chest tightness)?

no

yes

44 Have you ***ever*** had fainting spells?

no

yes

ALLERGIES AND TRIGGERS

45 **Some people know what triggers their asthma symptoms (coughing, wheezing or chest tightness). Could you please tell me *from you own experience* which of the following factors trigger your asthma and what you do about it.**

Do any of these factors trigger your asthma?		What action do you take? *check the most appropriate statement*			
List of Factors	*check if yes*	"I do nothing"	"I take medication when symptoms develop"	"I take medication before I'm exposed"	"I avoid the trigger"
pollens					
molds					
house dust					
other dusts					
colds, flu					
physical activity					
stress					
excitement					
depression					
animals					
foods					
drugs					
cigarette smoke					
wood smoke					
burning field stubble					
perfume, fumes					
cold air					
weather changes					
other					

YOU AND YOUR DOCTOR

46 Are your asthma medications or treatments prescribed by any of the following?
check all that apply

- acupuncturist
- allergist
- chiropractor
- emergency room doctor
- family doctor
- herbalist
- naturopath
- respiratory doctor
- other

47 Have you seen a family doctor for your asthma in the **last 12 months** ?

no *go to question 48.*

yes *answer questions 47.1 to 47.3*

47.1 How many family doctors did you see in the **last 12 months** for your asthma?

47.2 If you saw **more than one**, did they all practice in the same clinic or office?

- no
- yes
- saw only one doctor

47.3 Did you have an appointment with a family doctor for your asthma in the **last two weeks**?

- no
- yes

48 Did you see a specialist for your asthma in the **last 12 months**?

no *go to question 49.*

yes *answer questions 48.1 to 48.2*

48.1 How many specialists did you see for your asthma in the **last 12 months** ?

48.2 Did you have an appointment with a specialist for your asthma in the **last two weeks**?

- no
- yes

EMERGENCY ROOM TREATMENT

I would like to ask you about treatment you may have received for your asthma.

49 If you needed to go to a hospital emergency room for asthma treatment, what hospital would you go to?

Name of Hospital City

50 Have you ever needed to go to an emergency room to get help for your asthma?

no *go to question 65.*

yes *read directions below:*

We have two groups in this study. One group is identified through emergency room records. The second group is identified from a list of randomly generated telephone numbers. Please follow the directions beside the statement that I have marked.

You have been identified through emergency room records. Your doctor has explained the study and asked if you would agree to participate. **Question 51 has the name of the hospital and the date of when you were seen in emergency.** Please answer questions 52 to 64.

You have agreed to participate in this study during a recent phone call to your home. Please tell us about the **last time** you needed to go to the emergency room. If you don't remember the exact day, give the month or season and the year. Please answer questions 51 to 64.

51 What hospital emergency room did you go to the last time you needed to go?

Name of Hospital City

day *month* *year*

When did you go there?

EMERGENCY ROOM TREATMENT

52 What did you receive in the emergency room?
check all that apply

puffer and spacer (metered dose inhaler and aero-chamber)

nebulizer (mask)

intravenous (IV)

steroids in emergency room

oxygen

other

don't know

53 In your opinion, how helpful were the doctors, nurses, and hospital staff?

very

good

fair

poor

54 Were you taking antibiotics at the time you went to the emergency room?

no

yes

55 **What asthma medication(s) did you take *24 hours* before you went to the emergency room? Please also tell me the dosage you took before going to the emergency room and your usual dosage.**

List of Medications	Medication taken before going to emergency room: *check if yes*	Dosage taken before going to emergency room: *An estimate is ok*	Usual dosage taken: *An estimate is ok*
beta-agonist bronchodilator inhalers: **Alupent, Berotec, Bricanyl, Bronkaid, Medihaler, Nephron, Pro-Air, Salbutamol, Ventolin**		puffs/day	puffs/day
beta-agonist bronchodilator diskhaler: **Ventodisk**		blisters/day	blisters/day
beta-agonist bronchodilator rotacaps: **Ventolin Rotacaps**		caps/day	caps/day
ipratopium bronchodilator: **Atrovent**		puffs/day	puffs/day
bronchodilator nebulizer- medication by mist inhaled: **Ventolin Nebulizer**		nebs/day	nebs/day
cromoglycate nebulizer- medication by mist inhaled: **Intal Nebulizer**		nebs/day	nebs/day
ipratopium nebulizer- medication by mist inhaled: **Atrovent Nebulizer**		nebs/day	nebs/day

