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# Severity and associated triggers for acute asthma attack in patients presenting to the emergency department of the Bertha Gxowa hospital

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# SEVERITY AND ASSOCIATED TRIGGERS FOR ACUTE ASTHMA ATTACK IN PATIENTS PRESENTING TO THE EMERGENCY DEPARTMENT OF THE BERTHA GXOWA HOSPITAL

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree

of

Master of Medicine in Family Medicine

12th August 2016 in Johannesburg

## DECLARATION

I, Dalton Mulombe Kabundji, declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Medicine in Family Medicine (MMed Fam Med) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



DM Kabundji

*MBBCh (Unikin) MSc Med EM (Wits)*

Date: 12th August 2016

## DEDICATION

To our Almighty God the Lord and Saviour Jesus-Christ, because all glory is yours.

To my late father Daniel Kabundji Munkindji. Before you had been called by God, you sacrificed your entire life to make me a real man. This is your wish for me. I will never forget your honourable memory in my life. Let your soul rest in peace.

To my mother Marie Lofo Bonyoma for all you have done for me.

To my lovely family: My wife Jenny Maviluka Kabundji and three sons: Eli Munkindji Kabundji, Christian Romeo Kabundji and Michael Kabundji for your love, patience and support.

To my brothers and sisters.

This is to say thank you so much.

## ABSTRACT

**Background**: Many avoidable triggers lead to uncontrolled asthma and subsequent Emergency Department (ED) visits. The aim of this study was to determine the severity of and potential associated triggers for acute asthma attack in patients presenting to the ED of the Bertha Gxowa Hospital (BGH).

**Methods:** Prospective cross-sectional study. Data from 239 patients managed between February 2015 and April 2015 was collected through a survey questionnaire and analysed. The Chi-square test or Fisher Exact Test was used to test the associations between variables and acute asthma severity. Bivariate logistic regression was used to ascertain factors and/or triggers associated with acute asthma attack. P-values $< 0.05$ were considered statistically significant.

**Results**: Overall, 239 patients were enrolled (139 males, 100 females, and median age 31 years). The majority of them had moderate acute asthma attack (52.72%). Active cigarette smoking ($p < 0.001$) and/or passive cigarette smoking ($p = 0.004$) were identified to be potential associated triggers for acute asthma attack. Low level of education ($p < 0.001$) was identified to be significant factor associated with acute asthma attack. There was no significant association between acute asthma attack severity and age ($p = 0.592$), gender ($p = 0.240$), race ($p = 0.759$), occupation status ($p = 0.291$), employment status ($p = 0.268$), type of housing ($p = 0.982$), acute respiratory infection ($p = 0.818$), use of medication-related asthma triggers ($p = 0.942$), knowledge of asthma allergens ($p = 0.086$), and stress or anxiety ($p = 0.475$).

**Conclusion**: The study shows that the majority of patients presented with moderate acute asthma attack at the BGH ED. Active and/or passive cigarette smoking is a potential associated trigger

for acute asthma attack. In addition, this study shows that low level of education is a significant factor associated with acute asthma attack.

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## LIST OF ABBREVIATIONS

BGH: Bertha Gxowa Hospital

BTS: British Thoracic Society

CDC: Centre for Disease Control and Prevention

CEO: Chief executive officer

CI: Confidence interval

COPD: Chronic Obstructive Pulmonary Disease

ED: Emergency Department

EPR: Expert Panel Report

FET: Fisher Exact Test

FEV1: Forced expiratory volume in first second

FVC: Forced vital capacity

HCP: Healthcare provider

HR: Heart rate

HREC: Human Research Ethics Committee

ICU: Intensive Care Unit

Ig: Immunoglobulin

LRTI: Lower respiratory tract infection

NSAID: Non-steroid anti-inflammatory drug

OPD: Out-patient department

OR: Odds ratio

Pa CO2: Partial pressure arterial carbon dioxide

PaO2: Partial pressure arterial oxygen

PEF: Peak expiratory flow

PEF AIB: Peak expiratory flow after initial bronchodilator

PHC: Primary health care

PIN: Patient identification number

RCT: Randomized controlled trial

RDP: Reconstruction and development programme

RR: Respiratory rate

RSA: Republic of South Africa

Sa O2: Arterial blood oxygen saturation

SD: Standard deviation

SLTA: Severe life-threatening asthma

UK: United Kingdom

URTI: Upper respiratory tract infection

USA: United States of America

WGSATS: Working Group of the South African Thoracic Society

WHO: World Health Organization

## DEFINITION OF TERMS[1]

**Acute asthma attack:** A state of acute airway obstruction and bronchospasm in asthmatic patients manifested by expiratory wheezing, shortness of breath or chest tightness, and cough.

**Acute respiratory infection:** Non-specific term used to describe respiratory tract infection (upper and/ or lower) that affects an individual for less than two weeks' duration.

**Asthma exacerbation:** is synonymous with acute asthma attack, and both terms are used interchangeably in this report.

**Asthma trigger**: A factor that may exacerbate asthma, or a stimulus which causes an increase in asthma symptoms due to airway limitation or obstruction, such as dust mites, cockroaches, pollens, respiratory viruses, smoke, and medication-related asthma trigger. They are directly implicated in the pathogenesis and/or pathophysiology of asthma.

**Beta-adrenergic blocking agents:** A class of drugs that competes with beta-adrenergic agonists for available receptor sites: some compete for both $\beta_1$ and $\beta_2$ receptors, whereas others are primarily either $\beta_1$ or $\beta_2$ blockers; used in the treatment of a variety of cardiovascular diseases and related conditions, for which beta-adrenergic blockage is desirable.

**Bronchospasm:** An excessive and prolonged involuntary contraction of the smooth muscle of the bronchi and bronchioles, resulting in an acute functional narrowing and obstruction of the respiratory airway.

**Corticosteroids:** Group of natural and synthetic analogues of the hormones secreted by the hypothalamic-anterior pituitary-adrenocortical axis or pituitary gland, including glucocorticoids, which have potent anti-inflammatory properties.

**Employment status**: A status of a person in employment as an employee.

**Factor associated with asthma exacerbation**: A non-specific term used to describe any variables that may be associated with an increase in the incidence of asthma exacerbation, either by being directly implicated (triggers), or not (factors) in the pathogenesis and/or pathophysiology of asthma. Examples of these factors are age, gender, race, and occupation status, level of education, and stress or anxiety.

**Forced expiratory volume in first second:** The maximum volume of air expired from the lung in one second when starting from maximum inspiration.

**Forced vital capacity:** The volume of air exhaled with maximum effort and speed after a full inspiration.

**Hypoxaemia:** Lower than normal oxygen tension in the arterial blood inducing a lower than normal saturation of haemoglobin and oxygen content per unit volume.

**Hypoxia:** Reduction of oxygen supply to a tissue below physiological levels without or not a good perfusion of the tissue by blood.

**Inflammation:** A fundamental pathological process consisting of a dynamic of histological apparent cytologic changes, cellular infiltration, and mediator release that occurs in the affected blood vessels and adjacent tissues in response to an injury or abnormal stimulation caused by a chemical or biologic agent.

**Lower respiratory tract infection:** Nonspecific term used to describe acute infections involving bronchi, bronchioles, trachea, alveoli and lung tissues.

**Non-steroidal anti-inflammatory drugs:** Group of anti-inflammation and analgesic drugs, including Diclofenac, Aspirin, Ibuprofen, Meloxicam, Ketorolac, and Mefenamic acid, which act by inhibiting the cyclooxygenase pathway and preventing the release of potent inflammatory mediators (i.e. Prostaglandins, Leucotrienes, and Thromboxanes). They are used for acute and/or chronic pain and inflammation.

**Occupation status**: A status of a person having a money-generating activity, including self-employment.

**Oedema:** Accumulation of an excessive amount of watery fluid in cells, tissue, or serous cavities.

**Passive cigarette smoking**: Cigarettes smoked by patient's household (in the context of this study).

**Peak expiratory flow** (PEF): The greatest rate of airflow that can be achieved during forced expiration, beginning with the lungs fully inflated.

**Statistical power**: Ability to find a difference that truly exists or probability of correctly rejecting the null hypothesis when it is false; related to number of patients or size of difference sought. This avoids Type II error or error of failing to observe a difference when in truth there is one.

**Uncontrolled asthma**: is defined in the presence of ≥ 3 features of partly controlled asthma (daytime symptoms more than twice a week, any limitation of activity, any nocturnal symptoms/awakening, need for reliever medication more than twice a week, PEF < 80% predicted or personal best, and ≥ 1 exacerbation per year), or an exacerbation in any week.[2]

**Upper respiratory tract infection:** A nonspecific term used to describe acute infections involving the nose, paranasal sinuses, tonsils, pharynx, and larynx.

**Ventilation:** The movement of air (oxygen) between the environment and the lungs by inhalation and exhalation.

# CHAPTER 1

# INTRODUCTION

## 1.1. Background information

Asthma is a major public health problem worldwide, generates significant healthcare costs and has high morbidity and mortality rates.[3] The World Health Organization (WHO) estimated that between 100 and 150 million people worldwide suffer from asthma, and over 180 000 deaths occur annually.[4] In the United States of America (USA), it is estimated that approximately 18.7 million adults (8.2%) had asthma according to 2010 data from the experts of the Centers for Disease Control and Prevention (CDC).[5] The Republic of South Africa (RSA), with 8.1% prevalence over all ages, ranked 25$^{th}$ worldwide, and the asthma case fatality rate in the country is reported as being the fourth highest in the world, with 1.5% deaths annually.[6,7] Recently, it has been documented that South Africa has the highest prevalence of asthma in Africa.[8] Adeloye et al. conducted a systematic review to ascertain an estimate prevalence of asthma in Africa in which they included 45 studies covering most parts of Africa (South Africa: 11 studies, Nigeria: 8 studies, Ethiopia: 6 studies, Kenya: 5 studies, and 4 studies in each in Algeria, Morocco and Tunisia). They found that cumulative prevalence of asthma was highest in South Africa.[8] Asthma morbidity and mortality are potentially preventable with optimal control of chronic asthma and appropriate management of acute exacerbation.[9]

Asthma is a chronic inflammatory disease of the airways which is usually allergic in origin, characterized by a markedly variable degree of reversibility of airflow obstruction and bronchospasm.[9,10] A wide range of stimuli in addition to genetic predisposing factors readily induce a state of airway hyperresponsiveness in asthmatic patients.[9,10] This is a result of an excessive bronchoconstrictor response to multiple inhaler triggers that would have no effect on a normal airway.[10] The pathophysiology of acute asthma consists of bronchoconstriction, inflammation, and mucus impaction.[5,10] These result from the release in the systemic circulation of a variety of cell types, including mast cells, eosinophils, lymphocytes, macrophages, and neutrophils.[5,10]

These cells release a number of potent inflammatory mediators, including Prostaglandins, Leucotrienes and Thromboxanes, which interact in complex ways to induce a chronic state of airway inflammation in both the mucosal and muscle layers of the airways.[10] This ultimately leads in the former to epithelial cell desquamation, mucus hypersecretion and mucosal oedema, and in the latter to smooth muscle hypertrophy, hyperplasia, and contraction or bronchospasm.[5,10] These in turn will lead to a reduction in forced expiratory volume in first second (FEV1), FEV1/forced vital capacity (FVC) ratio, and PEF, and as well as an increase in airway resistance.[10] There is also evidence of reduction of ventilation and increased pulmonary blood flow, resulting in a mismatch of ventilation and perfusion, thus further inducing hypoxaemia.[2,10]

The diagnosis of asthma is based primarily in the history of young age of onset, family history of asthma, the presence of atopy, identification of asthma triggers and common symptoms, which include wheezing, shortness of breath or chest tightness, and coughing.[5,9,10] Spirometric lung function tests are useful in the diagnosis, assessment of severity and management of asthma.[9] The commonest diagnostic abnormality is a reduction in FEV1 and PEF, and the ratio to FEV1 to FVC to below 70% is characteristic of obstructive airways disease.[9,10] A significant reversibility of the airway obstruction is the hallmark of bronchial asthma, which is defined as the presence of an increase in FEV1 of > 12% and 200 ml, 15 to 30 minutes following the inhalation of 200 to 400 microgram of a short-acting bronchodilator (i.e. Salbutamol), or a 20% improvement in PEF from baseline.[9,10]

Its treatment goals are to relieve hypoxaemia and airflow limitation or obstruction as urgently as possible, and provide a suitable plan to control the disease and avoid relapse.[5,9] These require urgent and aggressive treatment with simultaneous administration of oxygen, inhaler bronchodilators, including Beta-2-agonists and Ipratropium bromide, and Corticosteroids.[5] Intravenous magnesium sulphate provides additional benefits in the case of severe acute asthma refractory to previous treatment.[5,9] Intubation may be indicated for impending acute respiratory failure unresponsive to the previously described treatment.[5] Triggers leading to acute asthma attack should be identified and preventable measures implemented to prevent acute attacks.[9]

## 1.2. Rationale of the study

There are many avoidable triggers leading to uncontrolled asthma and subsequent Emergency Department (ED) visits,[10-12] and acute asthma attack is preventable with optimal control of these triggers.[10-12] This conclusion had been reported in many studies.[11,12] Examples include the cross-sectional study of factors associated with patient visits to the ED in Saudi Arabia by Al-Jahdali et al.,[11] and the cross-sectional study of triggers in adult asthma by Goksel et al. in Turkey.[13]

In the course of working at Bertha Gxowa Hospital (BGH) the researcher noticed that many patients presenting to the ED with acute asthma attack had uncontrolled asthma and low income. Most of them were also smokers, unemployed or uneducated, and were not educated about asthma triggers. Finally, they had not consistently made follow-up visits to clinics or to private doctors. The Working Group of South African Thoracic Society (WGSATS) 2013 guidelines assert that in order to optimize patient care the avoidable triggers for acute asthma attack should be reviewed or provided to all asthmatic patients prior to their being discharged from the hospital.[9] The importance of this was confirmed by Gibson et al. in their meta-analysis of 26 randomized controlled trials (RCTs).[12]

To the best of the researcher's knowledge, there are very few published South African studies that have investigated the triggers for acute asthma attack in South Africa. An online literature research yielded these two examples: the study of the magnitude of the asthma problem in Cape Town by Westerman et al. and the case-control study of severe life-threatening asthma (SLTA) by Van der Merwe et al.[14,15] The two studies were conducted in tertiary hospitals in Cape Town in 1978, and between 1997 and 2000, respectively. The former included mainly the white population, as this was during the apartheid period.[14] The latter focused on patients with imminent respiratory arrest asthma admitted to the intensive care unit (ICU) and asthmatic patients attending outpatient respiratory clinic.[15]

There are no recent South African studies that have attempted to determine the severity and associated triggers for acute asthma attack in the ED. Therefore, the purpose of this study was to determine the severity of and associated triggers for acute asthma attack at the BGH ED. This study has relevance to Family Medicine, as asthma has a significant morbidity and

mortality, especially in South Africa, a developing country with a developing primary healthcare (PHC) system facing resource constraints.[2,7,9]

The researcher hopes that the recommendations made from the findings of this study to the management of the BGH will result in lower asthma presentation rates in the hospital ED. This will ultimately curb the expenditure associated with asthma care. This information will also be useful to policy makers and facility managers nationally, especially at the PHC level, in saving cost, optimizing patient care and improving healthcare services.

## 1.3. Organizational report

The research report has five central chapters. Chapter 2 is a literature review, Chapter 3 deals with materials and methods, Chapter 4 covers results, Chapter 5 is discussion, and Chapter 6 contains conclusions and recommendations. These chapters are followed by appendices and references. The next chapter reviews the literature relevant to the study.

# CHAPTER 2

# LITERATURE REVIEW

The researcher searched Pubmed, Cochrane Library, SUM Search 2, TRIP Database, Essential Evidence Plus, Up to date and Google Scholar for studies in relation to his research question. Relevant studies were selected for review and the information obtained is presented. It includes the proportion of patients presenting with acute asthma attack in an ED, severity assessment and factors and/or triggers associated with acute asthma attack presentation.

