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Occurrence of obesity and risk of obstructive sleep apnoea syndrome in adult patients presenting for elective surgery at an academic hospital

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Occurrence of obesity and risk of obstructive sleep apnoea syndrome in adult patients presenting for elective surgery at an academic 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 the branch of Anaesthesiology

Johannesburg, 2015

Declaration

I, Kamini Naidoo, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Anaesthesiology in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

..... (Signature of candidate)

..... day of ..... (month), 20.....

Dedication

To everyone who supported me and made this possible.

Presentations arising from this study

This study was presented as a powerpoint presentation at the South African Society of Anaesthesiologist congress held in March 2014.

Abstract

Background: Worldwide obesity has more than doubled since 1980 and is the fifth leading cause of death (1). Obesity is a risk factor for the occurrence of obstructive sleep apnoea syndrome (OSAS) (2). The incidence of OSAS in the USA is reported to be between 9 to 26% with the incidence in the surgical population reportedly being higher (3, 4). Obesity and OSAS have implications for the anaesthetic management of patients. It is important for the anaesthesiologist to know the occurrence of obesity and risk of OSAS in the patient population presenting for surgery (5, 6).

Aim: The aim of this study was to describe the occurrence of obesity and risk of OSAS in adult, elective surgery patients at an academic hospital.

Method: A descriptive, contextual, prospective study design was used. The height, weight, used to calculate the BMI, and neck circumference, used as part of the STOP-BANG questionnaire, were taken by the researcher. The STOP-BANG questionnaire was used to assess for risk of OSAS in all patients.

Results: The study included 250 patients of which 153 (61%) were female and 97 (39%) were male. There were 223 (89.2%) black patients, 15 (6.0%) coloured, 10 (4.0%) white and 2 (0.8%) Indian patients. Of these patients 81 (32.4%) had a BMI of ≥ 30 (95% CI 26.6-38.2%) and were classified as obese. There were 69 (45.1%) obese females and 12 (12.4%) obese males. A STOP-BANG score of < 3 was attained by 205 (82%) patients and ≥ 3, indicating a risk for OSAS, by 45 (18%) patients of which 22 (48.9%) had a BMI of < 30 and 23 (51.1%) a BMI ≥ 30. Chi-square tests revealed statistically significant relationships between obesity and gender with a lower BMI being associated with being male (χ^2 [1] = 29.03, p = 0.001), and age younger than 40 years (χ^2 [1], p = 0.001). Chi-square tests revealed statistically significant relationships between BMI and risk of OSAS, with lower risk being associated with a lower BMI (p = 0.003). A lower risk of OSAS was also associated with being female (p = 0.004) and a higher risk of OSAS was associated with being ≥ than 40 years of age (p = 0.001).

Conclusion: Obesity is a multi systemic disease which carries significant morbidity and mortality.It is not only important to identify the disease but also to grade its severity and assess the degree of dysfuction it has caused so that the patient can be optimally

assessed by the anaesthetist. Our study showed a occurrence of obesity of 32.4% which was comparable with the highest prevalences in the world. This should however be intepreted with caution as the study may not be generalisable to other communities.

OSAS too is associated with a higher morbidity and mortality. It goes undiagnosed or under-diagnosed in a large proportion of patients, and poses increased anaesthetic risk. It should be screened for and identified as well as it's severity graded in order to institute appropriate anasthetic management and make plans for post operative care in a specialised environment. The risk of OSAS was found to be 18% in our study. It was found to be higher in males, and age older ≥ 40. Although there was a high occurence of obesity in the females there was a lower risk of OSAS. The risk of OSAS was similar in obese and non obese patients.

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Table of Contents

Declaration I

Dedication II

Presentations arising from this study III

Abstract IV

Acknowledgements VI

Table of Contents VII

Chapter One: Overview of the study 1
- 1.1 Introduction 1
- 1.2 Background 1
- 1.3 Problem statement 2
- 1.4 Aim and objectives 3
  - 1.4.1 Aim 3
  - 1.4.2 Objectives 3
- 1.5 Research assumptions 3
- 1.6 Demarcation of study field 3
- 1.7 Ethical considerations 4
- 1.8 Research methodology 4
  - 1.8.1 Research design 4
  - 1.8.2 Study population 4
  - 1.8.3 Study sample 4
  - 1.8.4 Data collection 4
  - 1.8.5 Data analysis 5
- 1.9 Significance of the study 5
- 1.10 Validity and reliability 5
- 1.11 Study outline 5
- 1.12 Summary 5

Chapter Two: Literature review 6
- 2.1 Introduction 6
- 2.2 Obesity 6
  - 2.2.1 Definition of obesity 6
  - 2.2.2 Prevalence 7
- 2.3 Pathophysiology of obesity 9
- 2.4 Risk factors of obesity 11
- 2.5 Diagnosing obesity 16
- 2.6 Sequelae of obesity 20
- 2.7 Anaesthetic considerations in obesity 24
  - 2.7.1 Pre operative management 24
  - 2.7.2 Intra operative management 26
  - 2.7.3 Post operative management 31
- 2.8 Definition of OSAS 32
- 2.9 Prevalence of OSAS 32
- 2.10 Pathophysiology of OSAS 33

2.11 Risk factors of OSAS 34
2.12 Screening tests for OSAS and diagnosis of OSAS 34
2.13 Anaesthetic management of OSAS 40
2.14 Conclusion 44

Chapter Three: Research methodolgy 45
3.1 Introduction 45
3.2 Problem statement 45
3.3 Aim and objectives 45
3.3.1 Aim 45
3.3.2 Objectives 45
3.4 Ethical considerations 46
3.5 Research methodology 47
3.5.1 Research design 47
3.5.2 Study population 47
3.5.3 Study sample 47
3.5.4 Data collection 48
3.5.5 Data analysis 49
3.6 Validity and reliability of the study 50
3.7 Summary 50

Chapter Four: Results and discussion 51
4.1 Introduction 51
4.2 Attaining the study sample and approach to data analysis 51
4.3 Demographic Data 51
4.4 Description of BMI 52
4.5 Risk of OSAS 53
4.6 BMI and the risk of OSAS 53
4.7 BMI and gender 53
4.8 BMI and age 54
4.9 Risk of OSAS and gender 54
4.10 Risk of OSAS and age 55
4.11 Discussion 55
4.12 Conclusion 58

Chapter Five: Summary, limitations, recommendations and conclusions 59
5.1 Introduction 59
5.2 Summary of the study 59
5.2.1 The aim of the study 59
5.2.2 Objectives of the study 59
5.3 Methodology of the study 59
5.4 Main findings and summary of the study 60
5.5 Limitations of the study 60
5.6 Recommendations from the study 61
5.6.1 Recommendations for clinical practice 61
5.6.2 Recommendations for further research 61
5.7 Conclusion 62

List of abbreviations 63

References 64
Appendix 1: Data collection sheet 74
Appendix 2 : Participant Information leaflet 75
Appendix 3: Consent form 77
Appendix 4 : Ethics approval letter 78
Appendix 5: Post graduate approval letter 79
Appendix 6: Permission to conduct research 80

List of Tables

Table 2.1 Prevalence of obesity in countries outside Africa 7

Table 2.2 Prevalence of obesity in some African countries 8

Table 2.3 Classification of BMI 19

Table 2.4 American Society of Anesthesiologists (ASA) Scoring system for Peri-operative risk from OSA 37

Table 2.5 STOP-BANG Questionairre 38

Table 2.6 Severity of OSA 40

Table 4.1 Demographic data 52

Table 4.2 Relationship between BMI and risk for OSAS 53

Table 4.3 Relationship between BMI and gender 54

Table 4.4 Relationship between BMI and age group 54

Table 4.5 Relationship between risk of OSAS and gender 55

Table 4.6 Relationship between risk of OSAS and age 55

List of Figures

Figure 2.1 Berlin questionnaire 36

Figure 2.2 Epworth Sleepiness Scale 39

Figure 4.1 Gender distribution by BMI classification 52

Chapter One: Overview of the study

1.1 Introduction

In this chapter the background, problem statement, aims and objectives, research assumptions, demarcation of study field, ethical considerations, research methodology, significance, validity and reliability, and an outline of this study will be discussed.

1.2 Background

The World Health Organisation (WHO) emphasized that obesity is becoming a major health problem in developing countries. (7) The WHO rates obesity as the fifth leading risk for death worldwide and an estimated 2.8 million adults die each year as a result of being overweight or obese. Furthermore being overweight and obese account for 44% of the diabetes burden, 23% of the ischaemic heart disease burden and between 7 to 41% of cancers. About 65% of the world's population lives in countries where being overweight and obese kills more people than being underweight. Worldwide obesity has more than doubled since 1980. In 2008, more than 1.4 billion adults, 20 years and older, were overweight. Of these over 200 million men and nearly 300 million women were obese. (7) Obesity is associated with a constellation of complications including insulin resistance and type 2 diabetes (8, 9), dyslipidaemias (10, 11), cardiovascular disease, which includes hypertension, heart disease and stroke (12), gallbladder disease (13), osteoarthritis (14), kidney disease (15), cancer (16) and respiratory complications (17, 18).