continue on next page

EMERGENCY ROOM TREATMENT

55 con't

List of Medications	Medication taken before going to emergency room: *check if yes*	Dosage taken before going to emergency room: *An estimate is ok*	Usual dosage taken: *An estimate is ok*
bronchodilator tablets containing theophylline: **Choledyl, Quibron, Phyllocontin, Somophylline, Tedral, TheoDur, Theolair, Uniphyl**		tabs/day	tabs/day
inhaled steroid inhalers: **Azmacort, Bronalide, Becloforte, Beclovent, Pulmicort, Vanceril**		puffs/day	puffs/day
inhaled steroid diskhaler: **Beclodisk**		blisters/day	blisters/day
inhaled steroid rotacaps: **Beclovent Rotacaps**		caps/day	caps/day
steroid tablets: **Cortisone, Deltasone, Prednisone,** etc		... 5mg or . 25mg tabs/day	. 5mg or 25mg tabs/day
inhaled cromoglycate/ nedocromil: **Intal, Tilade**		tabs/day	tabs/day
Zaditen tablets		tabs/day	tabs/day
adrenalin injection or epinephrine: **Ana-Kit, EpiPen**		dosage	dosage
other		dosage	dosage

56 How long did you feel unwell before you went to the emergency room?

less than one day

- less than 2 hours
- from 2 to 24 hours

more than one day

- from 1 to 3 days
- from 3 to 7 days
- more than 7 days

57 What time of day did you go to the emergency room?

- morning (6 am - noon)
- afternoon (noon - 6 pm)
- evening (6 pm - midnight)
- night (midnight - 6 am)

EMERGENCY ROOM TREATMENT

58 Were you alone when your asthma symptoms (coughing, wheezing, and chest tightness) became severe?

no

yes

59 Which of the following statements apply to your situation before you went to the emergency room? *check all that apply*

my medication wasn't working

my medication ran out

I was exposed to something(s) I am allergic to

I ate something(s) I am allergic to

I was exposed to something(s) that triggered my asthma

I had a cold, flu or chest infection the week before

someone I live with had a cold, flu, or chest infection the week before

something exciting happened to me

my life was quite stressful

I had been sad and depressed

I felt very anxious

other

I don't know or can't remember

60 Within the **12 hours** before going to the emergency room were you involved in any of the following activities? *check all that apply*

vigorous physical activity

sleeping

at a bar/party

at a restaurant

other

61 What were the weather conditions the **day before** you went to the emergency room? *check all that apply*

sudden weather change

hot

damp/rain/snow

sunshine

wind

cold

other

don't remember

EMERGENCY ROOM TREATMENT

62 Did you go back to the emergency room for more treatment within **14 days** because your asthma got worse?

no

yes

63 For the first treatment in the emergency room, did you leave the emergency room with a prescripton for a "short burst" or "short course" of steriods (less than 2 weeks)?

no

yes

not discharged from emergency room, admitted to hospital

64 For the first treatment in the emergency room, what other medications (not including steriods) were given to you when you left the emergency room?

Please specify

HOSPITALIZATION

65 Were you ***ever*** admitted to the hospital for a day or more for your asthma?

no

yes *approximately how many times? An estimate is ok*

ARTIFICAL RESUSCITATION

66 Have you ***ever*** had artificial resuscitation such as mouth to mouth, cardiac massage (CPR) or insertion of a tube into the airway (intubation) for your asthma?

no

yes

SMOKING

I would like to ask you some questions about smoking.

67 Have you ever smoked *cigarettes?*
No means less than 20 packs of cigarettes or 12 oz. of tobacco in a lifetime or less than 1 cigarette a day for 1 year.

no *go to question 68.*

yes *answer questions 67.1 to 67.6*

67.1 Do you now smoke cigarettes (as of 1 month ago)?

no

yes

67.2 How old were you when you first started regular cigarette smoking?

Age in years

67.3 If you have stopped smoking cigarettes completely, how old were you when you stopped?

Age in years *Check if still smoking cigarettes*

67.4 How many cigarettes do you smoke per day now?

Cigarettes per day

67.5 On the average of the entire time you smoked, how many cigarettes did you smoke per day?

Cigarettes per day

67.6 Do/did you inhale the smoke?

not at all

slightly

moderately

deeply

68 Have you ever smoked *a pipe* regularly?
Yes means more than 12 oz. of tobacco in a lifetime.

no *go to question 69.*

yes *answer questions 68.1 to 68.5*

68.1 How old were you when you first started to smoke a pipe regularly?

Age in years

68.2 If you have stopped smoking a pipe completely, how old were you when you stopped?

Age in years *Check if still smoking a pipe*

68 cont'