## 2.1. Proportion of patients presenting with acute asthma attack to an Emergency Department

Many studies indicate that acute asthma attack is a common medical emergency, with significant numbers of ED visits and subsequent hospital admissions and deaths.[16,17,18] Higher proportions of acute asthma attack in ED have been reported in many international studies.[16,17,19] For example, in the USA, acute asthma attack represents the 11$^{th}$ most frequent ED diagnosis.[16] In their review of acute asthma in adults, Rodrigo et al. documented a proportion of 20%.[17] Watase et al. in Japan also reported a proportion of 47%.[19] Surprisingly, lower proportions of acute asthma attack in ED have been reported in developing countries compared to that of the developed countries.[18] The study by Kirenga et al. of asthma and patterns of asthma medication prescriptions among adult patients conducted in ED and the respiratory clinic of a tertiary healthcare facility in Uganda found a proportion of 2.5%.[18] In addition, the authors of this study documented a proportion of 16.9% of acute asthma attack in the respiratory clinic of the same hospital where the study was conducted.[18]

In the RSA there are few published studies investigating the proportion of patients presenting with acute asthma attack in ED. One study, by Westerman et al., of the magnitude of the asthma problem at Groote Schuur Hospital, in Cape Town, has shown that acute asthma attack represents 10% of all patients seen in the ED.[14] This data indicates that, overall, acute asthma attack accounts for a significant number of ED visits worldwide, including in South Africa.

## 2.2. Severity assessment of acute asthma attack

Many studies have demonstrated that there is a poor correlation between clinical judgment and lung function, and patients and healthcare providers (HCP) both underestimate acute asthma severity.[5,9] The use of clinical symptoms and signs together with lung function measures and laboratory parameters may overcome these difficulties by reproducing an accurate judgment of the degree of airflow limitation.[9] This principle has been used in the development of the two guidelines described below:

The revised British Thoracic Society (BTS) guidelines published in October 2014 classified acute asthma attack as mild, moderate, severe, life-threatening and near-fatal acute asthma attack.[20] Acute moderate asthma attack includes increasing asthma symptoms, PEF > 50-70% and no features of acute severe asthma attack. Acute severe asthma attack is defined in one of: PEF 33-50% best or predicted, respiratory rate (RR) ≥ 25 breaths/min, heart rate (HR) ≥ 110 beats/min and inability to complete sentences in one breath. Life-threatening acute asthma includes any of: PEF < 33% best or predicted, oxygen saturation (SO2) on room air < 92%, partial pressure arterial oxygen (PaO2) < 8 kpa, normal partial pressure arterial carbon dioxide (PaCO2) which is within 4.6 and 6.0 kpa, silent chest, cyanosis, poor respiratory effort, arrhythmia, exhaustion or altered consciousness level and hypotension. Near-fatal acute asthma attack is documented in the presence of raised PaCo2 and/ or requiring mechanical ventilation with raised inflation pressure.[20] Patients with asthma exacerbations without the above-mentioned criteria are classified as having mild acute asthma attack.[20]

The WGSATS published their guidelines in March 2013, which conveniently classified acute asthma attack as mild, moderate, severe, and imminent respiratory arrest attack based on symptoms, signs, lung function and laboratory parameters (Appendix A).[9] In this later guideline it has been recommended that the presence of several parameters, but not necessary all, indicates the general classification of the exacerbation.[9] This is practical in ED, as most patients with asthma exacerbation do not require laboratory studies,[5] especially for the South African population given the resource constraints the healthcare system in South Africa faces.[9]

Regarding the proportions of mild, moderate and severe acute asthma attack in ED, studies have reported different findings.[21,22,23] Dankner et al. in Israel found that the majority of patients (37.9%) had moderate acute asthma attack.[21] In this study the authors assessed the severity of asthma exacerbation through a simplified scoring system for asthma exacerbation in ED.[21] This scoring system is based solely on vital signs, readily available symptoms and signs, including pulse rate, wheezes, rales or prolonged expirium, oxygen saturation on room air, and the use of accessory muscles of respiration, measured upon arrival of patients in ED.[21] However, this conclusion was in contrast with the findings of Refaat et al. in their prospective study of acute asthma in ED, prevalence of respiratory and non-respiratory symptoms, in Egypt, in which they found a large proportion of patients (52.6%) had severe acute asthma attack.[22] Sanya et al. in Uganda also reported a higher proportion (55%) of severe acute asthma attack.[23]

## 2.3. Triggers and /or factors associated with acute asthma attack

Many triggers have been reported to cause patients with a poor asthma control status to increasingly frequent EDs.[9] These triggers include active and/or passive cigarette smoking, acute respiratory infection, asthma allergens, and medication-related asthma trigger (non-steroid anti-inflammatory drugs (NSAIDs) and Beta-blockers).[9,13] There are also many factors that have been reported to be associated with acute asthma attack presentation.[6,9,13] These factors include demographic factors (age, gender, race), social factors (employment or occupation status, low income, low education level, and non-urban type of housing), clinical factors (not being educated about asthma allergens and non-adherence to asthma treatment), and psychological factor (stress and anxiety).[6,9,13] Asthma triggers can induce a functional state of airway narrowing and bronchospasm with subsequent wheezing and dyspnoea or chest tightness in asthmatic patients.[6,10]

Most experts have agreed that reducing the need for the use of ED for acute asthma attack treatment remains an important goal of the overall management of the disease, as acute asthma ED care is substantial.[16,17] The importance of this has been demonstrated by Weis et al. in their study of an economic evaluation of asthma in the USA, in which they demonstrated that the utilization of the ED for asthma management accounted for almost one-

third of all asthma costs.[24] Thus, asthma triggers need to be well explored and identified in order to optimize health care and minimize the cost related to asthma care.

### 2.3.1. Demographic factors

Many demographic factors are reported to be associated with acute asthma attack presentation. These factors include age, gender, and race.

#### 2.3.1.1. Age

The evidence indicates that acute asthma attack and related deaths have been significantly associated with age.[15,24,25] A USA study demonstrated that the number of acute asthma presentations and related deaths increase with age.[24] In their study of risk factors for hospitalization among adults with asthma and the influence of socio-demographic factors and asthma severity, Eisner et al. found that age (increases by ten years) was a significant factor associated with acute asthma severity and/or hospitalization.[25] This conclusion have been reported in many other studies.[15,26] Examples include the study by Van der Merwe et al. in Cape Town and the study by Bavbek et al. in Turkey.[15,26] However, Fernandes et al. in Brazil found non-significant association between age and asthma exacerbation.[27]

#### 2.3.1.2. Gender

The female gender has been reported to be associated with severe acute asthma attack.[28,29] In their study of the gender dimension of asthma, in the USA, Kynyk et al. found that women are more likely to have severe acute asthma and suffer greater morbidity than men ($p < 0.05$).[28] This conclusion was also reported by Eisner et al. in USA[25] and by Lkeue et al. in Japan.[29] However, other studies have found that male gender is a significant factor associated with acute asthma attack.[27] In their study of risk factors for death in patients with severe asthma, Fernandes et al. found a significant association between male gender and severe acute asthma attack and/ or death ($p < 0.001$).[27]

#### 2.3.1.3. Race

Evidence has shown that being a member of a non-white race, especially black, is a significant factor associated with acute asthma severity.[15,25,30] In their prospective cohort study of the role of race/ethnicity and socioeconomic status of acute asthma among adults presenting to the ED in USA, Boudreaux et al. found significant racial/ethnicity differences in the sense that there were more black than white patients with severe acute asthma attack ($p < 0.001$).[30] Eisner et al. also in USA found that being a member of a non-white race (Hispanic) was associated with severe asthma exacerbation and/or hospitalization (OR 3.1, 95% CI: 1.1 to 8.8).[25]

### 2.3.2. Social factors and/or triggers

Many social factors have been shown to be associated with acute asthma attack as they have a potential impact on asthmatics' quality of life, adherence to asthma treatment, and chronic asthma control.[12,24] These factors include having a low income, living in rural type of housing (informal settlement (IS), reconstruction development programme (RDP), and squatter camp (SC)), and having a lower level of education.[12,15,24,31] There is another social factor (active and/or passive cigarette smoking) capable of inducing asthma exacerbation. Thus, it is considered an asthma trigger.[10]

#### 2.3.2.1. Occupation or employment status

Studies have demonstrated that not having an income-generating occupation or being unemployed is a significant factor associated with severe acute asthma attack.[15] The study by Van der Merwe in Cape Town found that lack of formal employment was significantly associated with severe life-threatening asthma ($p = 0.002$).[15] With regard to this conclusion, an important factor to be taken into account is that the study was conducted only in a public health institution (Tygerberg Academic Hospital), which could be acknowledged as one of the study limitations by the inverstigators.[15] However, many international studies, for example, those by Fernandes et al. in Brazil and by Schwenkglenks et al. in Swaziland, have also pointed in the same direction in the sense that lack of income-generating occupation was a significant factor associated with asthma exacerbation.[27,32]

#### 2.3.2.2. Low income

Low income is also considered as significant factor associated with severe acute asthma attack.[25] There are several possible explanations for this. Firstly, low income may induce higher level of stress in asthmatic individuals.[10] Secondly, for private patients or countries where medical care is paid by patients themselves, the provision of asthma treatment is costly and needs to be afforded by asthmatic individuals.[10] Failure to secure this will ultimately occasion non-adherence to asthma treatment and subsequent asthma exacerbations.[4,10] Thirdly, low income is documented as being a greater barrier for specialized medical care, especially for private patients.[15] Lastly, low income may be a marker for other exacerbating factors, such as cockroach antigen exposure, cigarette smoking, and secondhand smoke exposures.[25] The study by Eisner et al. described above found that lower household income was significantly associated with greater risk of hospitalization (OR 1.1, 95% CI: 0.9 to 1.3).[25] Van der Merwe et al. in Cape Town also found that no formal income in an individual was a significant factor associated with severe life-threatening asthma ($p = 0.002$).[15]

#### 2.3.2.3. Education level

Low level of education had been reported to be significant factor associated with acute asthma attack presentation.[12] Studies have shown that lower level of education has negative outcomes in asthmatic patients as it increases poor disease control and asthma-related ED visits with subsequent asthma morbidity and mortality. In their study of risk factors for emergency room visits due to asthma exacerbations in Brazil, Brandao et al. documented that having a low level of education was significantly associated with asthma exacerbation (OR 1.53, 95%CI: 1 to 2.39).[33] Bavbek et al. in Turkey also found a statistically significant difference between low education level and asthma exacerbation ($p < 0.05$).[26]

#### 2.3.2.4. Type of housing

Certain specific types of housing is significant factor associated with acute asthma attack.[15] The study by Van der Merwe et al. in Cape Town described above found that a rural type of housing (IS, RDP, and SC) was a significant factor associated with severe life-threatening asthma ($p = 000.5$).[15] Surprisingly, this conclusion was previously reported even in developed countries, such as United Kingdom (UK) and Australia.[34,35] This type of housing is mainly found in rural areas where access to specialized medical care is limited, which in turn could lead to sub-optimal asthma management, especially in severe asthma exacerbation.[15,35] Also,

a rural type of housing may be a marker for other asthma-exacerbating triggers, such as cockroach antigen exposure, dust at home, and secondhand smoke exposure.[25]

### 2.3.2.5. Active and passive cigarette smoking

Cigarette smoking considerably increases the risk episodes of breathing difficulty due to asthma in addition to cigarette smoke-induced fast decline in lung function and lung diseases, including chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD) and lung cancer.[4] Also, there is evidence that cigarette smoking interferes with the anti-inflammatory actions of corticosteroids, necessitating higher doses for asthma control, or leading to detrimental effects in effectiveness of steroid therapy.[10,36] Cigarette smoking cause airway irritation, and increases its responsiveness and sensitization to several allergens, and precipitate acute episodes of asthma.[10] The literature has also indicated the negative effects of active and/or passive cigarette smoking in the sense that it significantly induces entire airway destruction, leading to higher asthma-related complications, with subsequent morbidity and mortality.[4,10] Diaz-Sanchez et al. in their randomized, placebo-controlled crossover study, have proven the negative effects of cigarette smoke in asthmatic individuals.[37] Thus, active and/or passive cigarette smoking has been strongly reported as being one of the potential triggers of acute asthma attack.[5,10]

The study by Lkeue et al. found that cigarette-smoking was common among patients with acute asthma, and the current-smoker status was significantly associated with frequent ED visits and severe acute asthma attack ($p < 0.05$).[29] Westerman et al. also arrived at the same conclusion.[14] However, this conclusion was not in line with the findings of other studies.[38] The study by Patel et al. found that one-third of ED patients with acute asthma smoked cigarettes, although there was no significant association between cigarette smoking and acute asthma exacerbation.[38] The number of cigarettes smoked per day has also been reported as being a significant exacerbating asthma factor. Morkjaroenpong et al. in the USA, Thomson et al. in the UK, and Jindal et al. in India have documented statistically significant associations between numbers of cigarettes smoked per day and asthma exacerbation.[39,40,41]

### 2.3.3. Clinical factors

#### 2.3.3.1. Acute respiratory infection

Upper respiratory tract infection (URTI) is a potential trigger associated with acute asthma attack.[42,43,44] In a case-control study of viral and bacterial infection in acute asthma and COPD that increases the risk of readmission in Australia, Wark et al. found that URTIs are important determinants of more severe exacerbation of asthma.[42] Upper respiratory tract virus such as *Rhinovirus, Respiratory syncytial virus,* and *Coronavirus* are the most commonly reported viruses in the pathogenesis of asthma exacerbation.[10] They have the potential to invade the epithelial cells of both upper and lower airways and increase the airway inflammation with a significant number of eosinophils and neutrophils.[10] There is also evidence of the reduction of type I Interferons production by epithelial cells from asthmatic patients, leading to increased susceptibility to these viral infections and significant inflammatory response of the entire airway.[10]

Nicholson et al. used culture and serological methods of extreme sensitivity (RT-polymerase chain reaction assays) in detecting respiratory viruses.[45] In their longitudinal study of 138 adults with asthma, nose and throat swabs and blood samples were collected to coincide with symptoms of URTI or severity of asthma exacerbation.[45] They found 25% of confirmed viral infections were associated with a mean PEF of 50 l/min or more and 15% were associated with a PEF of 25 l/min or more.[45] In addition, Nicholson et al. found that respiratory viruses were implicated in 50% of all severe acute asthma attacks, which were defined as decreased PEF to equal or below 50 l/min.[45] In their multivariate analysis, Sanya et al. found that URTI was a significant trigger associated with acute asthma attack (OR 4.516, 95%CI: 1.258 to 16.213; p = 0.018).[23]

#### 2.3.3.2. Medication-related asthma triggers

Some medications, namely Beta-adrenergic blockers and NSAIDs, have been shown to trigger asthma exacerbation.[5,10] These medications are involved in the pathophysiology of asthma, as they induce bronchoconstriction by different intracellular pathways.[5,10] The mechanisms of which Beta-adrenergic blockers induced asthma exacerbation are not clear, but are likely mediated through increased cholinergic bronchoconstriction.[7] The mechanisms by which NSAIDs, including Aspirin, induce asthma exacerbation are by inhibiting cyclooxygenase enzyme with the immediate effect of releasing potent bronchoconstrictors, including prostaglandins and thromboxanes in the systemic circulation.[10] Thus, these

medications are considered triggers associated with acute severe asthma attack.[5,10] The two Turkish studies described above, namely by Bavbek et al. and by Goksel et al., found that medication-related asthma was a potential associated trigger for asthma exacerbation.[13,26]