Obstructive sleep apnoea syndrome (OSAS) is a well described association of obesity (2, 19). Its incidence is reported to be between 9 to 26%. The majority of these studies were done in the United States (3, 4, 20). Finkel et al (4) found 23.7% patients who screened high risk for OSAS in the surgical population of whom 82% were undiagnosed. This has serious consequences as untreated OSAS has been linked to increased mortality (3, 21). There are numerous scales available to assess risk for OSAS, for example Epworth Sleep Scale, Berlin score, American Society of Anesthesiologists scoring system and STOP BANG questionnaire. The STOP-BANG questionairre (22, 23) is a validated score that has been used in surgical patients to predict risk of OSAS.

Obesity and OSAS pose a challenge for the anaesthetist as various anaesthetic considerations come into play. Pharmacokinetics is altered in obesity (24-26), airway management is potentially difficult, as is positioning of patients. Lung ventilation strategies are different, regional blocks are technically more difficult and may carry a higher rate of complications (27). Peri-operative monitoring is therefore more important in these patients (27, 28). OSAS carries its own set of associated co-morbidities. These include cardiovascular disease and stroke and a higher rate of post operative complications, longer hospital stays and specialised intensive care management (29-31). These patients also suffer an increased morbidity and mortality, thus obesity and OSAS are important risk factors to illicit pre operatively so that appropriate peri-operative management is implemented (32, 33).

1.3 Problem statement

Obesity is associated with increased co-morbid conditions and increased morbidity and mortality among patients undergoing surgery. (34) OSAS is associated with further peri-operative morbidity and mortality (29), and is under diagnosed in a large number of patients.(3, 5, 20) Finkel et al (4) in 2009 described an 82% prevalence of undiagnosed OSAS among American adults presenting for surgery. Obesity and OSAS have implications for the anaesthetic management of patients (25, 28, 30, 35, 36). It is therefore important for the anaesthetist to know the occurrence of obesity and OSAS in the patient population presenting for surgery.

The occurence of obesity and the risk of OSAS among patients at Chris Hani Baragwanath Academic Hospital (CHBAH) who present for elective surgery is unknown.

1.4 Aim and objectives

1.4.1 Aim

The aim of this study was to describe the ocurrence of obesity and risk of OSAS in adult patients going for elective surgery at the J.D. Allen and the Gynaecology Theatre Complex, at CHBAH.

1.4.2 Objectives

The primary objectives of this study were to:

- describe the BMI of adult patients undergoing elective surgery
- describe the risk of OSAS using the STOP BANG questionnaire.

The secondary objectives of this study were to:

- compare the BMI with the risk of OSAS
- compare the BMI with gender
- compare the BMI with age
- compare the risk of OSAS with gender
- compare the risk of OSAS with age.

1.5 Research assumptions

The following definitions will be used in this research.

Adult: is defined as a person 18 years or older.

Obesity: is defined by a BMI greater than or equal to 30 kg/m^2.(37)

STOP-BANG questionnaire: is a validated questionnaire (Appendix 1) comprising of eight questions which assess the risk for OSAS in patients. (22, 23)

1.6 Demarcation of study field

This research was conducted at CHBAH, a central hospital located in Soweto, Johannesburg and affiliated to the University of Witwatersrand. The hospital has an

estimated 2 888 beds and 26 theatres in eight theatre complexes and on average 65 000 surgical procedures are completed per year. (38)

1.7 Ethical considerations

Permission was obtained from the relevant authorities to conduct this study.

Adult patients presenting for elective surgery were invited to take part in the study. The researcher explained the study to the patients and those agreeing to participate received an information letter (Appendix 2) and were asked to sign informed consent (Appendix 3). Anonimity and confidentiality were ensured. If a patient was concerned about their weight, they were referred to the dietetics department at CHBAH.

This study was carried out in accordance with The Declaration of Helsinki (39) and the South African Good Practice Guidelines (40).

1.8 Research methodology

1.8.1 Research design

A prospective contextual, descriptive study design was utilised.

1.8.2 Study population

The study population will be adult patients presenting to CHBAH for elective surgery in various disciplines.

1.8.3 Study sample

In consultation with a bio-statistician, using nQuery Advisor, a sample size of 250 patients was determined and a convenience sampling method was used. Inclusion and exclusion criteria were used to select suitable participants for the study.

1.8.4 Data collection

Data was collected over a 16 day period. The patient's heights, neck circumferences and weights were measured by the reseacher using the same equipment and identical methods in order to standardise the results.

1.8.5 Data analysis

All data recorded was captured on a Microsoft Excel spread sheet. The data was analysed in consultation with a bio-statistician.

1.9 Significance of the study

Obesity is often associated with a more complicated anaesthetic management plan and increased morbidity and mortality. (28) It is also associated with a constellation of co-morbidities (10). This study may create awareness around obesity allowing the anaesthetic management of these patients to be optimised. OSAS is largely undiagnosed, the consequences of which can be catastrophic, as these patients need individualised and specialised perioperative care (29, 31).

This study was the first to determine the occurence of obesity and risk of OSAS in the adult surgical population at CHBAH. The results of this study may increase anesthetists awareness of obesity and the risk of OSAS in this population.

1.10 Validity and reliability

Measures were taken to ensure the validity and reliability of this study.

1.11 Study outline

The outline of this study is as follows.

- Chapter 1: Overview of the study
- Chapter 2: Literature review
- Chapter 3: Research methodology
- Chapter 4: Results and discussion
- Chapter 5: Summary, limitations, recommendations and conclusion

1.12 Summary

In this chapter an overview of the background, problem statement, aims and objectives, research assumptions, demarcation of study field, ethical considerations, research methodology, significance, validity and reliability, and study outline were discussed.

Chapter Two: Literature review

2.1 Introduction

In this chapter the literature pertaining to the definition and prevalance of obesity, the pathophysiology, risk factors, diagnosis of obesity, risk factors related to obesity and the anaesthetic considerations of the problem shall be discussed. OSAS literature will also be discussed with regards to pathophysiology, risk factors, diagnosis of OSAS and anaesthetic management.

2.2 Obesity

2.2.1 Definition of obesity

Obesity is a chronic disease consisting of an increase in body fat stores. The word obesity comes from the Latin word ob-esum, meaning on account of having been eaten, and this, partly, is what leads to this disease. Obesity arises when the caloric intake exceeds the energy expenditure in an individual. The body mass index (BMI) is a value used to classify obesity. A BMI greater than or equal to 30 kg/m^2 is considered obese. (1, 27)

A complex set of interactions come into play between genetics, behaviour, environment, culture and socioeconomic status that lead to obesity. People may make decisions based on their enviroment, the decision to walk rather than use motor vehicles or public transport may be due, for example, to their environment being deemed unsafe. Genetics has also been found to have a direct link to obesity. Diseases and drugs further contribute to obesity. Endocrine disorders including Cushing's disease and hypothyroidism may lead to weight gain and obesity as may polycystic ovarian syndrome. The side effects of drugs like antidepressants and steroids can also cause weight gain. (1, 27, 41)

2.2.2 Prevalence

International prevalence

The WHO reports that one in ten of the world's population is obese. The prevalence of obesity has more than doubled since 1980. In 2008 more than 1.4 billion adults above the age of 20 were overweight. Of these 200 million men and 300 million women were obese. (1)

In the United States of America (USA) the Centers for Disease Control and Prevention (CDC) estimated that 35.7% of USA men and women were obese in 2009 to 2010. There was no significant difference between the prevalence among males (35.5%) and females (35.8%) (42). In 2013 the prevalence was quoted as being 34.9% (43).

The National Health Statistics (NHS) survey in The United Kindgom in 2012 found 26% of both men and women obese (44). Data from 2013 showed that in Canada 22% of males and 20% of females were obese, in Belgium 20% of males and 21.7% of females were obese and in Mexico 24.2% of males and 34.5% of females were obese. (45, 46) Table 2.1 below shows the prevalence of obesity in some other countries outside Africa.

Table 2.1 Prevalence of obesity in countries outside Africa

Country	Year of survey	Age	National prevalence of obesity (%)		
			Males	Females	Total
Australia (47)	2004-5	18-100	18%	17%	17.5%
Japan (48)	2004	15-100	2.9%	3.3%	3.1%
Brazil (49)	2002-3	20-100	8.90%	13.10%	11.10%
China (49)	2002	18-100	2.4%	3.40%	4.9%
India (37)	2005-6	15-49	1.30%	2.80%	2%

African prevalence

The prevalence across Africa varies considerably from as little as 2.1% in Madagascar and 2.3% in Gambia to as much as 30.3% in Egypt. Table 2.2 shows some African countries and their rates of obesity (7). Some of this information may seem outdated but these countries do not regularly update their data.