68.3 On the average, over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week? *A standard pouch of tobacco contains 1 1/2 oz.*

oz. per week

68.4 How much pipe tobacco are you smoking now?

oz. per week

68.5 Do/did you inhale the smoke?

not at all
slightly
moderately
deeply

69 Have you ever smoked *cigars* regularly?
Yes means more than 1 cigar a week for a year.

no *go to question 70.*
yes *answer questions 69.1 to 69.5*

69.1 How old were you when you first started smoking cigars regularly?

Age in years

69.2 If you have stopped smoking cigars completely, how old were you when you stopped?

Age in years *Check if still smoking cigars*

69.3 On the average, over the entire time you smoked cigars, how many cigars did you smoke per week?

Cigars per week

69.4 How many cigars are you smoking per week now?

Cigars per week

69.5 Do/did you inhale the cigar smoke?

not at all
slightly
moderately
deeply

PASSIVE SMOKE

70 Have you been regularly exposed to tobacco smoke in the last 12 months?
Regular means on most days or nights

no *go to question 71.*

yes *answer questions 70.1 to 70.3*

70.1 Not counting yourself, how many people in your household smoke regularly?

70.2 Do people smoke regularly in the room where you work?

no

yes

70.3 How many hours per day are you exposed to other people's tobacco smoke?

71 Did your mother or female guardian ever smoke regularly during your childhood?

no

yes

don't know

72 Did your father or male guardian ever smoke regularly during your childhood?

no

yes

don't know

CHILDHOOD HISTORY

I would like to ask you a few questions about your birth, and respiratory diseases you had during your childhood.

73 Where you a full term baby?

no *how many weeks were you born early? An estimate is ok*

yes

don't know

74 How much did you weigh when you were born?

An estimate is ok

CHILDHOOD HISTORY

75 Did you have a serious chest illness such as influenza, pneumonia, bronchitis, or bronchiolitis before you were 1 year old?

no

yes

don't know

76 Did you have bronchitis or pneumonia before you were 16 years old?

no

yes

don't know

77 Have you had your tonsils removed?

no

yes *how old were you? An estimate is ok*

HOME ENVIRONMENT

I would like to ask you some questions about the home you live in now.

78 How long have you lived in your present home?

Years

79 When was your present home built?

before 1960

1961 - 1970

1971 - 1980

1981 or later

don't know

80 Has any room in your house been remodelled, refurnished, or re-carpeted in the last 12 months?

no

yes

81 What type of heating do you have in your home?

forced air

electric

hot water

other

HOME ENVIRONMENT

82 About how often is the dust filter on the furnace in your home changed or cleaned?

once a month

4 times a year

2 times a year

once a year

do not have a furnace with a dust filter

83 How often do you use the wood burning fireplace in your home during the winter months?

every day

less than two times a week

less than twice a month

never

do not have a woodburning fireplace

84 Have you ever used a kerosene heater regularly in your home?

no

yes

85 What type of cooking stove do you have in your home?

gas/propane

electric

wood

other

86 In which room(s) have you found mold or mildew (excluding food mold) in the **last 12 months**? *check all that apply*

bathroom

bedroom

living area

kitchen

basement or attic

other

have not found mold or mildew

87 What type of humidifier do you use in your home?

- system built into heating system
- portable cold mist (e.g. ultrasonic)
- portable hot mist vaporizer
- other
- do not use a humidifier

88 Do you use a humidifier in your room while sleeping?

- no
- yes
- do not use a humidifier

89 Do the windows in your home **frequently** steam up in the winter months?

- no
- yes

90 Does anyone in your home use drycleaning?

- no, not at all
- yes, weekly
- yes, monthly
- yes, infrequently

90.1 Are freshly drycleaned clothes kept in your bedroom closet?

- no
- yes

91 What type of flooring do you have in your bedroom?
check all that apply

- wall to wall carpet
- area rug(s)
- hardwood
- linoleum
- other

HOME ENVIRONMENT

92 What type of a mattress do you sleep on?

spring

water

foam

air

futon (cotton stuffed mattress)

kapok

other

do not use any of the above

93 Do you use any of the following? *check all that apply*

plastic or vinyl cover on the mattress

wool blankets

feather pillow

goose down duvet/comforter

94 Do you sleep with a window full or partially open during the summer?

never

all the time

sometimes

95 Do you sleep with a window full or partially open during the winter?

never

all the time

sometimes

96 In the **past two weeks** did you experience asthma symptoms such as coughing, wheezing, or chest tightness as a result of outside air pollution?

no

yes

97 During the **past two weeks** did you limit or avoid going outside because of air pollution?

no

yes

WORK HISTORY

I am interested in your job/career history.