#### 2.3.3.3. Adherence to asthma treatment

Lack of adherence to asthma treatment results in increasing asthma morbidity and mortality, and it is associated with increasing asthma treatment cost.[10,31,46,47] The WHO 2003 report estimates that asthma treatment adherence rate is often below 50% in developing countries.[46] The chronic course of asthma is often characterized by asymptomatic episodes and/or without immediate short-term complications.[48] These factors may contribute to making adherence to treatment challenging.[48] Non-adherence to the recommended treatment plan increases the number of asthma attacks and hospitalizations.[46,47] In their prospective, observational study of current outpatient management of asthma showing poor compliance with international consensus guidelines, in Pittsburgh, Taylor et al. found that significant proportions of asthmatic patients presenting to the ED (11% for bronchodilators and 89% for corticosteroids) did not comply with their treatment recommendation ($p < 0.05$).[47] The study by Geyser et al. in Pretoria and by Engelkes et al. in the UK, also found that non-compliance was significantly associated with asthma exacerbation (all $p < 0.005$).[49,50]

Studies have found different possible explanations for non-adherence to asthma treatment.[50,51,52,53] Sundberg et al. in Sweden found that anxiety was an independent reason for non-adherence to an asthma treatment regimen (OR 2.35, 95%CI: 1.18 to 4.69).[51] In their review of adolescent treatment compliance in asthma, Dinwiddie et al. documented reasons for not adhering to asthma treatment, such as inadequate instructions, a too-complex regimen, it being time-consuming, inadequate training in inhaler technique, and a lack of understanding of the need for long-term preventive treatment, especially when preventive medication does not produce immediate symptom relief.[53]

#### 2.3.3.4. Knowledge of asthma allergens

Asthma allergens have been reported as potential triggers associated with acute asthma attack.[10] Allergens activate mast cells which bind Immunoglobulin (Ig) E directly, leading to airway oedema and acute inflammatory response with increased eosinophils and neutrophils.[10] Rosenstreich et al. in the USA found that asthmatic patients sensitized and highly exposed to cockroach allergens were at greater risk of severe asthma exacerbation

and/or hospitalization, compared with either the non-exposed or non-sensitized patients.[54] Rosas et al. also documented a significant association between asthma-related ED visits and the presence of asthma allergens ($p < 0.05$).[55] In addition to this, the authors of this study demonstrated that grass pollen exposure was a significant trigger associated with asthma hospitalization in both children and adults, independently to other known asthma allergens ($p < 0.001$).[55]

A lack of education about allergens has been documented previously as a potential factor associated with asthma exacerbation.[12,56] In their study of how well asthmatic patients were educated about their asthma, Lee et al. concluded that asthmatic patients are not educated about their disease, including the role of asthma allergens.[56] Interestingly, the authors of this study also demonstrated that patients not well educated about asthma allergens had a greater chance of having more acute asthma attacks than those who are well educated on asthma allergens ($p < 0.05$).[56] The study by Refaat et al. described above found that a significant proportion (21.3%) of adult patients with asthma exacerbation were exposed to allergens.[22] Thus, educating asthmatic patients on asthma allergens may potentially decrease the higher rates of asthma exacerbations documented worldwide.[57-59,60-62, 63-68,69]

### 2.3.4. Psychological factor

#### 2.3.4.1. Stress or anxiety

Stress or anxiety is a significant factor associated with acute asthma attack.[10] Asthma and stress or anxiety can mutually potentiate each other through direct psychological mediation or cholinergic reflex pathways, non-adherence to medical treatment regimen, inaccurate perceptions about asthma symptoms and exposure to asthma triggers.[10,51,70] For example, an anxious asthmatic individual may became careless in taking his/her medications or in consistently making follow-up visits to healthcare facilities.[51] This was confirmed by Sundberg et al. in Sweden, who found that anxiety (OR 2.35, 95%CI: 1.18 to 4.69) was one of the independent reasons for non-adherence to asthma treatment regimens.[51] Kolbe et al. in New Zealand concluded that anxiety was a considerable factor in psychological morbidity in hospitalized patients admitted with acute asthma attack.[70] In addition to this, the authors of this study demonstrated that stress or anxiety was a significant factor associated with acute asthma attack presentation ($p < 0.05$).[70]

## 2.4. Summary of the literature review

The above literature review shows that the proportion of acute asthma attacks in EDs worldwide, including South Africa, is significant. Several factors, including demographic, social, clinical and psychological, can be significantly associated with acute asthma attack presentation. There are also several potential triggers for acute asthma attack, including active and/or passive cigarette smoking, asthma allergens, upper respiratory infection, and medication-related asthma triggers.

## 2.5. Study aim

The aim of the study was to determine the severity of and associated triggers for acute asthma attack in patients presenting to the Emergency Department of the Bertha Gxowa Hospital.

## 2.6. Study objectives

1. To determine the proportion of patients presenting with acute asthma attack at the Bertha Gxowa Hospital Emergency Department.
2. To determine the severity of acute asthma attack in patients presenting at the Bertha Gxowa Hospital Emergency Department.
3. To describe the socio-demographic factors pertaining to these patients.
4. To determine factors and/or triggers associated with acute asthma attack in these patients.

The next chapter describes the materials and methods used in the study.

# CHAPTER 3

# MATERIALS AND METHODS

This chapter describes the study methodology employed and the permission granted to undertake the study. It includes the study design, site, population, sample size, inclusion and exclusion criteria, pilot study, data collection tool and data collection, data analysis, and ethical considerations.

## 3.1. Study design

A "cross-sectional study design" is a survey of the frequency of disease, risk factors or other characteristics in a defined population at a particular time.[71] It is a design used in quantitative research, which is based on the measurement and analysis of data collected in numerical quantities.[71] A prospective study refers to the procedure followed in collecting data by the study investigator before any of the study participants have developed any of the outcomes of interest.[71] Thus defined, this was a prospective cross-sectional study.

## 3.2. Study site

The study was conducted in the ED of the BGH in Germiston, South Africa. The hospital is the only district hospital located in Germiston in the southern sub-district of the Ekurhuleni Heath District, in Health Region B of Gauteng Province, in South Africa. District hospitals form part of the district health system by assuring delivery of comprehensive PHC services.[72] They play a pivotal role in supporting PHC, on the one hand, and being a gateway to more specialist care, on the other.[72]

As a district hospital, BGH provides level one (generalist) services to in-patients and out-patients (ideally on referral from community health centres or clinics). It has 258 beds for in-patient care distributed across four wards (medical, surgical, paediatrics, and obstetrics and gynaecology). It also has an out-patient department (OPD), operating theatres, and an ED. Its ED has 24-hour services which are run by clinical associates, interns, medical officers, family medicine registrars, specialist family physicians, and a specialist emergency physician. BGH refers all serious conditions to a level two hospital, Thelle Mogoerane Regional Hospital.

BGH also serves as a training site of students for the Faculty of Health Sciences of the University of the Witwatersrand.

## 3.3. Study population

The study population consisted of patients diagnosed with acute asthma attack, aged 18 years or above, presenting at the BGH ED from 01st February 2015, 00h 00 to 30th April 2015, 00h 00.

## 3.4. Study sample size

The sample size was calculated using the Raosoft software.[73] The records of the BGH information system showed that the total number of patients presenting with acute asthma attack at the BGH ED was between 180 and 210 per month. As the study was done over a three-month period, the total population was approximately 630. Using a 5% margin of error, 95% confidence interval (CI) and 50% response distribution, the sample size determined was 239. Consecutive sampling was used. Every patient with acute asthma attack was invited to participate voluntarily in the study until the required sample size was reached.

## 3.5. Study inclusion criteria

- All patients aged 18 years or above, managed at BGH ED with acute asthma attack
- All patients able to perform a PEF for airflow limitation assessment

## 3.6. Study exclusion criteria

- Patients unable to speak and understand English
- All patients who declined to participate in the study

## 3.7. Pilot study

A pilot study, comprising a sample of seven participants, was done to test if the questions on the study questionnaire were well understood by the participants. This sample was not included in the data analysis. There were no major adjustments in the study questionnaire. Minor changes were made to the numbering of questions for better data capturing and analysis. Also, a few questions were removed from the study questionnaire, as the researcher found that they were not contributing much in answering the research question.

## 3.8. Data collection tool

A study questionnaire (Appendix B) was used. This was written in English. This tool was developed by the researcher with the aim of answering the research question. This study questionnaire was divided into three parts. The first part determined the socio-demographic characteristics of the participants. The second part assessed the severity of acute asthma attack in these patients using the WGSATS guidelines (Appendix A).[9]

The third part included five sections: the first section determined the presence of concomitant acute respiratory infection in these patients. The second section determined the presence of any prior or concomitant use of certain medication known as triggers associated with asthma exacerbation by these patients. The third section assessed the patient's adherence to his/her asthma treatment at home. The fourth section focused on asthma triggers. The "Talking about asthma" pamphlet recommended by the South African Department of Health was used. Finally, the last section determined other relevant triggers for acute asthma in these patients (Appendix B).

## 3.9. Data collection

The study proceeded as follows: before commencing the study the researcher explained to ED colleagues that he was conducting a study to determine the severity and associated triggers for acute asthma attack in patients presenting to the BGH ED, discussed this with them in general, and requested them to volunteer to participate in the study (Appendix C). The researcher then asked them to assess the patient's acute asthma attack severity as per WGSATS recommendations (Appendix A). This was made available in all ED consulting rooms for quick reference. After an eligible patient was managed and stabilized by the ED colleagues the researcher interviewed the patient and requested his/her participation in the study, following written informed consent (Appendix D). Following this, the researcher confirmed that the case fitted the study inclusion criteria and then collected all the required study information, including their PEF assessments, as per the study questionnaire (Appendix B).

A small proportion of data was collected by the ED colleagues in the absence of the researcher in ED, for example after working hours. In this case, before collecting data, the ED staff communicated telephonically (using social media networks: WhatsApp and Viber)

with the researcher to ascertain his availability in the next few hours. In the majority of cases the researcher came to attend to the patients, as he stays approximately 10 minutes from the BGH. In cases when the researcher could not come, the ED staff discussed with the patients and agreed on the need to collect data on the next day of admission by the researcher in the medical ward for in-hospital treatment patients. For patients who were discharged home, the ED staff collected all the data required for the study. Also, prior to collecting data the researcher had a meeting with the ED colleagues in which they agreed on a common understanding on the PEF procedure.[2,10] By the end of data collection process ninety percent of data had been collected by the researcher personally and the remaining ten percent by the ED colleagues.

## 3.10. Data analysis[64]

The collected data was entered on an Excel™ spread sheet. Statistical data analysis was carried out using Stata version 12 software, and charts to present data were constructed in Excel. Descriptive statistics, such as means and standard deviations (SD), or medians and ranges, were used to summarize quantitative characteristics. A Pie chart was used to graphically display the categorical characteristics, such as proportion of patients presenting with acute asthma attack in ED. A frequency histogram was constructed to present the distribution of quantitative data, such as severity of acute asthma. Frequencies and percentages were used to summarize categorical characteristics such as gender, asthma triggers, adherence to asthma treatment, level of education, and acute respiratory infection.

The Chi-square test or Fisher exact test (FET) was used to test the associations between different variables (age, gender, race, level of education, employment and occupation status, type of housing, acute respiratory infection, adherence to asthma treatment, medication-related asthma triggers, active and passive cigarette smoking, and stress or anxiety) across acute asthma attack severity. FET was used when the expected numbers of subjects in the cells were less than five. Bivariate logistic regression was used to ascertain factors and/or triggers associated with acute asthma attack presentation in the ED. Odds ratios (OR) with 95% CI and p-values were tabulated to describe the strength of these associations. P-values less than 0.05 were considered statistically significant.

## 3.11. Ethical considerations

The research was approved by the Human Research Ethics Committee (HREC) of the University of the Witwatersrand (Protocol approval number M141115 – see Appendix E). The researcher also had permission from the Ekurhuleni Health District Research Committee (Appendix F), the Chief Executive Officer (CEO) and the head of the ED of the BGH before data collection started. The BGH ED doctors were informed about the study and requested to volunteer to participate (Appendix C). Using a subject information form, research participants were informed about the study and a written informed consent was obtained from them (Appendix D). Confidentiality was maintained by not using patient names but giving a unique patient identification number (PIN) to each patient, starting from 001 (Appendix G). The PINs were known only to the researcher and the supervisors of the study. The next chapter describes the results of the study.

# CHAPTER 4

# RESULTS

This chapter describes the findings of the study. It includes the following results: proportion of patients presenting with acute asthma attack at the BGH ED, severity assessment of their acute asthma attack, their socio-demographic characteristics, and the associations between variables (age, gender, race, level of education, employment and occupation status, type of housing, active and passive cigarette smoking, acute respiratory infection, medication-related asthma triggers, adherence to asthma treatment, knowledge of asthma allergens, and stress or anxiety) across acute asthma attack severity to ascertain significant factors and/or triggers associated with acute asthma attack in these patients.

## 4.1. Proportion of patients presenting with acute asthma attack at the Bertha Gxowa Hospital Emergency Department

During the study period from 01st February 2015, 00h 00, to 30th April 2015, 00h 00, a total of 5260 patients presented at BGH ED with various health conditions, including acute asthma attack. Of these 5260 patients, a total of 251 (4.77%) had asthma exacerbation and were enrolled in the study (Figure 4.1). From these 251 acute asthma attack patients, twelve were excluded from the study: four refused to participate and eight had clinical conditions which did not allow PEF assessment. No patient was excluded from the study because he/she did not understand English language. As a result, 239 asthmatic patients were analysed.

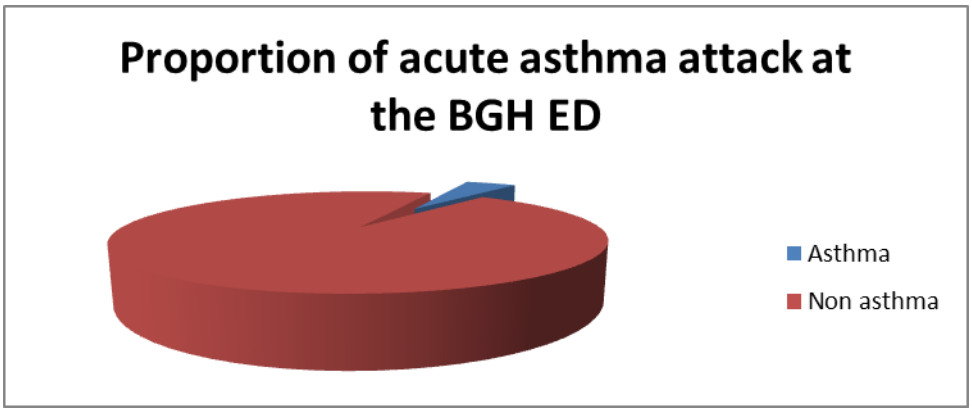



**Figure 4.1: Proportion of acute asthma attack at the BGH ED**

## 4.2. Severity assessment of acute asthma attack of patients presenting at the BGH ED

Figure 4.2 displays the assessment of the severity of acute asthma attack of patients presenting at the BGH ED.

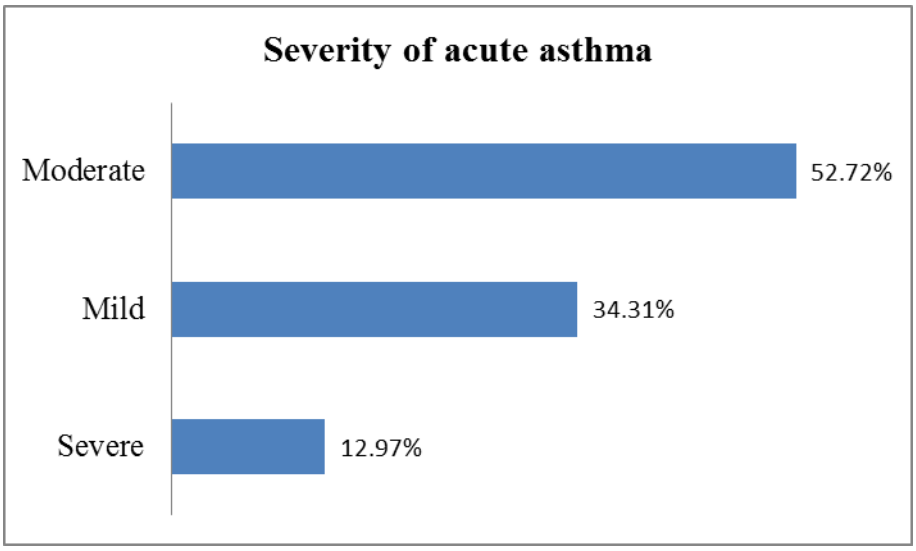



**Figure 4.2: Severity assessment of acute asthma attack of patients**

Eight out of 247 acute asthma patients (3.20%) were not able to perform a PEF assessment because of their clinical conditions at the presentation to the hospital ED. Therefore, they were excluded from the study. It is possible that some of these excluded patients had imminent respiratory arrest asthma exacerbation. Consequently, this category of asthma exacerbation was not reported in the study.