Table 2.2 Prevalence of obesity in some African countries (7)

Country	Year	Prevalence (%)
Egypt	2006	30.3%
Tunisia	1996-1997	17.2%
Morocco	2000	16%
Zimbabwe	2005	15.7%
Mauritius	2002	14.4%
Ghana	1998	3.1%
Gambia	1997	2.3%
Madagascar	1999	2.1%

South African prevalence

In 1998 The South African Demographic Health Survey was undertaken and published in 2002. This demonstrated 29% of men and 56% of women being classified as overweight or obese. This was unusual as the prevalence in most other countries showed a higher incidence of obesity in males (50, 51). In a sample of 7726 South African women aged 15 to 95 years old the highest prevalence of overweight and obesity was found in black women (58.5%), followed by women of mixed ancestry (52%), white women (49.2%) and Indian women (48.9%). In a sample of 5401 men aged 15 to 95 years the prevalence of overweight and obesity was highest in white men (54.5%), followed by Indian men (32.5%), then men of mixed ancestry (31%) and the lowest prevalence among African men (25%) (50).

In 2012 the World Federation of Obesity released statistics from the South African National Health and Nutrition Examination Survey, indicating that in South Africa 10.6% of males and 39.2% of females were found to be obese (46).

2.3 Pathophysiology of obesity

Obesity is a disorder of supply and demand. When the intake of calories exceeds its utilisation, obesity ensues. Obesity should be viewed as a systemic disease with multiple effects in the body. Its pathogenesis is complex and interlinked. It is caused by impaired regulation of lipid metabolism and lipid toxicity. Genetic and environmental factors are also thought to play a role. The regulation of appetite and satiety is impaired. Pathologies linked to obesity include dyslipidaemia, impaired glucose metabolism, secretion of adipokines, hypertension and atherosclerosis. The pathophysiology of obesity and reasons for these associations will be discussed in more detail. (34, 52, 53)

Dysregulation of lipid metabolism and lipid toxicity

In obesity there is excess caloric intake and a supply that exceeds the demand. Free fatty acids, which in normal individuals are stored in fat cells as triacylgylcerols, are now freely circulating in the blood. This is a result of increased lipolysis stimulated by the sympathetic state which occurs in obesity. Lipotoxicity occurs as the lipids and their metabolites cause oxidative stress, particularly to the mitochondria and endoplasmic reticulum. Lipogenesis is inhibited by excessive free fatty acids release resulting in inadequate clearance of serum triacylglycerol. This then contributes to hypertriglyceridemia. (52, 53)

Insulin resistance and hyperglycaemia

There are a few contributing mechanisms to insulin resistance. Release of free fatty acids from lipoproteins by lipoprotein lipase causes lipotoxicity and resulting insulin receptor dysfunction and insulin resistance. This creates hyperglycaemia. Hyperglycaemia is compensated for by increased hepatic gluconeogenesis. Increased hepatic production of glucose further causes hyperglycaemia aggravated by insulin resistance. Fat associated macrophages, secreted by adipocytes, that secrete monocyte chemoattractant protein-1, macrophage migration factor and restin all decrease sensitivity to insulin and thus insulin

resistance. Lipotoxicity also decreases secrection of beta cell insulin eventually resulting in cell exhaustion. (52, 53)

Adipokines

In order to further understand the pathophysiology, adipocytes must be thought of as endocrine organs. White adipose tissue secrete a variety of adipokines. Inflammatory adipokines together with free fatty acids cause diffuse inflammation. Inflammatory markers that are raised in obesity include tumour necrosis factor alpha (TNF α), interleukin 1, and interleukin 6. Acute phase proteins also upregulated include C-reactive protein and the specific amyloid antigen. These inflammatory markers that are increased in obesity contribute to inflammatory conditions such as those in the bronchial tree of patients with OSAS. Visceral adipokines are transported by the portal system to the liver. This then enhances non-alcoholic steatohepatitis. Adipose cells secrete anti-inflammatory secretagogues such as adiponectin and visfatin. These hormones are meant to counteract the pro-inflammatory adipokines, enhance insulin sensitivity, improve vascular endothelium dysfunction and are anti-inflammatory and anti-atherogenic. (53)

Hypertension

Adipokines cause increased vasomotor tone by secreting renin, angiotensinogen and angiotensin II. These substances are similar to those secreted by the renal renin angiotensin system and enhance hypertension when secreted by adipocytes. (34)

Atherosclerosis

In addition to insulin resistance the pro-inflammatory state causes, obesity also perpetuates the development of atherogenesis. White adipose tissue secretes endothelial modulators which include vaso active endothelial growth factor, plasminogen activator inhibitor-1, angiotensinogen, renin and angiotensin, which in addition to contributing to impaired vasomotor tone and hypertension also causes endothelial dysfunction. Later as atherosclerosis progresses with macrophage and smooth muscle infiltration there is the additional secretion of cytokines like monocyte chemoattractant protein-1, macrophage migration factor, and endothelin-1. These enhance the inflammation that occurs in the vascular walls containing the atherscleroticplaques which are inflammatory lesions.

Adipokine procoagulants causing thrombosis include plasminogen activator inhibitor-1. Interleukin-6, tumour growth factor β and TNF α. These cause thrombosis, especially from ruptured atherosclerotic plaques. Matrix metalloproteinases, also secreted from adipocytes, lead to the progression of athersclerotic changes in vesssels with the propagation of plaque formation and the collagen remodeling. This then causes a thinning of the atheroma cap and the release of tissue factor which futher propagates thrombosis. (34)

2.4 Risk factors of obesity

Numerous risk factors have been associated with obesity. These include genetics, intrauterine and early life influences, diet, physical activity, age, gender, socio-economic and cultural factors, education, parity, and stress. (54-57)

Genetics

Biologists believe that genes have a direct link to obesity, evidenced by disorders like Bardet–Biedl syndrome, a ciliopathic genetic disorder that produces many effects including obesity, retinis pigmentosa, polydactylly, hypogonadism and renal failure. Prader–Willi syndrome, a rare genetic disorder of chromosome 15 characterised by low muscle tone, short stature, incomplete sexual development, cognitive disabilities and a chronic hunger leads to over eating and obesity.

The human gene map has approximately 127 genes with at least a single phenotypical relationship to obesity. These genes include ACE, ADIPOQ, ADRB2, ADRB3, DRD2, GNB3, HTR2C, IL6, INS, LDLR, LEP, LPER, LIPE, MC4R, NR3C1, PPARG, RETN ,TNFA, UCP1, UCP2, UCP3 and VDR. Bouchard (54) suggests five major types of genotypes that are associated with obesity. They are as follows

- “a thrifty genotype which is associated with a low metabolic rate and insufficient thermogenesis.
- a hyperphagic genotype which is associated with poor regulation of appetite and satiety and a tendency to overfeed.
- a sedens genotype with a propensity to physical inactivity.
- a low lipid oxidation genotype and

- an adipogenesis genotype which is associated with the ability to expand adipocytes which have a high lipid storage capacity."

Therefore there is strong evidence for a genetic component to obesity. (57, 58)

Intrauterine and early life influences

There is evidence linking adverse intrauterine environment to chronic diseases later in life. Rogers (55) suggests an element of intrauterine programming, where the effects of diabetes, smoking or even famine conditions in utero can affect future BMI. There is an association between birthweight and BMI in later life. This study shows that the higher the birthweight the greater the chance of a higher BMI and thus obesity. The prenatal and neonatal period may be critical for the development of obesity. A higher birth weight may be associated with a more favourable intrauterine environment with a few exceptions for example foetal macrosomia found in diabetic women**.** Ong (59) conversely showed that a low birth weight is associated with an increased risk of obesity, insulin resistance, and cardiovascular disease in adults. (55, 59, 60) This may be explained by the fact that foetal metabolic and hormonal responses to intrauterine growth restraint followed by rapid postnatal growth responses are a predispostion to obesity. There are a few hypotheses proposed as to the link between low birthweight and adulthood disease. The thrift type phenotype hypothesis proposes that maternal-foetal undernutrition could result in long term programming change in metabolic or hormonal activity involving insulin and insulin like growth factors predisposing to diabetes. The foetal insulin hypothesis proposes that children born with low birthweights inherit mutations in the genes coding for glucokinase and insulin secretion and this may be responsible for maturity onset diabetes. The surviving small baby/thrifty genotype hypothesis proposed that low birthweight infants are at an increased risk of mortality and this could demonstrate an increased risk of diseases and are genetically predisposed to disease but due to better health care they survive to demonstrate this disease in adulthood. (54, 55, 59, 61)

Diet

With increased urbanisation a more Westernised diet has been adopted. One of the pertinent features of this is increased fat intake, these dietary changes contribute to obesity (56). The more urbanised communities become, the higher their rate of obesity. In urbanised settings food, high in fat, is cheaper and more easily available (62). The South African National Health and Nutritional Examination Survey (63) also provided information about the relationship between diet, nutritional status and health in the South African population. It showed that there was a worsening in nutritional status in males and females based on anthropometric measurements including BMI, waist circumference, and waist-hip ratio.