98 What is your current occupation?

99 **Please list all the previous jobs starting with the first job you held. Continue on a separate sheet if necessary.**

Occupation *Job title and brief description*	**Business, Industry, or Service**	**Years Worked:** *An estimate is ok* *from*	*to*	Did/does this job affect your breathing? *check if yes*
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	
		19	19	

WORK HISTORY

100 If any job or conditions at work affected your breathing, what did you do about it?
check all that apply

- nothing
- quit job
- wore a respirator or face mask
- moved to another area in the same company
- cleaned up pollutant
- other

not applicable

101 Have you ***ever*** lived or worked on a farm?

no *go to question 102.*

yes *answer questions 101.1 to 101.3*

101.1 How old were you when you started living or working on a farm?

An estimate is ok

101.2 In total how many years have you lived or worked on a farm?

An estimate is ok

101.3 What type(s) of farming were you involved in?
check all that apply

- grain
- dairy cattle
- beef cattle
- poultry
- mixed
- other

EXPOSURE HISTORY

102 **Have you *ever* been exposed to any of the following? Please check appropriate responses and tell me how old you were when you were first exposed.**

List of Exposures	Were you ever exposed? *check to select*	Are you currently exposed? *check if yes*	Age in years when first exposed: *an estimate is ok*	Did/does this exposure affect your breathing? *check if yes*
autobody shop work	no yes			
spray painting	no yes			
welding	no yes			
soldering	no yes			
sandpapering and varnishing of wooden floors/furniture	no yes			
saw dust	no yes			
diesel/gasoline fumes	no yes			
toxic gases and fumes (e.g. chlorine, sour gas)	no yes			
solvents & glue	no yes			
cleaning fluids	no yes			
cutting oils	no yes			
grain dust	no yes			
fertilizers	no yes			
herbicides/fungicides	no yes			

103 Are you exposed to any **other** dusts, fumes, or substances which make your breathing worse?

no

yes *specify*

104 Do you wear a mask or respirator in a dusty environment?

no

yes

not applicable

ANIMAL EXPOSURE

105 **I would like to ask you some questions about *pets*. Please check appropriate responses and tell me your age when you first were exposed.**

Type of Pet	Did you ever live with this pet in your house *check to select*	Do you **currently** live with this pet in your house? *check if yes*	Did/does this pet stay in the **bedroom** with you at night? *check if yes*	Age in years when first lived with this pet: *an estimate is ok*	Did/does this exposure **affect your breathing?** *check if yes*
cats	no yes				
dogs	no yes				
birds	no yes				
rabbits	no yes				
gerbils, hamsters, guinea pigs	no yes				
other	no yes				

106 **I would like to ask you some questions about *farm animals*. Please check appropriate responses and tell me your age when you first were exposed.**

Type of Farm Animal	Were you ever exposed to these animals? *check to select*	Are you **currently** exposed to these animals? *check if yes*	Age in years when first exposed to these animals: *an estimate is ok*	Did/does this exposure **affect your breathing?** *check if yes*
horses	no yes			
cattle	no yes			
poultry	no yes			
other	no yes			

The following questions ask about your understanding and beliefs of asthma.

107 How do you think **bronchodilators** work?
Bronchodilators include Alupent, Atrovent, Berotec, Bricanyl, Bronkaid, Choledyl, Medihaler, Nephron, Phyllocontin, Pro-Air, Quibron, Salbutamol, Somophylline, TheoDur, Theolair, Uniphyl, and Ventolin.

relaxe the muscles in airways

decrease inflammation

relaxe muscles in airways and decrease inflammation

don't know

108 How do you think **corticosteroids** work?
Corticosteroids include Beclovent, Becloforte, Bronalide, Pulmicort, and Vanceril.

relaxe the muscles in airways

decrease inflammation

relaxe muscles in airways and decrease inflammation

don't know

109 Do you think antibiotics control asthma?

no

yes

don't know

110 Do you believe that asthma can be cured?

no

yes

111 Do you believe that some asthmatics are at a greater risk of dying of asthma than other asthmatics?

no

yes

112 Do you consider yourself to be in a high risk group?

no

yes

ASTHMA OPINION SURVEY

113 We want to learn more about your opinions concerning your asthma and the quality of medical care you are currently receiving from the clinic, hospital, physician, etc. where you go for asthma treatment. Please draw a circle around the number under each of the following statements to indicate the extent to which you agree or disagree with it.