## 4.3. Socio-demographic factors of the study participants

### 4.3.1. Age

The findings related to ages of patients are shown in Table 4.1. The median age was 31 years and age ranged from 18 years to 75 years.

**Table 4.1: Percentage distribution between age group and acute asthma attack severity of patients**

| Age group | Frequency of age group | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| 18-24 | 26.78% | 34.38% | 48.44% | 17.19% | 100.00% |
| 25-34 | 31.80% | 38.16% | 51.32% | 10.53% | 100.00% |
| 35-44 | 12.97% | 19.35% | 70.97% | 9.68% | 100.00% |
| 45-54 | 12.13% | 31.03% | 51.72% | 17.24% | 100.00% |
| 55-64 | 9.21% | 31.82% | 54.55% | 13.64% | 100.00% |
| 65-75 | 7.11% | 52.94% | 41.18% | 5.88% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between age and acute asthma attack severity of patients presenting at the BGH ED gave the following results: Pearson $Chi^2$ = 9.4179, degree of freedom = 10 and p = 0.523. Further analysis with the bivariate logistic regression model gave the following results: (OR 0.99, 95% CI: 0.97 to 1.02; p = 0.592) (Table 4.17). In the logistic regression calculation, the outcome is categorized into severe versus mild/moderate.

### 4.3.2. Gender

The findings of the gender distribution of the patients are shown in Table 4.2.

**Table 4.2: Percentage distribution between gender and acute asthma attack severity of patients**

| Gender | Frequency of gender | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| Male | 58.18% | 37.41% | 51.80% | 10.79% | 100.00% |
| Female | 41.82% | 30.00% | 54.00% | 16.00% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between gender and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 2.2007, degree of freedom = 2 and p = 0.333. Further analysis with the bivariate logistic regression model gave

the following results: (OR 1.57, 95% CI: 0.74 to 3.36; p = 0.240) (Table 4.16). In the logistic regression calculation, the outcome is categorized into severe versus mild/moderate.

### 4.3.3. Race

The racial distribution of the patients is shown in Table 4.3.

**Table 4.3: Percentage distribution between race and acute asthma attack severity of patients**

| Race | Frequency of race | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| White | 8.37% | 40.00% | 55.00% | 5.00% | 100.00% |
| Black | 63.18% | 35.10% | 50.99% | 13.91% | 100.00% |
| Indian | 11.72% | 28.57% | 64.29% | 7.14% | 100.00% |
| Coloured | 16.74% | 32.50% | 50.00% | 17.50% | 100.00% |

The Chi-square statistic for the association between race and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 3.8423, degrees of freedom = 6 and p = 0.759. Further analysis using the bivariate logistic regression model gave the following results, where the white race was used as the reference category: black (OR 3.07, 95% CI: 0.39 to 24.15; p = 0.287), Indian (OR 1.46, 95% CI: 0.12 to 17.32; p = 0.764) and coloured (OR 4.03, 95% CI: 0.46 to 35.50; p = 0.208) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.3.4. Employment status

The results of the employment status of the patients are shown in Table 4.4.

**Table 4.4: Percentage distribution between employment status and acute asthma attack severity of patients**

| Employment status | Frequency of employment status | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| Employed | 83.26% | 32.16% | 53.77% | 14.07% | 100.00% |
| Not employed | 16.74% | 45.00% | 47.50% | 7.50% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between employment status and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 2.9570, degree of freedom = 2 and p = 0.256. Further analysis with the bivariate logistic regression model gave the following results: (OR 0.5, 95% CI: 0.14 to 1.72; p = 0.268) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.3.5. Occupation status

The results of the occupation status of patients are shown in Table 4.5.

**Table 4.5: Percentage distribution between occupation status and acute asthma attack severity of patients**

| Occupation status | Frequency of occupation status | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| No occupation | 16.32% | 46.15% | 46.15% | 7.69% | 100.00% |
| Occupation | 83.63% | 32.00% | 54.00% | 14.00% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between occupation status and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 2.2878, degree of freedom = 2 and p = 0.212. Further analysis with the bivariate logistic regression model gave the following results: (OR 1.95, 95% CI: 0.56 to 6.78; p = 0.291) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.3.6. Level of education

The level of education of the patients is shown in Table 4.6.

**Table 4.6: Percentage distribution between level of education and acute asthma attack severity of patients**

| Level of education | Frequency of level of education | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| No school | 2.93% | 71.43% | 14.29% | 14.29% | 100.00% |
| Secondary | 77.82% | 31.72% | 52.15% | 16.13% | 100.00% |
| Tertiary | 19.25% | 39.13% | 60.87% | 0.00% | 100.00% |
| Total | 100.00% | 34.30% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between level of education and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 14.4447, degree of freedom = 4 and $p < 0.001$. Further analysis with the bivariate logistic regression model gave the following results: (OR 1.15, 95% CI: 0.13 to 9.93; p = 0.896) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate. Also, there were too few study participants with no schooling, and therefore this category could not be included in the logistic regression calculation.

### 4.3.7. Type of housing

The type of housing of the patients is shown in Table 4.7.

**Table 4.7: Percentage distribution between housing type and acute asthma attack severity of patients**

| Type of housing | Frequency of type of housing | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| RDP | 1.26% | 66.67% | 33.33% | - - | 100.00% |
| IS or SC | 1.26% | - - | 100.00% | - - | 100.00% |
| Hostel | 0.84% | - - | 100.00% | - - | 100.00% |
| Flat | 71.55% | 33.92% | 52.63% | 13.45% | 100.00% |
| Townhouse | 25.10% | 36.67% | 50.00% | 13.33% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

- - : zero percent

The Chi-square statistic for the association between the type of housing and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 6.2282, degree of freedom = 8 and p = 0.822. Further analysis with the bivariate logistic regression model gave the following results: (OR 0.99, 95% CI: 0.42 to 2.35; p = 0.982) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.3.8. Smoking status

The current smoking status of the patients is shown in Table 4.8.

**Table 4.8: Percentage distribution between cigarette smoking status and acute asthma attack severity of patients**

| Cigarette smoking | Frequency of cigarette smoking | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| Yes | 15.06% | 22.22% | 30.56% | 47.22% | 100.00% |
| No | 84.96% | 36.45% | 56.65% | 6.90% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between cigarette smoking and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 44.0897, degree of freedom = 2 and p < 0.001. Further analysis with the bivariate logistic

regression model gave the following results: (OR 12.08, 95% CI: 5.16 to 28.27; p < 0.001) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

#### 4.3.8.1. Number of cigarettes smoked per day

Table 4.9 shows the results of the number of cigarettes smoked per day by the patients.

**Table 4.9: Percentage distribution between number of cigarettes smoked per day and acute asthma attack severity of patients**

| Numbers of cigarettes smoked per day | Frequency of cigarettes smoked per day | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| < 5 | 38.89% | 42.86% | 35.71% | 21.43% | 100.00% |
| 5 -10 | 50.00% | 11.11% | 33.33% | 55.56% | 100.00% |
| > 10 | 11.11% | -- -- | 25.00% | 75.00% | 100.00% |
| Total | 100.00% | 22.200% | 33.33% | 44.44% | 100.00% |

- -: zero percent

The Chi-square statistic for the association between numbers of cigarettes smoked per day and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 7.6875, degree of freedom = 2 and p = 0.114. Further analysis with the bivariate logistic regression model gave the following results: (OR 4.58, 95% CI: 0.94 to 22.24; p = 0.059) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.3.9. Cigarettes smoked by a household member

Table 4.10 shows the results of passive cigarette smoking of the patients.

**Table 4.10: Percentage distribution between cigarette smoking by a household and acute asthma attack severity of patients**

| Cigarette smoking by a household | Frequency of passive cigarette smoking | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| Yes | 22.19% | 28.57% | 42.86% | 28.57% | 100.00% |
| No | 77.82% | 35.29% | 54.41% | 10.29% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between cigarette smoking by a household (a form of passive cigarette smoking) and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 8.8442, degree of freedom = 2 and p = 0.012. Further analysis with the bivariate logistic regression model gave the following results: (OR 3.49, 95% CI: 1.47 to 8.25; P < 0.004) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

## 4.4. Clinical factors

### 4.4.1. Acute respiratory infection

Table 4.11 shows the presence of acute respiratory tract infections among the patients.

**Table 4.11: Percentage distribution between acute respiratory infection and acute asthma attack severity of patients**

| Acute infection | Frequency of acute infection | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| None | 89.12% | 33.33% | 53.52% | 13.15% | 100.00 |
| URTI | 10.05% | 41.67% | 45.83% | 12.50% | 100.00 |
| LRTI | 0.84% | 50.00% | 50.00% | - - | 100.00 |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00 |

- -: zero percent

The Chi-square statistic for the association between acute respiratory tract infection and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 1.0945, degree of freedom = 4 and p = 0.873. Further analysis with the bivariate logistic

regression model gave the following results: (OR 0.86, 95% CI: 0.24 to 3.06; p = 0.818) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.4.2. Use of medication-related asthma triggers

Table 4.12 shows the use of medication-related asthma triggers by the patients

**Table 4.12: Percentage distribution between medication-related asthma triggers and acute asthma attack severity of patients**

| Medication used | Frequency of medication used | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| None | 97.91% | 33.76% | 52.99% | 13.25% | 100.00 |
| NSAIDs | 2.09% | 60.00% | 40.00% | - - | 100.00 |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00 |

- -: zero percent

The Chi-square statistic for the association between use of medications known to trigger asthma exacerbation and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 1.8015, degree of freedom = 2 and p = 0.432. Further analysis with the bivariate logistic regression model gave the following results: (OR 0.95, 95% CI: 0.27 to 3.41; p = 0.942) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

### 4.4.3. Adherence to asthma treatment

Table 4.13 shows adherence status to asthma treatment of the patients

**Table 4.13: Percentage distribution between adherence to asthma treatment and acute asthma attack severity of patients**

| Adherence | Frequency of adherence | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| Yes | 58.00% | 32.57% | 54.59% | 12.84% | 100.00% |
| No | 40.00% | 64.29% | 28.57% | 7.14% | 100.00% |
| Not sure | 2.00% | 28.57% | 42.86% | 28.57% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic for the association between adherence to asthma treatment and acute asthma attack severity of patients presenting at the BGH ED gave the following results: ($Chi^2$ = 24.5349, degree of freedom = 4 and $p < 0.001$). Further analysis with the bivariate logistic regression model gave the following results: (OR 11.09, 95% CI: 4.31 to 27.09; $p < 0.001$) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

## 4.4.4. Asthma allergens and its knowledge score

### 4.4.4.1. Knowledge of asthma allergens

Table 4.14 shows knowledge of asthma allergens distribution of the patients.

**Table 4.14: Percentage distribution of knowledge of asthma allergens of patients**

| Allergen type | Frequency of correct answers |
|---|---|
| Cigarette smoke | 100.00% |
| Cold weather | 96.65% |
| Feathers | 95.82% |
| Dust at home or street | 94.77% |
| Chemicals like paint, detergents, soap | 93.10% |
| Spray from deodorant, perfume and air fresher | 92.68% |
| Seeds from weed or grass | 91.25% |
| Pollen | 89.96% |
| Cockroaches | 83.20% |
| Fruits like peanut and mango | 81.59% |
| Smoke from coal, fire, wood and paraffin stoves | 79.55% |
| Red wine | 74.48% |
| Cat | 66.53% |
| Yellow/orange flavoured/coloured food | 59.00% |

### 4.4.4.2. Asthma allergens knowledge score

Each of the patients was given a score on knowledge regarding asthma allergens. Each correct answer was given a score of '1' and each wrong answer was given a score of '0'. A total score of 27 means that the participant knows all the 27 asthma allergens asked in the study questionnaire (Appendix B); higher scores close to 27 imply higher knowledge on asthma allergens. The mean (SD) of the score was 24.3 (1.3), indicating a very high knowledge of asthma allergens among the patients. Their scores ranged from 20 to 26 as shown in Table 4.15.

**Table 4.15: Percentage distribution between knowledge of asthma allergens and acute asthma attack severity of patients**

| Asthma knowledge score | Frequency of knowledge score | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| 20 | 2.09% | - - | 60.00% | 40.00% | 100.00% |
| 21 | 2.51% | 33.33% | 33.33% | 33.33% | 100.00% |
| 22 | 2.51% | 16.67% | 83.33% | - - | 100.00% |
| 23 | 6.70% | 37.50% | 43.75% | 18.75% | 100.00% |
| 24 | 43.09% | 33.98% | 53.40% | 12.62% | 100.00% |
| 25 | 25.10% | 41.67% | 48.33% | 10.00% | 100.00% |
| 26 | 17.99% | 30.23% | 58.14% | 11.63% | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

--: zero percent

The Chi-square statistic for the association between asthma knowledge score of asthma allergens and acute asthma severity of patients presenting at the BGH ED gave the following results: Pearson $Chi^2$ = 12.1257, degree of freedom = 12 and p = 0.462. Further analysis with the bivariate logistic regression model gave the following results: (OR 0.79, 95% CI: 0.60 to 1.03; p = 0.086) (Table 4.17). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

## 4.5. Psychological factor

### 4.5.1. Stress or anxiety

Table 4.16 shows the distribution of stress or anxiety of the patients.

**Table 4.16: Percentage distribution of stress or anxiety of and acute asthma attack severity of patients**

| Condition reported | Frequency of conditions | Mild attack | Moderate attack | Severe attack | Total |
|---|---|---|---|---|---|
| None | 84.94% | 35.96% | 51.72% | 12.32% | 100.00% |
| Stress | 14.64% | 25.71% | 57.14% | 17.14% | 100.00% |
| Anxiety | 0.42% | - - | 100.00% | - - | 100.00% |
| Total | 100.00% | 34.31% | 52.72% | 12.97% | 100.00% |

The Chi-square statistic between suffering from stress or anxiety and acute asthma attack severity of patients presenting at the BGH ED gave the following results: $Chi^2$ = 2.5167, degree of freedom = 4, p = 0.590. Further analysis with the bivariate logistic regression model gave the following results: (OR 1.42, 95% CI: 0.54 to 3.76; p = 0.476) (Table 4.16). In the logistic regression calculation, the outcome was categorized into severe versus mild/moderate.

## 4.6. Logistic regression results

Table 4.17 shows the results of bivariate logistic regression between different variables (age, gender, race, level of education, employment and occupation status, type of housing, active and passive cigarette smoking, acute respiratory tract infection, medication-related asthma triggers, adherence to asthma treatment, knowledge of asthma allergens, and stress or anxiety) and acute asthma severity of patients presenting at the BGH ED.