This survey identifed the concept of food security that is defined as, " a condition which exists when all people at all times have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs". The South African National Health and Nutrtional Examintion Survey also showed that only 45.6% of the population was food secure while 28.3% were at risk for hunger and a further 26% experienced hunger and were thus food insecure. The study further showed that the largest percentage of participants who experienced food insecurity were either from urban informal or rural formal settlements. This demonstrates the lower household income in these areas and thus less money available to be spent on food, leading to unhealthy but cheaper food sources, mainly starches such as maize, rice and bread, being the mainstay with little dietary diversity and lower amounts of fruit vegetables and protein as these are more expensive products. The amount of fat consumed by urban formal areas was significantly higher than that of rural informal areas. A higher sugar and salt intake also seen more in urban formal settlements increases the risk of obesity, although urban residents health and nutrition knowledge was deemed to be better. People living in rural or informal areas ate less fruit and vegetables than their urban counterparts. This leads to dietary deficiences in vitamins A and C, folate and potassium and inadequate intake of dietary fibre. This may be due to the lack of access and availability of fruit and vegetables in poorer communities such as informal settlements. (63)

Poor dietary diversity is found in many African countries and is not restricted to South Africa. Bouchard (54) quotes the development of an “obesogenic” environment which favours consumption of large portion size meals, high fat diets and many hours spent watching television or sitting with little physical activity. This is also fueled by media pressure and advertisments enticing consumers to consume more food. High fat and sugary foods are designed with enhanced flavour making them more desirable than healthier natural choices. (63)

Physical activity

Physical inactivity is recognised as the fourth leading risk factor for mortality and is responsible for 6% of all deaths according to the WHO and is a risk factor for non communicable diseases such as cancer, diabetes and cardiovascular disease. It is estimated that six out of 10 deaths are attributable to physical inactivity and that non communicable diseases are responsible for nearly half of the overall burden of disease. (64) There are a number of well documented effects of physical activity. It increases energy expenditure, is associated with better dietary adherence to weight loss and better long term weight loss management (65). The use of labour saving mechanical devices decreases energy expenditure. Urban communities engage in more passive entertainment such as television watching and less physical activity (62). South Africans in general have a low level of physical activity and this is one of the predictors of obesity (56). In the South African National Health and Nutrition Examination Survey in 2012 two thirds (62.4%) of males were found to be physically fit, while 27.9% tested unfit (63). A significantly lower number of the females tested were physically fit (42%) while a similar number (45.4%) were unfit. This demonstrates the high level of physical unfitness among the population especially the females. The South African National Health and Nutrition Examination Survey demonstrated that informal and formal urban settlements displayed differences in terms of fitness. Their study displayed that 51.4% of females surveyed in the informal settlements were found to be fit compared to only 33.9% in the formal settlements. This can possibly be explained by the higher level of physical activity in informal urban settlements, most of which is carried out by females. A higher percentage of males were found to be fit in both urban formal (57.2%) and urban informal settlements (74.6%) with a higher level of fitness again being seen in informal

settlements. A similar trend was seen in females. In 2003 another study on physical fitness confirmed the finding of low levels of physical activity among South Africans (66).

Gender

Gender is a known contributer to BMI. The South African National Health and Nutrition Examination Survey (63) has shown that South African females were significantly heavier than males, 72,2 kg compared to 67.3 kg. Other studies in the South African population by Puoane (50) and Kruger (51) have consistently shown a higher occurrence of overweight and obesity in females. This phenomenon could be explained by multiple factors including socio-cultural factors. Results of a WHO survey showed a similar pattern of a higher mean BMI in females in other African countries including Mozambique, Swaziland, Zimbabwe and Zambia (67).

Age

The trend for physical fitness was found to decrease with age (66). This then leads to an increase in BMI with age in modern sedentary societies (68). The South African National Health and Nutrition Examination Survey showed that among females there was an increase in fitness with age up to a plateau in the region of 30 to 40 years. It was also found that in the age groups 45 to 54 years and 55 to 64 years there was a higher mean BMI in both males and females when compared to ages between 17 to 24 years. In females the BMI then decreased from 65 years and older.

Socio-economic and cultural factors

There are traditional and cultural perceptions which impact on body size and obesity. In black communities in South Africa being overweight has many connotations. Research has shown that being obese is perceived to reflect affluence, happiness, and even a husband's ability to take care of his wife. Due to the HIV/AIDS epidemic, obesity is perceived to reflect people that are healthy and not infected (69). The highest prevalence of obesity in The South African National Health and Nutrition Examination Survey was in black African females, who are socio-economically disadvantaged. In addition both males and females from urban formal areas had a higher mean BMI and were more likely to be obese than

those from urban informal or rural areas. This may be related to the level of activity. (54, 63)

Education

It was found that the highest educated women had the smallest waists followed by those women with no education. Older men with between 8 to 12 years of education had higher levels of abdominal obesity. This can be accounted for by evidence suggesting that the more educated have a better understanding of health education and nutrition. They could therefore make more informed choices. Highly educated people also command higher salaries and thus have more income available to buy a diverse array of food groups that incorporate fruit, vegetables and protein sources into their diet. These individuals are also more likely to understand the benefits of exercise and thus more likely to make concerted efforts to exercise. Women with no education are often from rural or informal settlements and therefore have to do physically challenging jobs and are more active, accounting for their smaller waists. (50, 63)

Parity

Parity is associated with obesity, with as much as a 7% increase risk of obesity, in women, with each additional child, and 4% in men. This is probably attributed to lifestyle changes after the birth of a child with less time available for exercising.(70, 71)

Stress

High levels of stress are associated with weight gain. This may be related to endocrine changes. (71) Urbanisation itself is reported to produce stress and is thus linked to weight gain (7). In many settings obesity was associated with high levels of discrimination and stigmatisation contributing to stress (72). People may use food as a form of comfort to suppress negative emotions ranging from stress, anger, loneliness and fear to boredom (73).

2.5 Diagnosing obesity

There are a few common methods of diagnosing the amount of body fat. These include skin fold calipers, bioelectrical impedance analysis, anthropometric measurements,

hydrostatic weighing and a dual energy X-ray absorptionmetry scan. Many of these methods rely on algorithms to convert the measured parameter to an estimate of body fat percentage and as such none are perfect. (74-76)

Skin fold calipers

This is carried out by “pinching fat” and then measuring the thickness with a body fat caliper. The reading is given in millimeters which can then be compared to a chart with age and gender to arrive at a body fat percentage. Advantages include that it is easy to do and if done correctly is repeatable. The disadvantages include that the operator must be experienced and the same area must be used to measure each time or there will be variability in measurements. In patients who are overweight or obese the fat may not fit into the caliper and thus an erroneous reading will be produced. (74)

Bioelectrical impedance analysis (BIA): This method uses the opposition of flow of an electric current passed through the body to measure fat. Muscle has a higher water content and is far more conductive than fat. The impedance along with height and weight measurements can be used to estimate body fat percentage . Advantages include it being easy to do and inexpensive. Disadvantages are the questionable accuracy variation of results depending on the hydration status of the patient.

In a study by Corral et al (75) between 1988 to 1994, 13 601 subjects in the USA that were part of the Third National Health and Nutrition Examination Survey were enrolled. These patients who in addition to having their anthropometric measurements taken and BMI calculated also had bioelectrical impedance analysis done to estimate body fat percentage. The number of patients who met the WHO standard for obesity of body fat percentage, which was > 25% in males and > 35% in females, was then compared to the BMI range for obesity (BMI ≥ 30). Results showed that, WHO BMI defined obesity, was found in 21% of males and 31% of females. Body fat percentage which defined obesity, was interestingly found in 50% of males and 62% of females. This shows that actual body fat was under diagnosed in a considerable proportion of patients. (74, 75)

Hydrostatic weighing

This provides a measurement of body fat with a small margin of error. It requires being submerged in a specialised tank of water. Bone and muscle are denser than water. A large amount of fat mass will make the body lighter in water, indicating a higher percent body fat. Draw backs to this test are that it is expensive, impractical and accuracy of the readings is based on blowing all the air out of the lungs. It also takes 20 to 30 minutes to perform. (74)

Dual energy X-ray absorptionmetry scan

The dual energy X-ray absorptionmetry scan is another accurate method of body fat measurement. It is based on a three compartment model that divides the body into total body mineral, fat free lean mass and fat tissue mass. The dual energy X-ray absorptionmetry scan allows for fat distribution analysis. An advantage of this method is its accuracy. Disadvantages are that it is expensive, takes 10 to 20 minutes to complete and exposes patients to X-rays, although it is a low dose. (74)

BMI

BMI is a form of anthropometric measurement. It is a relatively old tool and was developed in the 19th century by Adolphus Quetelet. He made the observation that there was a proportional relationship between body weight and the square of the height in adults with normal body frames. It is this observation that is still used today and BMI is arguably the cornerstone screening test for obesity and widely used for the classification of obesity. It is considered an indicator of body fat but in effect is a surrogate measure because it measures excess weight rather than excess fat.