	Strongly disagree				Strongly agree
113.1 I have asthma attacks quite often.	1	2	3	4	5
113.2 People with asthma do better if they learn a lot about their disease.	1	2	3	4	5
113.3 I can tell when I'm about to have an asthma attack from how I feel inside.	1	2	3	4	5
113.4 When I get short of breath, I often get too upset to do much about it.	1	2	3	4	5
113.5 Patients here would get a lot better treatment for their asthma somewhere else.	1	2	3	4	5
113.6 I know some things to do that will help when I get short of breath.	1	2	3	4	5
113.7 I would be more successful if I didn't have so many breathing problems.	1	2	3	4	5
113.8 I always have to wait a long time before I get to see my doctor.	1	2	3	4	5
113.9 I generally know if I'm about to have a breathing problem.	1	2	3	4	5
113.10 My asthma interferes with my social life quite a bit.	1	2	3	4	5
113.11 Patients have very little to say about what happens to them here.	1	2	3	4	5
113.12 When I get short of breath, I can tell if it's going to get worse from how I feel inside.	1	2	3	4	5
113.13 I often worry about getting a serious disease such as cancer or a heart attack.	1	2	3	4	5
113.14 The doctors, nurses, and other staff here are quite nice to patients.	1	2	3	4	5
113.15 If an asthma attack starts to get worse, I know some things that will help me if I do them.	1	2	3	4	5
113.16 Because I have asthma, I am always going to have some breathing problems.	1	2	3	4	5
113.17 Doctors are too busy to give enough time to their patients when they require asthma treatment.	1	2	3	4	5
113.18 I usually can feel it when my chest begins to get tight from asthma.	1	2	3	4	5

MEDICAL RECORDS

We need to learn more about how medications are used by people with asthma. We would like to look at records from doctors, pharmacists, and other health care agencies.

114 May we have your permission to access the necessary records? ***Whether or not you agree to this, it will in no way change your medical treatment. All information is strictly confidential.***

no *go to 115 - Comments*

yes *answer questions 114.1 to 114.5*

114.1 It would help us to have the names of the **physicians** you have seen within the ***last year.***

Names of physicians Phone no.

114.2 It would help us to have the names of the **pharmacies** you have used within the ***last year.***

Names of pharmacies Phone no.

114.3 Could you please tell us the **hospitals** where you have been treated within the ***last year.***

Names of hospitals City

MEDICAL RECORDS

114.4 Do you have a special drug plan that helps you pay for your medication?

no *go to question 114.5*

yes *answer question 114.4.1*

114.4.1 If yes, what is the name of the insurance or drug plan and the plan no.?

Name of Insurance

e.g. Blue Cross, Manitoba Phamacare, Saskatchewan Drug Plan or company insurance.

Plan Number

114.5 Please sign No. 116 **Medical Release**, and No. 117 **Drug Plan Release** at the end of the questionnaire.

YOUR COMMENTS

115 Is there anything else you would like to tell me about your asthma?

You have made a valuable contribution to this study.

The University of Calgary and the University of Alberta together with the University of Saskatchewan and the University of Manitoba are conducting an asthma study in which I have agreed to participate. Please permit a member of the study team to access my medical files. I understand that the information is confidential and will not be released to anyone outside of the study members. Names will not be used when the information is published.

Name of Participant
please print

Name of Parent or Guardian *if participant is under the age of 18 years*
please print

Signature

if participant is under the age of 18, a parent or guardian must sign this release

Date

Name of Witness **Signature of Witness**
please print

Date

Please complete this section if the request for information is made on behalf of a family member.

I am the *relationship to study participant* **of** *name of study participant*

Name of Relative
please print

Signature of Relative

Date

Name of Witness **Signature of Witness**
please print

Date

117 • DRUG PLAN RELEASE

The University of Calgary and the University of Alberta together with the University of Saskatchewan and the University of Manitoba are conducting an asthma study in which I am participating.

I agree to allow *name of drug plan* **Drug Plan No.,**

to release my drug record of prescription claims to the Prairie Provinces Asthma Study. I understand that the information is confidential and will not be released to anyone outside of the study members. Names will not be used when the information is published.

Name of Participant

please print

Name of Parent or Guardian *if participant is under the age of 18 years*

please print

Signature

if participant is under the age of 18, a parent or guardian must sign this release

Date

Name of Witness **Signature of Witness**

please print

Date

Please complete this section if the request for information is made on behalf of a family member.

I am the *relationship to study participant* **of** *name of study participant*

Name of Relative

please print

Signature of Relative

Date

Name of Witness **Signature of Witness**

please print

Date

The Prairie Provinces Asthma Study
is conducted by

University
of
Alberta
•
University
of
Calgary
•
University
of
Manitoba
•
University
of
Saskatchewan
•
The Prairie Lung
Associations
•
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