**Table 4.17: Bivariate logistic regression results between variables and acute asthma attack severity of patients**

| Variables | OR | 95%CI | p-value |
|---|---|---|---|
| Age (years) | 0.99 | 0.97 to 1.02 | 0.592 |
| Female gender | 1.57 | 0.74 to 3.36 | 0.24 |
| *Race* | | | |
| White | Reference | | |
| Black | 3.07 | 0.39 to 24.15 | 0.287 |
| Indian | 1.46 | 0.12 to 17.32 | 0.764 |
| Other | 4.03 | 0.46 to 35.30 | 0.208 |
| Employment | 0.5 | 0.14 to 1.72 | 0.268 |
| Occupation | 1.95 | 0.56 to 6.78 | 0.291 |
| *Education* | | | |
| Secondary | Reference | | |
| Tertiary | 1.15 | 0.13 to 9.93 | 0.896 |
| *Housing* | | | |
| Flat | Reference | | |
| Townhouse | 0.99 | 0.42 to 2.35 | 0.982 |
| *Acute respiratory infection* | | | |
| None | Reference | | |
| URTI | 0.86 | 0.24 to 3.06 | 0.818 |
| Not adherent | 11.09 | 4.31 to 27.09 | <0.001 |
| Medication-related asthma triggers | 0.95 | 0.27 to 3.41 | 0.942 |
| Asthma allergens knowledge score | 0.79 | 0.60 to 1.03 | 0.086 |
| Smoking | 12.08 | 5.16 to 28.27 | <0.001 |
| *Number of cigarettes smoked per day* | | | |
| <5 | Reference | | |
| 5-10 | 4.58 | 0.94 to 22.24 | 0.059 |
| >11 | 11.00 | 0.82 to 147.87 | 0.070 |
| Someone smoking at home | 3.49 | 1.47 to 8.25 | 0.476 |
| Stress or anxiety | 1.42 | 0.54 to 3.76 | 0.476 |

The results of the bivariate logistic regression show that adhering to asthma treatment (OR 11.09, 95% CI: 4.31 to 27.09; $p < 0.001$), active cigarette smoking (OR 12.08, 95% CI: 5.16 to 28.27; $p < 0.001$) and passive cigarette smoking (OR 3.49, 95% CI: 1.47 to 8.25; $p = 0.004$) were the only statistically significant factors. For the calculation of the bivariate

logistic regression, acute asthma severity was tabulated in two groups, namely mild/moderate and severe acute asthma attack.

The bivariate logistic regression results show no significant association between level of education and acute asthma attack severity. However, the results of FET described above (Table 4.6) are not in line with this conclusion ($p < 0.001$). This difference in results is explained by the fact that there were too few patients with no schooling, and therefore it was not possible to include this category in the logistic regression calculation.

## 4.7. Summary of main study findings

The key findings from the study are as follows: the proportion of patients presenting with acute asthma attack at the BGH ED was 4.77%. The majority of them had moderate acute asthma attack (52.72%), were black (63.18%), young adults (83.68%), males (58.18%), completed secondary school (77.82%), employed (83.26%), had an occupation (83.63%), live in modern or urban type of house (96.65%), and were adherent to their asthma treatment (58.00%).

Low level of education ($p < 0.001$) was a significant factor associated with acute asthma attack presentation. Active cigarette smoking ($p < 0.001$) and/or passive cigarette smoking ($p = 0.004$) were identified to be potential triggers associated with acute asthma attack. There were no significant associations between acute asthma attack severity and age ($p = 0.592$), gender ($p = 0.240$), race ($p = 0.759$), occupation status ($p = 0.291$), employment status ($p = 0.268$), number of cigarettes smoked per day ($p = 0.059$), type of housing ($p = 0,982$), acute respiratory tract infection ($p = 0.818$), use of medication-related asthma triggers ($p = 0.942$), knowledge of asthma allergens ($p = 0.086$), and stress or anxiety ($p = 0.475$). The next chapter will discuss the findings of the study.

# CHAPTER 5

# DISCUSSION

This chapter contains a discussion of key findings of the results presented in the preceding chapter in light of the literature review. It includes the following discussion: the proportion of patients presenting with acute asthma attack at the BGH ED, their acute asthma severity assessment and socio-demographic characteristics, and the results of associations between different variables and acute asthma attack severity of these patients.

## 5.1. Proportion of patients presenting with acute asthma attack at the Bertha Gxowa Hospital Emergency Department

The results have shown that the proportion of patients presenting with acute asthma attack at the BGH ED is about 4.77%. This relatively low proportion was not surprising and is consistent with other studies.[18] A proportion as low as 2.50% was reported by Kirenga et al. in their study in Uganda.[18] Other studies have reported contradictory results that indicated higher proportions of acute asthma attack in an ED.[14,19] South African study by Westerman et al. described above, on the magnitude of the asthma problem at Groote Schuur Hospital, in Cape Town, reported a proportion of 10.0%.[14] In their study of multicentre observational analysis of adults with asthma exacerbation in ED, Watase et al. in Japan reported a proportion as high as 47%.[19]

The difference in proportions is explained by the socio-cultural habits of the population studied and the organization of healthcare system of country where the study is undertaken, including study site and level of care.[10,18] In the study by Kirenga et al. described above, patients with asthma exacerbation were managed in both the ED and respiratory clinic in the hospital where the study was conducted.[18] Importantly, both proportions (2.5% and 16.9% in the ED and respiratory clinic, respectively) were reported by the authors.[18] In the RSA, patients with acute asthma attack are mainly managed in ED, and a respiratory clinic is reserved more for patients in need of a pulmonology consultation.[15] Thus, if this practice was followed in Uganda there could be the possibility of Sanya et al. reporting a higher proportion of asthma exacerbation in ED.

A study conducted in a tertiary hospital is expected to report lower proportions of many health conditions, including acute asthma attack compared with the one conducted in a district hospital, which is the first point-of-care of most patients.[59] However, this was not the case with the Cape Town study conducted in a tertiary health facility by Westerman et al., which reported a significant proportion (10%) of acute asthma attack in ED,[14] whereas our study was conducted in a district hospital but found a lower proportion of asthma exacerbation in ED (4.77%). In addition, our study was conducted at one site, in one area of the country and in a public hospital setting only. This suggests that the relatively low proportion of acute asthma attack reported in our study has to be taken with caution. There is the possibility of higher proportions of acute asthma attack being reported in South African hospital EDs.

Higher proportions of acute asthma attack in EDs is of concern, as this can be regarded as treatment failure and deemed to be preventable through an optimal asthma management by both HCPs and patients.[57] Furthermore, ED visits imply a significant economic burden on healthcare spending – as much as five times more per visit than a typical outpatient visit for asthma.[57] This had recently indicated the importance of determining the reasons for ED visits for acute asthma attack. Hasegawa et al. concluded from both their bivariate and multivariate models that the use of EDs as the preferred source of asthma prescription was one of the significant reasons for ED visits by asthmatic patients (all $p < 0.005$).[57] This was an interesting study which included 64 USA EDs, a large sample size (1095), a design (cohort) of good evidence level and a study population comprising a diverse spectrum of ethnic groups of adult patients.[57,64] This indicates that asthmatic patients have possibly other reasons than seeking treatment for asthma exacerbation in ED, and addressing them may potentially reduce the higher rates of asthma exacerbation in EDs documented worldwide, including in South Africa.[2,9,10,49,57-59]

## 5.2. Acute asthma severity assessment of patients presenting at the BGH ED

The results have shown that patients presented with mild, moderate and severe acute asthma exacerbations at the BGH ED. In the study the majority of patients (52.72%) had moderate acute asthma attack. This is in line with the studies described above, by Dankner et al. in Israel and by Westerman et al. in Cape Town al.[14,21] This is in contrast with the study by

Refaat et al. in Egypt in which they found a large proportion (52.6%) of patients had severe acute asthma attack.[22]

The difference in proportions of moderate and severe acute asthma attack between studies is explained by many factors, including the guidelines used to classify asthmatic patients in ED, the social habits (i.e. cigarette smoking) of the study participants, and adherence to asthma treatment, occupation status, help-seeking behaviour and other factors like the presence of acute viral respiratory infection and asthma allergens.[10,22] For example, in their study Refaat et al. assessed acute asthma attack severity based on the Expert Panel Report-3 (EPR-3) of 2007, which categorized the attack based on PEF, above 70% as mild, between 69% to 40% as moderate, and below 40% as severe,[22] whereas the WGSATS guideline defines acute asthma attack as mild if PEF is above 80%, moderate between 80% and 60%, and severe if PEF is below 60%.[9] Refaat et al. could thus have reported an even higher proportion of severe asthma exacerbation than the actual proportion documented in their study (52.6%) if they had used the WGSATS guideline, as there are significant differences in PEF values between the two guidelines.[9,22]

Cigarette smoking is one of the main factors associated with severe acute asthma attack presentation.[10] The studies by Hasegawa et al. in USA and the study by Watase et al. in Japon found that cigarette smoking was a significant factor associated with severe asthma exacerbation in ED.[19,57] In addition to this, the authors of these studies demonstrated that current cigarette smoking was significantly associated with frequent ED visits (all $p < 0.05$).[19,61] The study by Hasegawa et al. is described above.[57] The study by Watase et al. included 23 EDs across Japan and was conducted over a two-year period. It had a large sample size (1002), a mixture of ethnic groups of adult patients, and a design (multicentre chart review) of good evidence level.[19,64] The findings of these two studies can be generalized, as their large sample sizes gave them enough statistical powers, in addition to their good study designs and the ethnic composition of the participants.[64]

Furthermore, in the study by Refaat et al. described above, 25.40% of patients were currently smokers,[22] whereas there were only 15.06% in our study. Thus, it is possible that the higher rate of severe asthma exacerbation documented by Refaat et al. compared to that from our study could be due to the significant number of current cigarette smokers in their study.[22]

## 5.3. Socio-demographic characteristics of the patients

### 5.3.1. Demographic characteristics

The results have shown that patients were mostly adults (18 years to 54 years: 84.00%) with a predominance of male gender (58.00%). This was similar to the findings of many European studies.[3,5] This was in contrast with the study by Westerman et al. in Cape Town.[14] Other studies have documented a predominance of female gender.[22,57] Examples include the study by Scharts et al. in the USA and the study by Refaat et al. in Egypt.[22,58]

The overall median age was 31 years, which was similar to the median age 33 years reported by Sanya et al. in Uganda[23] and 35 years reported by Refaat et al. in Egypt,[22] but lower than the median age of 41 years reported by Pearson et al. in the United Kingdom (UK).[59] The difference in the age range could be explained by the longer life expectancy of the population of developed countries compared to that of the African population.[60] The UK is a developed country where the life expectancy of the population is estimated to be longer (81 years) than that of Egypt (71 years), South Africa (60 years), and Uganda (59 years) population.[60] The youngest patient was 18 years old and the oldest patient was 78 years old. This was similar to the adult age range (18 years to 73 years) reported by Bellamy et al.,[61] but was in contrast with the age range (16 to 94 years) reported by Pearson et al.[59]

The results have shown that the majority of the patients (63.00%) were black (Table 4.3). This was similar to the findings of an American study of the impact on race on the severity of acute episode of asthma by El-Ekiaby et al.[62] This was in contrast with the study by Westerman et al. in Cape Town, which found that the majority of patients were white, followed by blacks.[14] The difference in findings can be explained by country, country politics and study site, including urban and rural areas. A study conducted in a predominantly black African country is expected to report a majority of blacks. The South African study by Westerman described above was conducted during the apartheid period, when the black population had difficulty in accessing medical care in South Africa. Consequently, the authors reported a majority of whites in their study population.[14]

### 5.3.2. Social characteristics

The results show that the majority of the patients were employed (83.00%) or had an occupation (84.00%). This was similar to the conclusion of the study by Sanya et al. in Uganda.[23] This was not in line with the study by Fernandes et al. in Brazil.[27] This was also not in line with the findings reported by Schwenkglenks et al. in Swaziland.[32] In terms of level of education, the majority of the patients (88.00%) completed secondary school, followed by tertiary school. This was similar to the findings of the study described above by Fernandes et al. in Brazil.[27] This was in contrast with the study by Geyser et al. at Kalafong Hospital in Pretoria.[49] The majority of patients (97.00%) in the study live in modern or urban type of housing. The study by Van der Merwe in Cape Town described above reported the same conclusion.[15] This was also similar to the study by Eisner et al. in California.[25]

## 5.4. Factors and/or triggers associated with acute asthma attack in patients presenting at the BGH ED

### 5.4.1. Age

The Chi-square statistic revealed no significant association between age and acute asthma attack ($p = 0.523$). This is in line with the results of the logistic regression (OR 0.99, 95% CI: 0.97 to 1.02; $p = 0.592$). Thus, age was not a significant factor associated with acute asthma attack in these patients. This conclusion has been found in many other studies.[23,27,49,63] In their study Sanya et al. found that age was not a significant factor associated with asthma exacerbation (OR 0.75, 95% CI: 0.523 to 1.090; $p = 0.710$).[23] This was also similar to the findings by Fernandes et al. in Brazil (OR 1.001, 95% CI: 0.994 to 1.009; $p = 0.781$).[27] Other studies have reported contradictory results, in the sense that belonging to a certain age group is a significant factor associated with asthma exacerbation and/or hospitalization.[63] The study by Bavbek et al. on the risk factors associated with hospitalizations for asthma attacks in Turkey found that advanced age was a significant factor associated with acute asthma attack and/or hospitalization ($p < 0.001$).[26] The study by Brandao et al. in Brazil and the study by Omachi et al. in USA have also arrived at the same conclusion that advanced age was a potential factor associated with asthma exacerbation.[33,63]

### 5.4.2. Gender

The Chi-square statistic revealed no significant association between gender and acute asthma attack ($p = 0.333$). This is in line with the results of the logistic regression (OR 1.57, 95% CI: 0.74 to 3.36; $p = 0.24$). Thus, gender was not a significant factor associated with acute asthma attack in these patients. This was similar to the study described above by Omachi et al. in USA.[63] This was in contrast with the case-control study by Van der Merwe et al. in Cape Town, which found that female gender was a significant factor associated with severe life-threatening asthma (OR 3.3, 95% CI: 1.2 to 9.6; $p = 0.02$).[15] This conclusion was in contrast with the findings by Fernandes et al. that male gender was significantly and independently associated with severe asthma exacerbation and/or death (OR 5.392, 95% CI: 2.373 to 12.254; $p < 0.001$).[27] This was attributed to non-adherence to asthma treatment and the failure to achieve good chronic asthma control in male asthmatic patients.[27]

In this study, the researcher did not investigate the gender distribution across adherence to asthma treatment. However, studies have documented conflicting reports with regard to gender distribution across adherence to the recommended treatment regimen.[51,51] Recently, Manteuffel et al. in the USA evaluated the differences between women and men in medication use, medication adherence, and prescribing alignment with clinical guidelines.[52] They included 29.5 million adults aged 18 and older, with a variety of acute and chronic health conditions.[52] They found that women were significantly more likely than men to use ≥ 1 acute medications (68% vs. 59%, respectively, $p < 0.001$), whereas they were less likely than men to be adherent in their use of chronic medications ($p < 0.0001$).[52] In their study of asthma in men and women, treatment adherence, anxiety, and quality of sleep, Sandberg et al. in Sweden found that women had a significantly reduced risk of non-adherence to their use of chronic asthma medication (OR 0.64, $p = 0.02$).[51] In addition to this, the authors of this study demonstrated that at exacerbation in asthma, women had a significantly greater risk of adherence to their asthma medication (OR 0.46, $p < 0.0001$).[51]

### 5.4.3. Race

The Chi-square statistic revealed no significant association between race and acute asthma attack ($p = 0.759$). This is in line with the results of the logistic regression (black: OR 3.07,

95% CI: 0.39 to 24.15; p = 0.287, Indian: OR 1.46, 95% CI: 0.12 to 17.32; p = 0.764, and coloured: OR 4.03, 95% CI: 0.46 to 35.50; p = 0.208). Thus, race was not a significant factor associated with acute asthma attack in these patients. This observation is striking in this context, given that multiple prior studies have demonstrated a markedly greater association between race and asthma exacerbation.[25,30,63] The study by Omachi et al. found that African-American race was significantly associated with lower risk of severe asthma exacerbation and death (p = 0.04) compared to whites.[63] The study by Boudreaux et al. found that more black than white people had severe acute asthma (p < 0.001).[30] The study by Eisner et al. also found a significant association between non-white (non-Hispanic) race/ethnicity and risk of hospitalization in asthmatic patients (OR 3.1, 95% CI: 1.10 to 8.80).[25] In addition to this, the authors of this study found that African-American race was associated with increased risk of hospitalization, compared with whites, non-Hispanic persons (OR 10.2, 95% CI: 1.80 to 58.4); and Hispanic race/ethnicity also appeared to be related to hospitalization (OR 4.09, 95% CI: 0.9 to 18.0).[25] In our study, white people constituted a small proportion (8.37%) compared to that in all studies described above.[25,30,63] It is possible that this could result in low statistical power to detect the significant association between the overall race distribution and asthma exacerbation.[1,63] Therefore, our conclusion has to be taken with caution.