The benefits of using the BMI are that it is simple, inexpensive and non-invasive. It also provides a standard and a reference on which prevalence and trends can be based. (76)

BMI is not without its limitations. BMI can provide misleading information about body fat content in instances including childhood and infancy, aging, racial differences and in athletes. Numerous factors influence the BMI. There is an increase in the ratio between lean body mass and fat in ageing, thus it may underestimate body fat. The BMI was based on Caucasian subjects, but certain ethnic groups display different relationships between BMI and body fat. BMI gives a poor representation of body fat in muscular people, giving

them a high BMI which does not correlate with their body fat content. In exercising individuals, BMI will not show them the percentage of fat they are losing or whether the weight loss is due to lean body mass being lost. In certain circumstances, like sepsis and endocrine abnormalities, that change the relationship between lean and fat tissue is altered, and BMI becomes inadequate. On average women also have greater amounts of total body fat than men with an equivalent BMI which is not taken into consideration in the BMI measurement. Corral et al's (75) study showed that although BMI had a high specificity it had a low sensitivity. It has limited value in being able to correctly diagnose patients with increased body fat, especially in patients between 25 to 30 kg/m^2, for men and the elderly.

BMI can be classified broadly as underweight, normal, overweight or obese. To compute this number the individuals weight, in kilograms, is divided by the height, in metres squared. Table 2.3 shows the classification of patients using BMI. (68, 76)

Table 2.3 Classification of BMI (68, 76)

BMI (kg/m^2)	
Underweight	<18.5
Severe	<16
Moderate	16 - 16.99
Mild	17 – 18.49
Normal	18.5 – 24.99
Overweight	≥ 25
Pre-obese	25 – 29.99
Obese	≥ 30
Obese class I	30 – 34.99
Obese class II	35 – 39.99
Obese class III	≥ 40

2.6 Sequelae of obesity

Obesity is associated with an increased risk of developing comorbid conditions, some of which include, hypertension (77, 78), heart disease (12), diabetes (9), gallstone disease, stroke, cancer (16), and psychological complications (70, 72), osteoarthritis (14) and respiratory complications (79).

Obese people are at a higher risk of cardiovascular disease. Abdominal or central obesity poses higher risk as visceral fat is more metabolically active producing more inflammatory cytokines. There are a variety of interlinked factors that come into play connecting obesity to heart disease. At the crux is the development of atherosclerosis. (80)

Hypertension

Hypertension has a well described relationship to obesity. The relationship between obesity and hypertension is complex and probably represents a multifactorial interplay between racial, gender, demographic, genetic, neurohormonal, and other factors. Upper body (android) obesity, especially in the presence of increased visceral fat, is more strongly associated with hypertension than lower body (gynoid) obesity. The National Health and Nutrition Examination Survey showed a relationship between BMI and arterial hypertension. The Health Professionals Follow-up study (81) showed that among obese men, 35% were hypertensive. The pathophysiology behind the link between obesity and hypertension, although not fully understood, is thought to be due to the increased intravascular volume and a peripheral vascular resistance that is not able to cope appropriately with the added intravascular volume. Obese patients also show an increased sodium retention and increased sympathetic activity adding to the development of hypertension. The renin-angiotensin-aldosterone system is overactive in obesity, further adding to the pathogenesis of hypertension. (77, 78)

Heart disease

Obesity is associated with increased risk of heart disease. This may be associated with the dyslipidemia, accelerated atherosclerosis and hypertension. Obesity was found to independently predict the risk of developing coronary atherosclerosis. Punyadeera et al (82) showed a higher rate of coronary heart disease in obese white women compared to

obese black women due to the distribution of their fat. This study demonstrated that obese black woman had higher levels of visceral fat which contributed to a more artherogenic lipid profile and therefore a higher risk of heart disease. The increase in stroke volume and cardiac output and hypertension demonstrated in the obese patient leave these patients suceptible to left ventricular hypertrophy and dysfunction. The right ventricle can also be dysfuctional, either from the left ventricular strain or from the prescence of concomittent OSAS and pulmonary hypertension. The person may thus present in biventricular failure. (34)

Diabetes

Obesity, particularly truncal obesity is closely correlated to the prevalence of diabetes. Adipokines including plasma leptin, tumour necrosis factor-α, and free faty acid levels are all elevated in obesity and play a role in causing insulin resistance. When there is beta cell dysfunctional, diabetes ensues. Glycaemic control as well as insulin resistence improve with a decrease in weight. (9)

Cancer

Obesity has been shown to to have a relationship with cancer. Obesity is associated with an increased risk of cancers of the oesophagus, pancreas, colon and rectum, breast (after menopause), endometrium, kidney, thyroid, and gallbladder. It is estimated that 4% of new cases in men and 7% in women were attributed to obesity. Some mechanisms proposed for the relationship include elevated levels of oestrogens in females, high levels of insulin like growth factor, especially in people with central obesity, which inhibits apoptosis and stimulates cell proliferation. Adiponectin could be involved with the risk of cancer. Genetics is also involved in the link between obesity and cancer. (83)

Gallbladder disease

Cholelithiasis is one of the primary hepatobiliary pathologies associated with obesity. The risk of having gallbladder disease is about twice as high in obese women as compared to normal weight women. The pathogenesis of gallbladder disease is postulated to be higher plasma concentrations of cholesterol and triglycerides . This concentration of fatty

substances is in excess of bile acids leading to precipitation of cholesterol gallstones in the gallbladder. (34, 53)

Stroke

There is a positive relation between obesity and both ischaemic and haemorrhagic stroke, independently of other risk factors including diabetes, hypertension and dyslipidemia. Plasma leptin may be the link between haemorrhagic stroke and obesity. Obese patients have a high level of leptin in plasma and lepin restistance as leptin may play a role in the activation of immune cells and cytokines accelarating atherosclerosis. (80)

Osteoarthritis

The occurrence of osteoarthritis is increased in overweight individuals. In the knees and ankles it may be directly related to the trauma associated with excess body weight and the effects of inflammatory adipokines on the joint synovium and function of muscle. (10, 18, 34)

Respiratory complications of obesity

Adverse effects of obesity include exertional dyspnoea, limited exercise capacity, and adverse effects in pulmonary mechanics. More importantly, it can result in sleep disordered breathing including OSAS and obesity related respiratory failure. Obesity has deleterious effects on the mechanics of the lung. BMI has a relationship with the degree of airway resistance and work of breathing and is inversely related to thoracic lung volumes. A reduction in functional residual capacity and expiratory reserve volume are associated with early airway closure and resultant gas trapping causing ventilation perfusion mismatching and hypoxia. Obesity also imposes a restriction defect due to mass effect on the chest wall with decreased compliance. Studies in anaesthetised obese patients have demonstrated a relationship between the degree of obesity and static lung compliance due to reduction of functional residual capacity. Breathing at low lung volumes causes expiratory flow limitation due to early airway closure which generates positive pressure causing increased work of breathing. All these changes are further exaggerated during sleep due to the negative impact of the supine position on the mechanics of breathing. (84-86)

Psychological complications of obesity

There is much stigma associated with being overweight (87). This can lead to body image issues, unhappiness, and disordered eating. Obese woman appear to be at greater risk of psychological dysfunction than obese men. This is possibly due to societal pressures to be thin (88). Obese individuals have abnormalities in health related quality of life (89).

2.7 Anaesthetic considerations in obesity

Obesity is a systemic disease and as such has a variety of anaesthetic considerations.

2.7.1 Pre operative management

Once the diagnosis of obesity is made it is important to quantify the burden of the disease and search for associated diseases and complications. On taking the history the patient should be asked questions pertaining to the duration of their weight problem. Has the patient received anaesthesia and if so any complications. A detailed systemic enquiry should be undertaken with special attention to the respiratory and cardiovascular systems. Respiratory enquiry should include symptoms of pulmonary hypertension, exertional dyspnoea, fatigue and syncope which show the inability to increase cardiac output during activity. A history of snoring or symptoms of OSAS should be elicited. This should include the STOP-BANG screening questionnaire. (Appendix 1). Enquiry of the cardiovascular system should include a history of hypertension and atherosclerosis. The functional status of the patient should be noted including ability to do daily activities of living. Diabetes should be enquired about and if present the degree of control. Gastointestinal symptoms should be enquired about including dyspepsia and reflux. Obese patients are at risk of deep vein thrombosis.Previous deep vein thombosis should be enquired about. (27, 32, 90)

Medication the patient is on currently, including weight reduction medication should be noted. Amphetamine based appetite suppresants contribute to increased cardiac risk (32).