### 5.4.4. Occupation and employment status

The Chi-square statistic revealed no significant association between occupation status (p = 0.287) or employment status (p = 0.258) and acute asthma attack. This is in line with the results of the logistic regression (occupation status: OR 1.95, 95% CI: 0.56 to 6.78; p = 0.291, and employment status: OR 0.5, 95% CI: 0.14 to 1.72; p = 0.268). Thus, occupation or employment status was not a significant factor associated with acute asthma attack in these patients. This conclusion has been reported by many other studies.[15,17,25] However, the study by Fernandes et al. described above pointed in a different direction in the sense that unemployment was significantly associated with severe acute asthma attack (p < 0.05).[27] This can be explained by the poor quality of life these patients experience, as demonstrated previously by Nogueira et al.[65] Another explanation is that individuals being unemployed or not having an occupation are potentially at risk of having low income, which is one of the significant factors associated with severe asthma exacerbation as demonstrated by Eisner et al. (OR 1.2, 95%CI: 0.9 to 1.3).[25] Importantly, there was a low proportion of no-occupation status (16.32%) or no-employment status (16.74%) among the patients in the study.

### 5.4.5. Level of education

The Chi-square statistic revealed a significant association between level of education and acute asthma attack ($p < 0.001$). Patients with a lower level of education experienced severe asthma attack compared to patients with a higher level of education. This was not in line with the results of the logistic regression (OR 0.15, 95% CI: 0.13 to 9.95; $p = 0.896$). The difference in results is explained by the fact that there were too few patients with no schooling, and therefore it was not possible for this category to be included in the logistic regression calculation. Thus, this study shows that lower level of education is a significant factor associated with acute asthma attack. The three studies described above, namely by Eisner et al. in USA, Bavbek et al. in Turkey, and brandoa et al. in Brazil, came to the same conclusion.[26,33] However, this conclusion was not in line with many other studies, namely by Sanya et al. in Uganda,[23] by Fernandez et al. in Brazil,[27] and by Omachi et al. in the USA.[63]

The authors of these studies did not give the reasons of their findings. However, several possible explanations of the difference in findings may be given. Firstly, in the prospective cohort study by Brandao et al., children and adults were all included in the study (sample size 253); and there were 43.00% of adults, very few of whom had completed tertiary education.[33] In this study, care-givers were playing a crucial role for many paediatric patients with regard to adherence to their asthma treatment.[33] And this study was conducted in a regional hospital.[33] Secondly, in the study by Omachi et al., the sample size was significant (865), comprising exclusively adult patients of a large racially diverse cohort, and including only the severe category of asthma exacerbation.[63] These had the effect of increasing the statistical power to detect risk factors for severity of asthma exacerbation, making the results more reliable and generalizable.[63,64] And the study was conducted in a regional hospital as well.[63] Lastly, our study was a cross-sectional one; conducted in a district hospital setting; focused exclusively on adult patients (sample size 239); and did not include imminent respiratory arrest asthma exacerbation category.

Therefore, these observations show that the differences in findings between studies may be explained by the study's methods, including the level of care where the study is conducted, the study sample size, the study inclusion and exclusion criteria, and the population studied, including their ages, asthma severity, and levels of schooling.

### 5.4.6 Type of housing

The Chi-square statistic revealed no significant association between type of housing and acute asthma attack (p = 0.822). This is in line with the results of the logistic regression (OR 0.99, 95% CI: 0.42 to 2.35; p = 0.982). Thus, type of housing was not a significant factor associated with acute asthma attack in these patients. This was not in line with the findings of other studies.[15,25] The study by Van der Merwe et al. in Cape Town found that rural residence (OR 8.1, 95% CI: 2.6 to 25.3; p = 0.0005) was a significant factor associated with severe life-threatening asthma exacerbation.[15] Surprisingly, international studies had also previously arrived at this conclusion.[34,35] Examples include the study by Tang et al. in Australia and the study by Higgins et al. in UK.[34,35] Rural type of housing may be a marker for other asthma triggers, such as cockroach antigen exposure, dust, and secondhand smoke exposure.[25] Importantly, there was a very low proportion (3.00%) of patients living in a rural type of housing (IS, RDP and SC) in the study. However, it is possible that the small proportion of patients living in rural types of housing in the study means that there is not sufficient statistical power to detect a significant association between type of housing and asthma exacerbation.[64] Therefore, our conclusion needs to be taken with caution.

### 5.4.7 Active cigarette smoking

The Chi-square statistic revealed a significant association between cigarette smoking and acute asthma attack (p < 0.001). For example, patients who smoked cigarettes were more likely to suffer severe acute asthma attack compared to patients who did not smoke cigarettes. This is in line with the results of the logistic regression (OR 12.08, 95% CI: 5.16 to 28.27; p < 0.001). Thus, this study demonstrates that cigarette smoking is a potential trigger associated with acute asthma attack. The study by Eisner et al. described above came to the same conclusion.[25] In addition, the authors of that study demonstrated that past cigarette smoking was a significant associated trigger for severe acute asthma attack and/or hospitalization (OR 1.3, 95% CI: 1.6 to 2.6).[25] The study by Lkeue et al. also arrived at the same conclusion.[29] However, other studies found no statistically significant differences between smokers and non-smokers in relation to asthma exacerbation.[23,38] Examples include the study by Sanya et al. in Uganda (OR 0.476, 95% CI: 0.082 to 2.745, p = 0.406) and the study by Patel et al. in USA (p > 0.05).[18,32]

In both studies described above, namely by Eisner et al. and by Lkeue et al., there were significant rates of current cigarette smokers.[25,29] For example, Sanya et al. reported a rate of

9.3%, whereas Lkeue et al. documented a rate of 35%. A large rate is representative of a true population studied and therefore makes the results more reliable compared to a small rate.[64] Thus, the non-significant association between current cigarette smoking and asthma exacerbation documented by Sanya et al. could be due to the small number of current cigarette smokers among their study participants.[18] This could result in low statistical power in detecting a significant association between variables measured.[64] Asthmatic patients who smoke cigarettes are more likely to have uncontrolled asthma than asthmatic non-smokers,[36] and this leads ultimately to an increase in the number of asthma exacerbations with subsequent ED visits.[5,10,36] These observations sustain the association between current cigarette smoking and acute asthma attack documented in many studies, including ours.[25,29]

#### 5.4.7.1. Number of cigarettes smoked per day

The Chi-square statistic revealed no significant association between number of cigarettes smoked per day and acute asthma attack ($p = 0.114$). This is in line with the results of the logistic regression (OR 4.58, 95% CI: 0.94 to 22.24; $p = 0.059$). Thus, the numbers of cigarettes smoked per day did not have a significant effect on asthma exacerbation in these patients. This conclusion was not in line with the findings documented by many studies, namely by Morkjaroenpong et al. in the USA, Thomson et al. in the UK, and Jindal et al. in India.[39-41] Morkjaroenpong et al. demonstrated the strong association between numbers of cigarettes smoked per day and asthma exacerbations in the sense that asthmatic individuals who smoked greater numbers of cigarette per day (≥ 10/day) were at greater risk of developing severe acute asthma attack (OR 2.83, 95%CI: 1.22 to 6.55) compared to those who smoked less than 10 cigarettes per day.[39]

Although in our study there was no significant association between numbers of cigarettes smoked per day and asthma exacerbation, there was a tendency towards significance, since the p-value is equal to 0.059. In reality, there is evidence of a difference or an impact in number of cigarettes smoked per day in the severity of asthma exacerbation in these patients, since the p-value is between 0.05 and 0.10.[64] It is possible that the proportion of smokers (15.06%) in the study was too small to allow enough statistical power in detecting a significant association between numbers of cigarette smoked per day and asthma exacerbation in these patients.[64] Another reason for the non-significance could be that the study did not record the actual numbers of cigarettes smoked per day; instead the researcher recorded only the intervals (< 5, 5 to 10, and > 10). This could also have resulted in low

statistical power to detect the association between numbers of cigarettes smoked per day and asthma exacerbation.[64]

### 5.4.8. Passive cigarette smoking

The Chi-square statistic revealed a significant association between cigarette smoking by a household (a form of passive cigarette smoking) and acute asthma attack (p = 0.012). Patients who have a household in which cigarettes are smoked were more likely to suffer severe acute asthma compared to patients who do not have such a household. This is in line with the results of the logistic regression (OR 3.49, 95% CI: 1.47 to 8.25; p = 0.004). Thus, this study shows that passive cigarette smoking is a potential associated trigger for acute asthma attack. In their cross-sectional study of passive smoking exposure, Radon et al. found that passive cigarette smoking was a significant associated trigger for acute asthma attack (OR 42.06, 95% CI: 1.07 to 3.97).[66] However, this was not in line with the study by Sanya et al. in Uganda (OR 0.405, 95% CI: 0.156 to 1.053, p = 0.064).[23]

In comparing the two studies above, namely by Radon et al. and by Sanya et al., there were significant differences in proportions of passive cigarette smokers (62.90% vs. 39.50%, respectively) and in sample sizes (1890 vs. 86).[23,66] The study by Sanya et al. was conducted at one site only, and in one country (Uganda), whereas Radon et al. included 55 sites in 23 European countries in their study.[23,66] Therefore, its large proportion of passive cigarette smokers, sample size, and multiple study sites make Radon et al.'s study results more reliable and generalizable than that of Sanya et al.[64] Our findings point in the same direction as the study by Radon et al.: both studies highlight the exacerbating effects of passive cigarette smoking in asthmatic individuals as demonstrated previously.[10,49]

### 5.4.9. Acute respiratory infection

The Chi-square statistic revealed no significant association between acute respiratory infection and acute asthma attack (p = 0.873). This is in line with the results of the logistic regression (OR 0.86, 95% CI: 0.24 to 3.06; p = 0.818). Thus, acute respiratory infection was not an associated trigger for acute asthma attack in these patients. A similar conclusion was reported by Geyser et al. at Kalafong Hospital in Pretoria.[49] This was not consistent with the findings by Sanya et al. in Uganda, which found that acute respiratory infection was

significantly associated with severe acute asthma attack (OR 4.51, 95% CI: 1.25 to 16.21; p = 0.018).[23] The literature reports that acute respiratory infection is a potential trigger associated with asthma exacerbation.[10,23,42-44] However, our findings point in a different direction. A possible explanation could be that these respiratory infections were not objectively assessed in the study, and reliance was instead placed on patients' self-report assessments. Also, there were few patients in the study with respiratory tract infections, and it is possible that this small proportion meant that there was insufficient statistical power to detect the significant association between acute respiratory infection and asthma exacerbation.[64] Thus, our conclusion needs to be taken with caution.

### 5.4.10. Medication-related asthma trigger

The Chi-square statistic revealed no significant association between medication-related asthma triggers (NSAIDs) and acute asthma attack (p = 0.432). This is in line with the results of the logistic regression (OR 0.95, 95% CI: 0.27 to 3.41; p = 0.942). Thus, medication-related asthma triggers were not associated triggers for acute asthma attack in these patients. This was similar to the conclusion reported by Geyser et al. in Pretoria (OR 1.2, 95% CI: 0.64 to 2.76; p = 0.45).[49] Sanya et al. in Uganda also came to the same conclusion.[23] These findings were not consistent with other studies.[5,10,67,69] One example is the study by Steppuhn et al. in Germany.[69] This was an interesting study which evaluated the effects of Acetylsalicylic acid on asthma-related ED admissions and hospitalization.[69] It included a total of 1136 adults from a large mixture of ethnic groups of adult patients over a one-year period. Steppuhn et al. found a strong association between Acetylsalicylic acid and asthma exacerbation (OR 45, 95%CI: 2.50 to 8.20), which persisted in the multivariate logistic model adjusting for gender, age group, level of body mass index, smoking status, education attainment, and duration of asthma.[69]

Though the overall difference between medication-related asthma trigger and asthma exacerbation was not statistically significant in our study, a possible explanation could be the small proportion of medication-related asthma triggers (2.09%) in our study. It is possible that this proportion not being representative impacted on the outcome measured by not allowing sufficient statistical power to detect the difference between variables measured.[1,64] Thus, these observations indicate that our conclusion needs to be taken with caution.

### 5.4.11. Adherence to asthma treatment

The Chi-square statistic revealed significant association between adherence to asthma treatment and acute asthma attack ($p < 0.001$). This is in line with the results of the logistic regression (OR 11.09, 95% CI: 4.31 to 27.09; $p < 0.001$). The results imply that adhering to asthma treatment was a significant factor associated with asthma exacerbation in these patients (Table 4.13). These unexpected results could be due to the fact that probably most patients were unwilling to admit that they were not taking their medications correctly as prescribed. In addition, these results could have been biased by self-reporting of adherence and it is possible that the results could have been different if a more objective technique of determining adherence to treatment was used.[64] The study by Sanya et al. found a non-significant association between non-adherence to asthma treatment and asthma exacerbation (OR 0.82, 95% CI: 0.35 to 19.4; $p = 0.662$).[23]

However, this was in contrast with the study by Engelkes et al., which found that good adherence to treatment tends to be associated with a lower risk of severe asthma exacerbations.[50] The study by Sanya et al. had a small sample size (86) and an unmatched case control design, and was conducted in one site only, between November 2011 and February 2012. The study by Engelkes et al. is a recent study (2015), its design (systematic review) is of higher level of evidence,[64] and it has a large sample size from 23 publications of high levels of heterogeneity with regard to adherence to treatment, acute asthma attack measurements, designs, and analysis procedures.[50,64] The large sample size and multiple study sites make Engelkes et al.'s study results more reliable and generalizable compared to that of Sanya et al.[64] Therefore, these observations show that our findings have to be taken with caution.

### 5.4.12. Knowledge of asthma allergens

The Chi-square statistic revealed no significant association between lack of knowledge on asthma allergens and acute asthma attack ($p = 0.462$). This is in line with the results of the logistic regression (OR 0.79, 95% CI: 0.60 to 1.03; $p = 0.086$). Thus, lack of knowledge on asthma allergens was not a significant factor associated with acute asthma attack in these patients. This conclusion has been reported in many other studies, namely by Janssens et al. in Belgium; Sanya et al. in Uganda; and Geyser et al. in South Africa.[23,49,68] In our study the participants had better knowledge about asthma allergens. However, knowledge needs to be put into practice in order to benefit from it. Thus, a possible explanation is that these patients

are not practising their knowledge on asthma triggers. However, other studies have found contradictory results in the sense that there was a significant association between knowledge of asthma allergen and acute asthma attack (all $p < 0.05$).[14,31,47]

### 5.4.13. Stress or anxiety

The Chi-square statistic revealed no significant association between suffering from stress or anxiety and acute asthma attack ($p = 0.590$). This is in line with the results of the logistic regression (OR 1.42, 95% CI: 0.54 to 3.76; $p = 0.476$). Thus, stress or anxiety was not a significant factor associated with acute asthma attack in these patients. This was similar to the study by Sanya et al. in Uganda, which found that anxiety (OR 0.677, 95% CI: 0.197 to 2.326; $p = 0.535$) and stress (OR 0.580, 95% CI: 0.231 to 1.460; $p = 0.247$) were not significant factors associated with acute asthma attack.[23] Geyser et al. in Pretoria also arrived at the same conclusion (anxiety: OR 0.95, 95% CI: 0.42 to 2.11; $p = 0.89$) and stress (OR 1.05, 95% CI: 0.51 to 2.13; $p = 0.90$).[49] This was in contrast with the findings by Kolbe et al. in New Zealand.[70] The significant difference in findings between these studies may be explained by the higher prevalence of stress or anxiety in developed countries compared to developing countries.[10,71] Other explanations could be that stress or anxiety was not objectively assessed in the study, and reliance was instead placed on patients' self-report assessments. The study found a relatively small proportion of patients with stress or anxiety. It is possible that this small number of asthma patients with stress or anxiety in the study could not give sufficient statistical power to detect the difference between stress or anxiety and asthma exacerbation in these patients.[1,64] Thus, these observations indicate that our conclusion needs to be taken with caution.

# CHAPTER 6

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1. Conclusions

The study has gained valuable information. Firstly, the study documents a relatively low proportion of acute asthma attack at the BGH ED. Secondly, the study shows that the majority of patients presented at the BGH ED with moderate acute asthma attack. However, the relatively significant proportion of patients with severe acute asthma attack reported in this study remains of concern. Thirdly, the study shows that the majority of patients with acute asthma attack who presented at the BGH ED were black, young adult males, completed secondary school, were employed, and had an occupation, live in a modern (urban) type of house, and were adherent to asthma treatment. Fourthly, this study demonstrated that lower level of education is a significant factor associated with acute asthma attack presentation. Lastly, the study shows that active and/or passive cigarette smoking is a potential associated trigger for acute asthma attack. This is a modifiable or avoidable trigger and warrants prompt interventions.

## 6.2. Source of bias

Firstly, the study was done during a short period of four months. Secondly, the questions that assessed patients' knowledge of asthma allergens did not contain any non-asthma allergens. These two factors might be regarded as potential sources of bias.

## 6.3. Potential strengths of the study

The study does have strengths. Firstly, it was a prospective study and therefore there was the opportunity to collect all the information that was required for the study analysis. Secondly, the study was powered, with the help of a statistician, prior to being conducted, to ensure that a sufficient number of patients was recruited in order to allow accurate statistical analysis. Finally, this study has relevance to Family Medicine and its practice in South Africa, as asthma has a significant morbidity and mortality, especially in South Africa, a developing country with a developing PHC system facing resource constraints.

## 6.4. Limitations of the study

The study does have some limitations. Firstly, the study was conducted at one site, in one area of the country and in a public, district hospital setting only. As a result the findings may not be generalizable to other geographical areas of South Africa and other settings and levels of care, including private hospitals and secondary- and tertiary-care hospitals. Secondly, variables like anxiety, stress, adherence to asthma treatment and acute respiratory infection were not objectively assessed in the study, and reliance was instead placed on patients' self-report assessments. Thirdly, the definition of passive cigarette smoking in the context of this study was limited to cigarettes smoked by the patient's household.

Lastly, patients unable to perform PEF assessment were excluded from the study. It is possible that there were cases of imminent respiratory arrest asthma exacerbations among the excluded patients. This category of asthma exacerbation was not part of the study. However, there were only 3.20% of patients excluded from the study because of not being able to perform a PEF assessment. Therefore, their inclusion in the study would not significantly affect the overall conclusions.

## 6.5. Recommendations

The results of the study will be discussed by the researcher with the BGH staff, including those in the ED. With regard to the main findings from the study the following priority improvements are recommended:

1. Although the proportion of acute asthma attacks at the BGH ED documented in the study was relatively low, HCPs still need to be committed to decreasing significantly the proportion of this condition at the BGH when taking into account the overall higher morbidity and mortality related to asthma. Also, the lowering of acute asthma presentation rates will ultimately curb the expenditure associated with asthma care.

2. Although in the study factors like age, gender, race, employment and occupation status, type of housing, knowledge of asthma allergens, URTI, not adhering to asthma treatment, medication-related asthma, and stress and anxiety were not identified as potential factors and/or triggers associated with acute asthma attack presentation, effort should be made nationally at all levels of care to educate patients on avoidance of these factors and/or

triggers, when applicable, as other many studies have demonstrated their strong associations with asthma exacerbation.

3. Vigorous asthma education programmes in relation to passive and/or active cigarette smoking should be promulgated by the BGH staff. This will ultimately optimize patient care and improve health outcomes.

4. It would seem, based on the current investigation, that further studies exploring the proportion, severity, socio-demographic profile and triggers associated with acute asthma attack presentation would be useful, particularly in our setting in South Africa.

# 7. APPENDICES

## Appendix A: Assessment of severity in acute asthma as per WGSATS[9]

| Observation | Mild | Moderate | Severe | IRA |
|---|---|---|---|---|
| PEF AIB | >80% of best predicted | 60 - 80% of best predicted | < 60% of best predicted | < 100 l/min |
| Breathless posture | Walk or can lie down | When talking prefer to sit | At rest hunched forward | Exhaustion |
| Talk in | Sentences | Phrases | Words | |
| Alertness | May be agitated | Agitated | Agitated | Drowsy or confused |
| Respiratory rate | Increased | Increased | Often > 30 breaths/ min | |
| Accessory muscles | Usually not | Usually | Usually | Thoraco-abdominal movements |
| Wheeze | Moderate | Loud | Usually loud | Absent: silent chest |
| Pulse | < 100 beats/ min | 100 – 120 beats/ min | ➢ 120 beats/ min | Bradycardia |
| Pa 02 on air | Normal | ➢ 8 KPa or > 60 mmHg | < 8 KPa or < 60 mm Hg or may be cyanosed | Cyanosis |
| Sa O2 on air | ➢ 95% | 91 – 95% | < 90% | |
| Pa Co2 | < 45 mm Hg | < 45 mmHg | ➢ 45 mmHg | |

IRA: Imminent respiratory arrest, Pa Co2: arterial blood carbon dioxide pressure, Pa O2: Arterial blood oxygen pressure, PEF AIB: Peak expiratory flow after initial bronchodilator, Sa O2: Arterial blood oxygen saturation. The presence of several parameters, but not necessarily all, indicates the general classification of the exacerbation

## Appendix B: Study questionnaire

Part I: Socio-demographic characteristics

1. How old are you, in years?
2. Gender:
    1. Male
    2. Female
3. Race:
    1. White
    2. Black
    3. Indian
    4. Coloured
4. What is your employment status?
        1. Employed
        2. Non-employed
5. What is your occupation?
    1. No occupation
    2. Occupation (specify):
6. What is your level of education?
    1. No school
    2. Primary school
    3. Secondary school
    4. Tertiary school (or post-matric schooling):
7. What type of house are you living in?
    3. Reconstruction and development programme (RDP)
    4. Informal settlement
    5. Squatter camp
    6. Hostel
    7. Flat

8. Townhouse
9. Other type of house (specify):

8. Which of the following areas is your place of residence?

1. Urban
2. Semi-urban
3. Rural

Part II: Acute asthma severity assessment

9. Assessment of acute asthma severity:

3. Mild
4. Moderate
5. Severe

**NB: Please use the WGSATS guidelines attached to assess the severity of asthma exacerbation.**

Part III: Asthma triggers

*Section 1: Acute infection*

10. Do you suffer from or have very recently had any of the following illnesses?

**Upper respiratory infections:**

1. Flu
2. Sinus infection
3. Ear infection
4. Tonsillitis
5. Laryngitis
6. Pharyngitis
7. Other (specify):

**Lower respiratory infections**:

1. Community-acquired pneumonia
2. Bronchitis
3. Bronchopneumonia
4. Other (specify):

*Section 2: Use of medication*

11. Patient is on or has recently used one of the following medications (this will be obtained from the patient's medical records):

    1. Aspirin
    2. Voltaren or Diclofenac
    3. Brufen
    4. Atenolol
    5. Propanolol
    6. Other medication containing aspirin, ibuprofen, or other NSAIDs (specify):

*Section 3: Adherence to asthma treatment*

12. Do you use your asthma medication every time as prescribed?

    1. Yes
    2. No
    3. Not sure

*Section 4: Asthma allergens*

13. Which of the following are asthma triggers? (Yes, No, or Not sure)

| Allergen type | Yes | No | Not sure |
|---|---|---|---|
| Cigarette smoke | | | |
| Cold weather | | | |
| Feathers | | | |
| Dust at home or street | | | |
| Chemicals like paint, detergents, soap | | | |
| Spray from deodorant, perfume and air fresher | | | |
| Seeds from weed or grass | | | |
| Pollen | | | |
| Cockroaches | | | |
| Fruits like peanut and mango | | | |
| Smoke from coal, fire, wood and paraffin stoves | | | |
| Red wine | | | |
| Cat | | | |
| Yellow/orange flavoured/coloured food | | | |

*Section 5: Other trigger factors*

17. a. Do you smoke?

1. Yes
2. No

17. b. If yes, how many cigarettes per day?

1. < 5
2. 5-10
3. > 10

18. Does anyone smoke cigarettes at home?

    4. Yes
    5. No

19. Are you sick from or have you recently had from the following illnesses:

    1. Stress
    2. Anxiety

PIN:……

## Appendix C: BGH ED staff information sheet

Dear colleagues

Good day! I am Dr Dalton Kabundji. I am currently a student in the **MMed Family Medicine** in the Department of Family Medicine, Faculty of Heath Sciences, University of the Witwatersrand. I am doing a project for my research report, **and am inviting you to volunteer for this research study.**

Asthma is a major public health problem worldwide, generates significant healthcare costs and has high morbidity and mortality rates. Many preventable trigger factors have been reported to cause patients to have poor asthma control status, thus leading to frequent ED visits and subsequent hospital admissions, and acute asthma attack is preventable with optimal control of them. Therefore understanding the trigger factors leading to asthma-related ED visits is important in controlling chronic asthma. This will also allow the development of specific intervention strategies to reduce the incidence of serious adverse events, therefore improving health outcomes.

The aim of the study is to determine the severity and associated triggers of acute asthma attack in patients presenting at the BGH ED. I will request you to assess the patient's acute asthma severity as per WGSATS recommendation. After the patient is managed and stabilized by you, I will attend to him/her and request voluntary participation in the study. I will take approximately fifteen minutes with the patient. If he/she agrees I will proceed as follows:

- I will confirm that the patient fulfils the study's inclusion criteria by asking him/her questions about his/her conditions and details about his/her symptoms.
- Following this I will collect all the relevant information required for the study.
- In order to protect patients' confidentiality, when recording details patients will be given a unique PIN. The PIN will be known only to the researcher and the supervisors of the study.
- Finally, I will analyse the data to determine the severity and associated triggers of acute asthma attack in these patients.

I would also like to state that none of your personal information will be recorded for this study.

The study will benefit participants for the future. This study will identify triggers of acute asthma attack in patients and deficiencies in the healthcare system. Therefore the hospital management will develop specific intervention strategies of addressing them, thus reducing the incidence of serious adverse events and improving health outcomes. There is no financial gain in participating in the study.

Thank you so much.

Dr Dalton M Kabundji

## Appendix D: Patient information sheet and consent form

Dear Sir/Madam

Good day! I am Dr Dalton Kabundji. I am currently a student in the Department of Family Medicine, Faculty of Heath Sciences, University of the Witwatersrand. I am doing a project for my research report, and am inviting you to volunteer for this research study.

Asthma is a major public health problem worldwide, generates significant healthcare costs and has high morbidity and mortality rates. Many preventable trigger factors have been reported to cause patients to have poor asthma control status, thus leading to frequent ED visits and subsequent hospital admissions, and acute asthma attack is preventable with optimal control of them. Therefore understanding the trigger factors leading to asthma-related ED visits is important in controlling chronic asthma. This will also allow the development of specific intervention strategies to reduce the incidence of serious adverse events, therefore improving health outcomes.

The aim of the study is to determine the severity of your disease and associated triggers that caused you to have asthma attack today. Please understand that your decision to participate in this research study is entirely voluntary and you are free to decline to join or withdraw your consent at any time, without consequence. I will take approximately fifteen minutes with you, and the study will be completed in twelve months. If you agree I will proceed as follows:

- I will confirm that you fulfil the study's inclusion criteria by asking you questions about your condition and details about your symptoms.
- In order to protect patients' confidentiality, when recording details, you will be given a PIN. The PIN will be known only to the researcher and the supervisors of the study.
- Following this I will collect all other relevant information for the study such as your age and gender, race, level of education, occupation and smoking status, type of house in which you live, your knowledge about asthma triggers, the use of some painkillers and antihypertensive medication by you, and if you adhere to your prescribed asthma treatment.
- Finally, I will analyse all relevant data to determine the reasons causing you to have asthma attack.

- I will need you to sign consent at the outset, and will retain a signed copy. Any personal information of yours that I collect during the course of this study will be kept strictly confidential.

The study will benefit you in the future. This study will identify triggers of acute asthma attack in patients and deficiencies in the healthcare system. Therefore the hospital management will develop specific intervention strategies to address them, thus reducing the incidence of serious adverse events and improving health outcomes. There is no financial gain in participating in the study.

If you want any information regarding your rights as a research participant, or complaints regarding this research study, you may contact the Chairperson of the University of the Witwatersrand, Human Research Ethics Committee (HREC), which is an independent committee, established to help protect the rights of research participants, at (011) 717-2230/1.

Also, in case of future concerns/questions regarding the study, you might contact me directly at my cell phone number: 0734494682 or email: jdmulombe@yahoo.fr

I, (participant), fully understand the research study aim, that my participation is entirely voluntary and that I may withdraw from the study at any time, without any consequences.

Thank you so much.

Patient's signature:

I, (researcher), confirm that I have explained the research process to the participant, and that I will adhere to the generally accepted ethical norms of research.

Researcher's signature: Witness's signature:

Date: / /2015.

PIN: _____

# Appendix E: Wits Human Research Ethics Committee (Medical) clearance certificate

R14/49 Dr Dalton Mulombe Kabundji

**HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)**

**CLEARANCE CERTIFICATE NO. M141115**

| | |
|---|---|
| **NAME: (Principal Investigator)** | Dr Dalton Mulombe Kabundji |
| **DEPARTMENT:** | Family Medicine<br>Bertha Gxowa Hospital, Germiston, Ekurhuleni |
| **PROJECT TITLE:** | Severity and Associated Triggers for Acute Asthma Attack in Patients Presenting to the Emergency Department of Bertha Gxowa Hospital |
| **DATE CONSIDERED:** | 28/11/2014 |
| **DECISION:** | Approved unconditionally |
| **CONDITIONS:** | |
| **SUPERVISOR:** | Dr MA Eyassu |
| **APPROVED BY:** | Professor P Cleaton-Jones, Chairperson, HREC (Medical) |
| **DATE OF APPROVAL:** | 09/01/2015 |

**This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.**

**DECLARATION OF INVESTIGATORS**

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature _____ Date _____

**PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES**

## Appendix F: Ekurhuleni Health District Research Committee clearance certificate

Ekurhuleni
METROPOLITAN MUNICIPALITY

# EKURHULENI RESEARCH CLEARANCE CERTIFICATE

**Research Project Title**: Severity And Associated Triggers For Acute Asthma Attack In Patients Presenting To The Emergency Department Of The Bertha Gxowa Hospital

**Research Project Number**: 20/01/2015-1

**Name of Researcher(s):** Dr D Kabunji

**Division/Institution/Company:** MMed Family Medicine, University of Witwatersrand

DECISION TAKEN BY THE EKURHULENI HEALTH DISTRICT RESEARCH COMMITTEE (EHDRC)

- *THIS DOCUMENT CERTIFIES THAT THE ABOVE RESEARCH PROJECT HAS BEEN APPROVED BY THE EHDRC. THE RESEARCHER(S) MAY THEREFORE COMMENCE WITH THE PILOT PHASE OF THE INTENDED RESEARCH PROJECT. THE RESEARCH PROJECT WILL ONLY BE FULLY APPROVED AFTER PRESENTING TO THE DSDTT MEETING IN FEBRUARY 2015*
- *NOTE THAT THE RESEARCHER WILL BE EXPECTED TO PRESENT THE RESEARCH FINDINGS OF THE PROPOSED RESEARCH PROJECT AT THE ANNUAL EKURHULENI RESEARCH CONFERENCE.*
- *THE RESEARCH COMMITTEE WISHES THE RESEARCHER(S) THE BEST OF SUCCESS.*

Dr J. Sepuya

**DEPUTY CHAIRPERSON: EKURHULENI METROPOLITAN MUNICIPALITY**
Dated: 20/01/2015

Dr. R. Kellerman

**CHAIRPERSON: GAUTENG DEPARTMENT OF HEALTH (EKURHULENI REGION)**
Dated: 20/01/2015

## Appendix G: Patient identification sheet

1. Surname and initials:
2. File number:
3. PIN:

Dalton Kabundji

Date: / /2015 Signature:

## Appendix H: Wits Faculty of Health Sciences' Higher Degree Committee approval of the research project title

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Ms Thokozile Nhlapo
E-mail: thokozile.nhlapo@wits.ac.za

09 January 2015
Person No: 348675
PAG

Dr DM Kabundji
Private Bag X47
Aukland Park
Johannesburg
2006
South Africa

Dear Dr Kabundji

**Master of Medicine: Approval of Title**

We have pleasure in advising that your proposal entitled *Severity and associated triggers for acute ashma attack in patients presenting to the Emergency Department of the Bertha Gxowa Hospital* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

## Appendix I: Research report English editing certificate

PROFESSOR CRAIG MACKENZIE – EDITOR
Professor of English, University of Johannesburg
*BA (Hons), MA (Natal), PhD (Rhodes)*

26 June 2016

To Whom It May Concern:

This is to confirm that I edited "Severity and Associated Triggers for Acute Asthma Attack in Patients Presenting to the Emergency Department of the Bertha Gxowa Hospital", by Dalton Mulombe Kabundji.