Examination

Height and weight of the patient should be done and the obesity graded. A note should also be made as to fat distribution, as abdominal obesity is associated with more morbidity. The patient should be examined in the supine position to assess ability to tolerate this position. Careful assessment of the airway is important. Patients often have short necks and parapharyngeal fat that makes intubation difficult. Mouth opening, Mallampati score and neck extension should be assessed. The patient should be evaluated for systemic hypertension, pulmomary hypertension, ischaemic heart disease

and signs of right and or left ventricular failure. Characteristic signs of cardiac failure, increased jugular venous pressure, added heart sounds, pulmonary crackles, hepatomegaly, and peripheral oedema may be difficult to illicit in obese patients. Peripheral and central venous access should be evaluated during the pre operative visit and the possibility of invasive monitoring discussed with the patient. (27, 32, 90)

Investigations should be patient and procedure specific and goal directed and may include blood investigations. Full blood count may reveal a polycythemia. There may be renal dysfunction, an increased glomerular filtration rate and proteinuria is often found in obese patients, especially in the case of associated diabetes and hypertension. Liver function tests may be appropriate if the patient is suspected of having nonalcoholic steatohepatitis. Blood glucose should be done as obese patients often have diabetes or impaired glucose tolerance. Coagulation studies should be done before surgery. Patients often have chronic vitamin K deficiency which can lead to an abnormal prothrombin time with a normal partial thromboplastin time because of deficiency of clotting factors II, VII, IX, and X. An arterial blood gas may be needed, especially if the patient is suspected of having obesity hypoventilation syndrome (Pickwickian) or OSAS. A baseline arterial blood gas will help evaluate carbon dioxide retention and provide guidelines for peri-operative oxygen administration and help decide on the need for post operative ventilation. A sleep study, where available, may be useful to diagnose OSAS. An ECG should be done in hypertensive patients or morbidly obese patients as they commonly have right ventricular hypertrophy, as evidenced by tall precordial R waves, right axis deviation and right ventricular strain. Echocardiogaphy may be needed to assess systolic and diastolic function, but this may be technically difficult due to poor cardiac windows. Tricuspid regurgitation may be useful to confirm the presence of pulmonary hypertension. A chest X-ray is helpful to detect cardiomegaly or evidence of heart failure as well as underlying lung pathology and prominent pulmonary arteries, suggestive of pulmonary hypertension. Cardiorespiratory testing would be beneficial in these patients to test reserve. Premedication for these patients is a problem as they may further depress respiratory function. Prophylaxis against aspiration and deep vein thrombosis should be given. Risk of deep vein thrombosis should be discussed with the patient pre operatively. Pharmacologic intervention with a H_2- receptor antagonist (e.g. cimetidine, ranitidine),

nonparticulate antacids (e.g. sodium bicarbonate) and proton pump inhibitors (e.g. omeprazole) reduce gastic volume and acidity, reducing the risk of aspiration. (27, 32, 90)

2.7.2 Intra operative management

Airway management

In the American Society of Anesthesiologists Closed Claim Database (91) obese patients were involved in 37% of all adverse airway events occurring upon induction and 58% of those following extubation. Increased BMI is an independent predictor of difficult mask ventilation and rapid desaturation (92). Another important predictor is a history of snoring or OSAS. There is also a reported three times more difficult intubation rate in the obese as compared to lean patients (93). High Mallampati score, increased neck circumference, and excessive pretracheal adipose tissue have been shown to increase the risk of difficult laryngoscopy in obese patients (94).

Various anatomical factors contribute to difficult airway management in obese patients. Excess adipose tissue in the face and cheeks makes applying a tight fitting mask challenging. Large breasts in both sexes encroach on the submandibular area making external laryngeal manipulation difficult and restricting access for laryngoscope handles and other intubation devices. Increased deposition of adipose tissues in the anterior neck further restricts access and makes palpation of landmarks for emergency surgical airway access difficult. Fat deposition in the posterior aspect of the neck and occiput, when severe, can reduce craniocervical mobility, interfering with head positioning and mouth opening for optimal intubation conditions. Parapharyngeal fat deposition, besides being a strong association of OSAS, causes narrowing of the airway making laryngoscopy difficult. Difficult airways are associated with death, brain injury, cardiopulmonary arrest, unnecessary tracheostomy, airway trauma, and damage to teeth. In preparation for instrumentation of the airway of an obese individual, proper positioning must be in place. This includes placing a blanket or wedge under the shoulders to compensate for the exaggerated flexed position from the posterior cervical fat. The tip of the chin is placed higher than the chest facilitating laryngoscopy and intubation. (91)

Obesity may in some way promote the development of gastro-oesophageal reflux disease and patients may need to be treated as an aspiration risk but obesity alone is not a risk factor for pulmonary aspiration.(32)

Obese patients should be well preoxygenated, preferably for a full three minutes or longer, with a well sealed mask, as these patients have up to a 50% decrease in FRC upon induction of anaesthesia. The decreased oxygen reserve combined with a higher metabolic rate in obesity means that these patients desaturate quicker. Intubation strategies should include a well thought out plan of what equipment would best suit the patient, and readily available back up devices which the user is proficient with should the initial intubation strategy not work. An awake intubation may be a preferred option. The American Society of Anesthesiologists difficult airway algorithm should be kept in mind for these patients. (91)

Positioning

Specially designed tables may be required for safe anaesthesia in obese patients. The weight limit of the operating table should be checked. Electrically operated tables may facilitate moving and positioning of patients. Care should be paid to protecting pressure areas as pressure ulcers and neural injuries are common especially in the morbidly obese and diabetic patients. Brachial plexus and sciatic nerve injuries are common. Stretch injuries may be caused by extreme abduction of the arms stretching the lower roots of the brachial plexus. (27)

Monitoring

Standard monitoring, as applicable to all patients, should be used including oxygen saturation monitoring, electrocardiogram recordings, and blood pressure monitoring. In morbidly obese individuals it may be difficult to obtain an accurate blood pressure via non invasive means as the patients may have conical upper arms that provide a poor fit for the non invasive cuff. Appropriately sized cuffs may be unavailable and cuffs too small for the individual can give a falsely high blood pressure reading. Cuffs with bladders that encircle at least 75% of the upper arm or preferably the entire arm should be used. Comparable and accurate blood pressure readings can be obtained from the wrist or

ankle using appropriately sized cuffs. In cases where no accurate non invasive blood pressure can be obtained an invasive blood pressure may need to be obtained via insertion of an arterial line. This has the added benefit of allowing sampling of blood for arterial blood gases. (27)

Ventilation strategies

A change of position from upright to supine causes a decrease in lung volume and respiratory system compliance in all patients, but these effects are magnified in the obese. In obese patients functional residual capacity is reduced and there is an associated decrease in lung and chest wall compliance. In anaesthetised obese patients, functional residual capacity decreases to approximately 50% of the pre induction value. (27) This is accompanied by atelectasis developing in the dependent regions of the lung, which may persist for 24 hours or longer post operatively, contributing to a reduction in the respiratory system compliance. The exaggerated atelectasis in obese individuals leads to an increased intra-pulmonary shunt and decreased partial pressure of arterial oxygen.

To prevent resorption atelectasis and hypoxaemia during apnoea at induction, it is recommended that continuous positive airway pressure is used to pre oxygenate the patient and the fraction of inspired oxygen concentration is limited to less than 80%. To expand atelectasis, recruitment manoeuvers are suggested. This entails maintaining sustained airway pressure for 8 to 10 seconds at greater than or equal to 40 cm water. It is important to monitor the patient for hypotension and bradycardia during these manoeuvers. These may be repeated intermittently to prevent reoccurrence of atelectasis. The effects of recruitment should be monitored by means of monitoring PaO_2 to confirm improvement of gas exchange. The improvement of lung compliance should also be monitored to ensure a balance between optimal gas exchange and preventing lung over distension. The lungs can be kept recruited by using positive end expiratory pressure of between 10 to 12cm of water. Positive end expiratory pressure should be used in conjunction with monitoring for hypotension and decreasing arterial oxygenation, as PEEP may increase pulmonary shunting. It is important not to increase ventilatory airway pressure excessively as it may lead to parenchymal stress, causing ventilatory associated lung injury. To avoid lung overdistension tidal volumes of 6 to 10 ml per

kilogram of ideal body weight should be used, end inspiratory pressures should be kept below 30 cm of water, the rate can be increased, and permissive hypercapnia can be used if necessary. (27, 32)

Obesity and anaesthetic agents

Pharmacokinetics is altered. Obesity brings about changes which affect the metabolism of drugs and therefore the dosing of these drugs (25). Blood volume increases proportionately to body weight leading to an increased cardiac output. Obese patients have increased lean body weight compared to normal. Even though obese patients have increased fat mass the adipose tissue is significantly less perfused, so lipophilic substances do not have a bigger volume of distribution. Obese patients have increased extra-cellular fluid thus increasing the volume of distribution of hydrophilic substances. Nonalcoholic steatohepatitis with or without liver dysfunction is common but no studies have looked at its effect on drug clearance. Dosing recommendations are usually based on total body weight. This approach is valid for normal weight subjects, total body weight and ideal body weight are similar. In morbidly obese patients the fat mass accounts for an increasing proportion of total body weight with a decreased lean body weight to total body weight ratio. Drug administration based on total body weight can result in overdose and drugs based on ideal body weight can lead to underdosing. (24-26)