All errors identified were corrected electronically and marked with the 'track changes' function.

The document was edited in accordance with the latest conventions of style and expression.

Sincerely



Prof. C. H. MacKenzie

Email: craigm@uj.ac.za; tel: w/ 27-11-559-2553; cell: 083-969-3029; fax: 27-11-559-3615

# 7. REFERENCES


1. Farlex. The free dictionary. From http://www.thefreedictionary.com/ (Last accessed: 20 June 2016).

2. Lalloo UG, Ainslie GM, Wong M, Abdool-Gaffar S, Irusen E, Mash R, et al. Guidelines for the management of chronic asthma in adolescents and adults. SA Fam Pract 2007; 49(5): 19-31.

3. Rowe BH, Sevcik W, Villa-Roel C. Management of severe acute asthma in the emergency department. Curr Opin Crit Care 2011; 17(4): 334-41.

4. WHO. Bronchial asthma. Fact Sheet n 206.

   From www.who.int/mediacentre/factsheets/fs2006/ (Last accessed: 14 October 2015).

5. Tintinalli JT, Kelen GD, Stapczynski JS. Emergency medicine: a comprehensive study guide. 6th ed. New-York: McGraw-Hill and American College of Emergency Physicians; 2004. p. 467-75.

6. Ehrlich RI, Jithoo A. Chronic respiratory infections in South Africa. In Steyn K (ed). *Chronic diseases of lifestyle in South Africa since 1995-2005*. Cape Town: Medical Research Council of South Africa; 2006. p. 368-71.

7. Zak HJ, Lalloo UG. Acute asthma treatment guidelines: reducing mortality and morbidity in South Africa. SAMJ 2013; 103(3): 159-60.

8. Adeloye D, Chan KY, Rudan I, Campbell H. An estimate of asthma prevalence in Africa: a systematic analysis. Croat Med J 2013; 54: 519-31.

9. Lalloo UG, Ainslie GM, Abdool-Gaffar MS, Awotedu AA, Feldman C, Greenblatt M, et al. Guideline for the management of acute asthma in adults: 2013 update. SAMJ 2013; 103(3): 189-98.

10. Longo DL, Fauci AS, Kasper DL, Jameson JL, Hauser SL, Loscalzo J. Harrison's principles of internal medicine. 18th ed. New-York: McGraw-Hill; 2012. p. 2102 – 15.

11. Al-Jahdali H, Anwar A, Al-Harbi A, Baharoon S, Halwani R, Al-shimemeni A. Factors associated with patient visits to the emergency department for asthma therapy. BMC Pulm Med 2012; 12:80-7.

12. Gibson PG, Powell H. Written action plans for asthma: an evidence-based review of the key components. Thorax 2004; 59: 94-99.

13. Goksel O, Celik GE, Erkekol FO, Gullu E, Mungam D, Misirligil Z. Triggers in adult asthma: are patients aware of triggers and doing right? Allergl Immunopath (Madr) 2009; 37(3): 122-8.

14. Westerman DE, Bateman ED, Alexander MG, Benatar SR. The magnitude of the asthma problem in Cape Town. SAMJ 1978; 53: 574-77.

15. Van der Merwe L, De Klerk A, Kidd M, Bardin PG, Van Schalkwyk EM. Case-control study of severe life-threatening asthma (SLTA) in a developing community. Thorax 2006; 61: 756-60.

16. American Academy of Allergy Asthma and Immunology (AAAAI). From: http:// www.aaaai.org/about-the-aaaai/newsroom/asthma-statistic.asp (Last access: 27 September 2015).

17. Rodrigo GJ, Rodrigo C, Hall JB. Acute asthma in adults. CHEST 2004; 125 (3): 1081-102.

18. Kirenga JB, Okot-Nwang M. The proportion of asthma and patterns of asthma medications prescriptions among adult patients in the chest, accident and emergency units of a tertiary health care facility in Uganda. *Afri Health Sci* 2012; 12 (1): 48-53.

19. Watase H, Hagiwara Y, Chiba T, Camargo C, Hasegawa K. Multicentre observational study of adults with asthma exacerbations: who are the frequent users of the emergency department in Japan? BMJ 2015; 5: 1-7.

20. BTS/SIGN Asthma Guideline 2014 British Thoracic Society. From: https://www.brit-thoracic.org.uk/document-library/clinical-information/asthma/btssign-asthma-guideline-2014/ (Last accessed: 10 June 2015).

21. Dankner R, Olmer L, Ziv A, Bentancur AG. A simplified severity score for acute asthma exacerbation. J Asthma 2013; 50(8): 871-76.

22. Refaat S, Aref H. Acute asthma in emergency department, prevalence of respiratory and non-respiratory symptoms. The ESCT 2014; 63: 777-6.

23. Sanya RE, Kirenga JB, Worodria W, Okot-Nwang M. Risk factors for asthma exacerbation in patients presenting to an emergency unit of a national referral hospital in Kampala, Uganda. *Afri Health Sci* 2014; 14(3): 1-9.

24. Weiss KB, Gergen PT, Hodgson TA. An economic evaluation of asthma in the United States. N Engl J Med 1992; 326(13): 862-6.

25. Eisner MD, Katz PP, Yelin EH, Shiboski S, Blanc PD. Risk factors for hospitalization among adults with asthma: the influence of socio-demographic factors and asthma severity. Respir Res 2001; 2 (1): 53-60.

26. Bavbek S, Celik G, Demirel YS, Misirligil Z. Risk factors associated with hospitalizations for asthma attacks in Turkey. Allergy Asthma Proc 2003; 24 (6): 437-42.

27. Fernandes AGO, Souza-Machado C, Coelho RCP, Franco PA, Esquivel RM, Souza-Machado A, et al. Risk factors for death in patients with severe asthma. J Bras Pneumol 2014; 40(4): 364-72.

28. Kynyk JA, Mastronarde JG, McLallister JW. Asthma, the sex difference. Curr Opin Pulm Med 2011; 17(1): 6-11.

29. Ikeue T, Nakagawa A, Furuta K, Morita K, Tajiri T, Maniwa K, et al. The prevalence of cigarette smoking among asthmatic adults and association of smoking with emergency department visits. Nihon Kokyuki Gasshi 2010; 48(2): 99-103.

30. Boudreau ED, Emond SD, Clark S, Camargo CA. Acute asthma among adults presenting to the emergency department: the role of race/ethnicity and socioeconomic status. CHEST 2003; 124(3): 803-812.

31. Green R, Davis G, Price D. Perceptions, impact and management of asthma in South Africa: a patient questionnaire study. *Prim Care Resp J* 2008; 17(4): 212-16.

32. Schwenkglenks M, Anderhub H, Szucs TD. Costs of asthma in a cohort of Swiss adults: associations with exacerbation status and severity. *Value Health* 2003; 6(1); 75-83.

33. Brandao HV, Cruz CS, Pinheiro MC, Costa EA, Guimaraes A, Souza-Machado A, et al. Risk factors for emergency room visits due to asthma exacerbations in patients enrolled in a program for the control of asthma and allergic rhinitis in Feira de Santana, Brazil. J Bras Pneumol 2009; 35(12): 1168-73.

34. Tang S, Drake P. Hospital admission and mortality differentials of asthma between urban and rural populations in New South Wales. Aust J Rural Health 1999; 7:18-22.

35. Higgins BG, Britton JR. Geographical and social class effects on asthma mortality in England and Wales. Respir Med 1995; 89: 341-6.

36. Stapleton M, Howard-Thompson A, George C, Hoover R, Self TH. Smoking and asthma. J Am Board Fam Med 2011; 24: 313-22.

37. Diaz-Sanchez D, Rumold R, Gong H. Challenge with environmental tobacco smoke exacerbates allergic airway disease in human beings. J Allergy Clin Immunol 2006; 118: 441-6.

38. Patel SN, Tsai CL, Boudreaux ED, Kilgannon JH, Sullivan AF, Blumenthal SD, et al. Multicenter study of cigarette smoking patients presenting to the emergency department with acute asthma. *Ann Allergy Asthma Immunol* 2009; 103(2): 121-7.

39. Morkjaroenpong V, Rand CS, Buts AM, Huss K, Eggleston P, Malveaux FJ, et al. Environmental tobacco smoke exposure and nocturnal symptoms among inner-city children with asthma. J *Allergy Clin Immunol* 2002; 110: 147-53.

40. Thomson NC, Chaudhuri R, Livingston E. Asthma and cigarette smoking. *Eur Respir J* 2004; 24: 822-33.

41. Jindal SK, Gupta D. Role of active smoking in asthma in adults. Indian J Med Res 2004; 443-53.

42. Wark PA, Tooze M, Powell H, Parsons K. Viral and bacterial infection in acute asthma and chronic obstructive pulmonary disease increases the risk of readmission. *Respirology* 2013; 18(6): 996-1002.

43. Osur SL. Viral respiratory infections in association with asthma and sinusitis: a review. *Ann Allergy Asthma Immunol* 2002; 89 (6): 553-60.

44. Johnston SL. Viruses and asthma. Allergy 1998; 53(10): 922-32.

45. Nicholson KG, Kent J, Ireland DC. Respiratory viruses and exacerbations of asthma in adults. BMJ 1993; 307: 982-86.

46. Gillissen A. Patient's adherence in asthma. *J Physiol Pharmacol* 2007; 58 Suppl 5 (1): 205-22.

47. Taylor DMcD, Auble TE, Calhour WJ, Mosesso VN. Current outpatient management of asthma shows poor compliance with international consensus guidelines. CHEST 1999; 116 (6): 1638-45.

48. Braido F. Failure in asthma control: reasons and consequences. *Scientifica* 2013; 2013: 1-15.

49. Geyser MM, Rheeder P. Risk factors precipitating exacerbations in adult asthma patients presenting at Kalafong Hospital, Pretoria. SA Fam Pract 2008; 50(4): 67-74.

50. Engelkes M, Janssens HM, De Jongste J, Sturkenboom MCJM, Verhamme KMC. Medication adherence and the risk of severe asthma exacerbations: a systematic review. *Eur Respir J* 2015; 45(2): 396-407.

51. Sundberg R, Toren K, Franklin KA, Gislason T, Omenaas E, Svanes C, et al. Asthma in men and women: treatment adherence, anxiety, and quality of sleep. Resp Med 2010; 337-44.

52. Manteuffel M, Williams S, Chen M, Verbrugge RR, Pittman DG, Steinkellner A. Influence of patient sex and gender on medication use, adherence, and prescribing alignment with guidelines. J Women Health 2014; 23(2): 112-19.

53. Dinwiddie R, Muller WG. Adolescent treatment compliance in asthma. *J R Soc Med* 2002; 95: 68-71.

54. Rosenstreich DL, Eggleston P, Kattan M, Baker D, Slavin RG, Gergen P, et al. The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. N Engl J Med 1997; 336: 1356-63.

55. Rosas I, McCartney HA, Payne RW, Calderon C, Lacey J, Chapela R, et al. Analysis of the relationships between environmental factors (acroallergens, airpollution, and

weather) and asthma emergency admissions to a hospital in Mexico City. Allergy 1998; 58: 394-401.

56. Lee PY, Khoo EM. How well were asthmatic patients educated about their asthma: a study of the emergency department. *Asia-Pacific J public Health* 2004; 16: 45-9.

57. Hasegawa K, Brenner BE, Clark S, Camargo CA. Emergency department visits for acute asthma by adults who run out of their inhaled medications. Allergy asthma Proc 2014; 35(3): e42-e50.

58. Schatz M, Clark S, Camargo CAJ. Sex differences in the presentation and course of asthma hospitalizations. CHEST 2006; 129 (1): 50-5.

59. Pearson MG, Ryland I, Harrison BDW. National audit of acute severe asthma in adults admitted to hospital. Qual Health Care 1995; 4: 24-30.

60. WHO 2016. Global health observatory data repository: life expectancy data by countries. From: http://apps.who.int/gho/data/node.main.688?lang=en (Last accessed: 18 June 2016).

61. Bellamy D, Collins JV. Acute asthma in adults. Thorax 1979; 34: 36-39.

62. El-Ekiaby A, Brianas L, Skowronski ME, Coreno AJ, Galan G, Frank J, et al. Impact of race on the severity of acute episode of asthma and adrenergic responsiveness. Am J Respir Crit Care Med 2006; 174: 508-13.

63. Omachi TA, Iribarren C, Sarkar U, Tolstykh I, Yelin EH, Katz PP, et al. Risk factors for death among adults with severe asthma. *Ann Allergy Asthma Immunol* 2008; 101 (2): 130-136.

64. Machin D, Campbell MJ, Walters SJ. Medical statistics. 4th ed. Sheffield: John Wiley & Sons; 2007. p. 108-274.

65. Nogueira KT, Silva JRL, Lopes CS. Quality of life of asthmatic adolescents: assessment of asthma severity, comorbidity, and life style. *J Pediatr (Rio J)* 2009; 85 (6): 523-530.

66. Radon K, Busching K, Heinrich J, Wichmann HE, Jorres RA, Magnussen H, et al. Passive smoking exposure: a risk factor for chronic bronchitis and asthma in adults. CHEST 2001; 122: 1086-90.

67. Chetty N. Asthma exacerbations: a review. *Current Allergy & Immunology* 2009; 22(2): 75-78.

68. Janssens T, Ritzt T. Perceived triggers of asthma: key to symptom perception and management. Clin Exp Allergy 2013; 43(9): 1000-8.

69. Stepphun H, Langen U, Scheidt-Nave C, Keil T. Major comorbid conditions in asthma and association with asthma-related hospitalization and emergency department admissions in adults: results from the German national health telephone interview survey GEDA 2010. *BMC pulm Med* 2013; 13:46-55.

70. Kolbe J, Fergusson W, Vamos M, Garrett J. Case-control study of severe life threatening asthma (SLTA) in adults: psychological factors. Thorax 2002; 57: 317-322.

71. Murtagh J. Murtagh's general practice. 5th ed. Australia: McGraw-Hill; 2010. p. 568-78.

72. South African Department of Health 2002. A district hospital service package for South Africa. From: www.kznhealth.gov.za/norms.pdf (Last accessed: 18 June 2016).

73. Raosoft Software. From: http://www.raosoft.com/samplesize.html (Last accessed: 25 June 2015).