Hypnotics

Thiopental is rapidly distributed from the plasma into the peripheral tissues. Termination of effect is due to rapid distribution in peripheral tissues (26). High lipophilicity increases the drug volume of distribution and elimination half-life in obese individuals. Total clearance is increased two fold in obese individuals but when normalised to total body weight there was no significant difference in clearance. Obese patients have a higher cardiac output compared to normal weight individuals and cardiac output is an important determinant of distribution with intravenous drugs. Thiopental induction doses adjusted to lean body weight resulted in the same peak plasma concentrations as doses adjusted to cardiac output. Induction should be based on lean body weight and maintenance on total body weight as volumes and clearance increase proportionally with total body weight. (24, 26)

Propofol distribution is similar to that of thiopental distribution. It is lipophilic, and distributes rapidly from plasma into peripheral tissues, which accounts for its short duration of action. Cardiac output is a determinant of peak plasma concentration. Comparison with non obese patients shows that the systemic clearance and the volume of distribution at steady state were related to total body weight. The elimination half life was found to be similar between obese and non obese individuals. It is recommended that propofol be dosed according to lean body weight, and maintenance should be based on total body weight. (24, 26, 95)

There is limited data as to the pharmacokinetics of etomidate, but based on its similarity to propofol it is recommended that it be dosed according to lean body weight. (26)

Opioids

Fentanyl has a high lipid solubility. Studies of pharmacokinetics in obese and normal weight patients have shown that the higher cardiac output in obese patients results in significantly lower fentanyl concentrations in the early phase of distribution. Clearance is also higher in obese patients. Recommendations have been made to dose fentanyl according to lean body weight as clearance increases arbitrarily with pharmacokinetic mass (a derived hypothetic scalar) which correlates well with lean body weight. Remifentanil similarly should be dosed on lean body weight. Obesity increases the risk of peri-operative hypoxia and as such all opioids should be carefully titrated according to the individual patients needs. (24, 25, 27)

Inhalational agents

Isoflurane is more lipophilic than desflurane or sevoflurane. Obese and non obese patients responded to commands equally after 0.6 minimum alveolar concentration of isoflurane in procedures lasting 2 to 4 hours. This may be due to the fact that even though the obese patients have increased body fat and an increased cardiac output, the blood flow per kilogram of body fat decreases with increasing obesity. Sevoflurane appears to have a slighty more rapid uptake and elimination than isoflurane (26). In general the effect of BMI on desflurane uptake is insignificant (25).

Neromuscular blocking drugs

These are dosed on ideal body weight, except succinylcholine which is dosed according to total body weight as the amount of extracellular fluid and pseudocholinesterase is increased. The polar hydrophilic nature of nondepolarising neuromuscular blockers limits their volume of distribution. A more predictable clinical effect occurs when based on ideal body weight. (24, 28)

Other considerations

Regional anaesthesia is an anaesthetic technique which would be beneficial to obese patients as it would allow pain control and is opioid sparing. The respiratory benefits include no manipulation of the airway, less post operative reduction in vital capacity and quicker return to pre operative lung volumes. Regional procedures in these patients however are technically difficult. (32)

Obese patients are at high risk of post operative wound infections and as such should receive antibiotic prophylaxis. (27)

Thromboprophylaxis is necessary as morbid obesity is an independent risk factor for acute post operative pulmonary embolus causing sudden death. Thromboprophylaxis should be administered until the patient is fully mobile. (27)

2.7.3 Post operative management

Monitoring of the obese patient

In general, no special monitoring is needed for the obese patient undergoing short and uncomplicated surgery. The length and complexity of surgery as well as the baseline functional status of the patient pre operatively dictate special monitoring. Obese patients who have undergone upper abdominal surgery are at increased risk of post operative atelectasis. A strategy for minimising this could include initiation of continuous positive pressure in recovery room and continuing overnight. Post operatively these patients should be kept in the recovery room longer than non obese patients especially when they have a history of OSAS. They should also be monitored closely for desaturation. A lower

threshold for admitting these patients to high care facilities or intensive care units should exist. (27, 28)

Analgesia should be carefully titrated and monitored. Post laparotomy pain may cause patients to avoid taking deep breaths, worsening atelectasis. Adequate analgesia and abdominal support may encourage patients to co-operate with early ambulation and incentive spirometry. (27)

Thromboprophylaxis should be given until the patient is ambulating as patients are at increased risk of thrombotic disease. (27)

2.8 Definition of OSAS

OSAS is a chronic condition where the patient frequently stops breathing during sleep, due to repetitive complete or partial collapse of the upper airway causing obstruction (96).

2.9 Prevalence of OSAS

The prevalence of OSAS is on the rise, especially in the face of increasing obesity. The prevalence of OSAS is under reported as only a small proportion of the population is adequately screened (5). The prevalence ranges from 9 to 26% depending on the study population and how the studies were conducted. (3, 4) A problem with describing the prevalence is that different studies use different methods to describe whether or not a patient meets the criteria for OSAS. Some studies use the apnoea hypopnoea index (AHI), whilst others use screening questionnaires.

The prevalence of OSAS in the surgical population is shown to be higher than that in the general population. This varies with the different surgical populations with patients for bariatric surgery having pervalences of as high as 95% (3, 20, 97).

Young et al (5) showed the estimated prevalence of OSAS in the adult USA population is 20%, then Hiestand (3) demonstrated that 25% of the adult population in the USA were at risk of OSAS. Finkel et al (4) screened adult surgical patients for OSAS at an academic hospital, using the apnoea risk evaluation system (ARES) OSAS screening questionnaire. This questionnaire combined three different screening tools, the Berlin questinnaire, the

Epworth sleepiness scale and the Flemons index. The patients who screened high risk were then offered a home sleep study to determine if they had OSAS. Patients were then offered polysomnography to confirm the diagnosis. This study showed that 661 patients (23.7%) screened high risk for OSAS. Of these, 534 (81%) had no prior diagnosis of OSAS. Portable sleep studies were then done in 207 high risk patients, with no prior diagnosis of OSAS and 170 (82%) were detected to have OSAS. PSG's were then done in 26 patients and OSAS was then confirmed in 19 patients. This study shows that undiagnosed OSAS is prevalent in adult surgical patients and it is important to screen for it.

2.10 Pathophysiology of OSAS

Obstructive sleep apnoea results from the forces that maintain a patent airway being overcome by forces that cause the airway to collapse. In individuals with OSAS, increased parapharyngeal soft tissue is found. This leads to a change in the geometry of the pharynx which reduces the effectiveness of the upper airway muscle tension and contraction that maintain patency of the upper airway. Decreased lung volumes, especially in patients with central obesity, lead to decreased traction on the trachea, further increasing upper airway collapsibility and resistance. The nasopharynx, hypopharynx and oropharynx are not supported by bone or cartilage making them prone to collapse. The patency of these segments are thus determined by the activity and contraction of the pharyngeal dilator muscles.

In patients with OSAS, rapid eye movement (REM) sleep results in decrease in the the upper airway neuromuscular activity and pharyngeal tone, leading to airway obstruction. The synchronisation of the upper airway and respiratory muscle activation prior to inspiration is disrupted in OSAS patients. The genioglossus muscle, responsible for preventing the tongue from falling back, especially in REM sleep, is relaxed in OSAS patients. Upper airway resistance increases during REM sleep as most of the pharyngeal dilator muscles relax. Diaphragmatic contraction produces sub-atmospheric pharyngeal pressure, leading to upper airway collapse involving the lateral pharyngeal walls. (5, 19)

Increasing hypopnoeic and or apnoeic events lead to increasing hypoxaemia and hypercapnia which lead to increasing ventilatory effort that eventually terminates in arousal and return of the pharyngeal dilator activity. Repetitive sympathetic nervous

system activity triggers a series of events leading to cardiovascular and metabolic complications. During an apnoeic attack, bradycardia, sinus pauses, ventricular dysrhythmias and second degree heart block occurs in 50% of OSAS patients. These changes increase in frequency when the arterial oxygen saturation is less than 60%. The intermittent nocturnal sympathetic activation with systemic hypertension and recurrent hypoxic pulmonary vasoconstriction with pulmonary hypertension may provide an explanation of right and left ventricular hypertrophy in OSAS patients. These cardiovascular changes increase the myocardial infarction and stroke rate in the OSAS population with associated increased mortality in patients that are untreated.

There is evidence that the hormone leptin is implicated in OSAS as it impairs the response to apnoea related hypercapnia and interferes with the arousal response. Oxidative stress secondary to hypoxia and reperfusion and high levels of cytokine contribute to endothelial dysfunction. There are complex changes that come into play in addition to the sympathetic activation which is responsible for the atherosclerotic cardiovascular disease and metabolic changes. Co-morbidities associated with OSAS include arterial hypertension, coronary artery disease, cerebrovascular disease and stroke, congestive cardiac failure, cardiac dysrhythmias, and diabetes mellitus. OSAS is an independent risk factor for the development of the metabolic syndrome. (27-29)

2.11 Risk factors of OSAS

Male gender is a predisposing factor. The exact etiology of this is unclear. Age greater than 40 is associated with greater pharyngeal collapsibility during sleep and therefore the risk of OSAS increases with age. A BMI greater than 35 kg/m^2 is associated with OSAS. The distribution of adipose tissue is significant with abdominal fat distribution or visceral fat, an increased waist hip ratio, and a neck circumference of greater than 39 cm in women and 41 cm in men being associated with an increased risk of OSAS. (19, 27, 98)

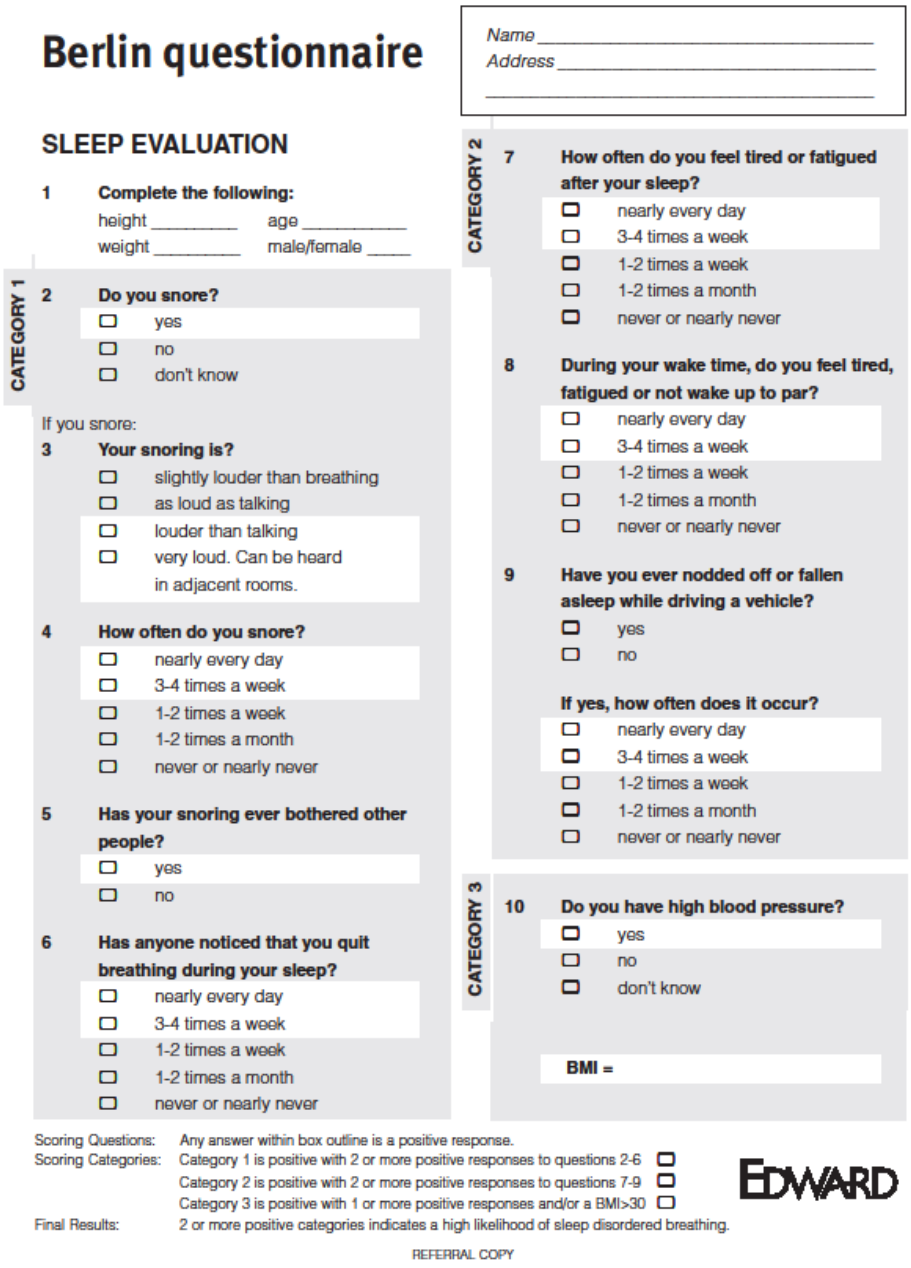
2.12 Screening tests for OSAS and diagnosis of OSAS

OSAS is associated with peri-operative morbidity but is under diagnosed. A 2012 study carried out by Singh et al (99), in Canada, investigated patients attending a pre operative clinic over a 4 year period. Of the 819 patients in their sample 111 had pre-existing OSAS.

Of the patients that were screened using the STOP-BANG questionnaire, 708 then had polysomnography (PSG) studies. The study found that 233 (31%) of the patients had no OSAS. The OSAS was then classified in terms of severity using the Apnoea Hyponoea Index (AHI). 218 (31%) had mild OSAS (AHI: 5 to 15), 148 (21%) had moderate OSAS (AHI: 15 to 30), and 119 (17%) had severe OSAS (AHI: >30). Of the 267 patients with moderate to severe OSAS 92% (n = 245) was not diagnosed by the surgeons and 60% (n = 159) of the patients were not diagnosed by the anaestheists. This study concluded that both anaesthetists and surgeons failed to identify the majority of patients with pre-existing OSAS and symptomatic undiagnosed OSAS before operation. This highlights the need for vigilence when screening pre operative patients. Many tools are available for screening OSAS. They are mainly based on questionnaires and are thus subjective. These questionnaires are then usually vailidated against the gold standard screening for OSAS, polysomnography.

The Berlin questionnaire

The Berlin questionnaire (Figure 2.1) was among the first sleep apnoea screening tools designed specifically for use in primary care settings. The questionnaire was the outcome of a consensus conference in Berlin, Germany, in April 1996. As part of the conference, 120 German and American primary care and pulmonary physicians chose questions from the literature relating to the risk of developing sleep apnoea. The result was a 14 item screening tool designed to assess the presence of sleep apnoea symptoms such as snoring, daytime sleepiness, and drowsiness when driving. This information was then correlated with patient specific data on age, gender, ethnicity, height, weight, neck circumference, and blood pressure. The Berlin questionnaire was initially used and validated for outpatient screening of OSA in primary care clinics but has also been validated as a screening tool in the surgical population. (22, 31, 100)



Berlin questionnaire

Name _____
Address _____
_____

SLEEP EVALUATION

1 **Complete the following:**
height _____ age _____
weight _____ male/female ____

CATEGORY 1

2 **Do you snore?**
- ☐ yes
- ☐ no
- ☐ don't know

If you snore:

3 **Your snoring is?**
- ☐ slightly louder than breathing
- ☐ as loud as talking
- ☐ louder than talking
- ☐ very loud. Can be heard in adjacent rooms.

4 **How often do you snore?**
- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

5 **Has your snoring ever bothered other people?**
- ☐ yes
- ☐ no

6 **Has anyone noticed that you quit breathing during your sleep?**
- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

CATEGORY 2

7 **How often do you feel tired or fatigued after your sleep?**
- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

8 **During your wake time, do you feel tired, fatigued or not wake up to par?**
- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

9 **Have you ever nodded off or fallen asleep while driving a vehicle?**
- ☐ yes
- ☐ no

If yes, how often does it occur?
- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

CATEGORY 3

10 **Do you have high blood pressure?**
- ☐ yes
- ☐ no
- ☐ don't know

BMI =

Scoring Questions: Any answer within box outline is a positive response.
Scoring Categories: Category 1 is positive with 2 or more positive responses to questions 2-6 ☐
Category 2 is positive with 2 or more positive responses to questions 7-9 ☐
Category 3 is positive with 1 or more positive responses and/or a BMI>30 ☐
Final Results: 2 or more positive categories indicates a high likelihood of sleep disordered breathing.

EDWARD

REFERRAL COPY

Figure 2.1 Berlin questionnaire (100)

American Society of Anesthesiologists OSAS scoring

The American Society of Anesthesiologists practice guidelines offer a scoring system (Table 2.4) that can be useful to estimate whether a patient is at increased peri-operative risk of complications from OSA. This includes questions about type of surgery and anaesthesia, use of post operative anaesthesia and presence and severity of OSAS or suggestive symptoms. This score consists of 3 sections .The overall point score for section

A is added to the score for either section B or C depending on which is greater to give a score from 0 to 6. Patients with a score of 4 are at increased peri-operative risk from OSA. Patients with a score of 5 or 6 are at significantly increased peri-operative risk from OSA. (29)

Table 2.4 American Society of Anesthesiologists (ASA) Scoring system for Peri-operative risk from OSA (29)

ASA Scoring system for Peri-operative risk from OSA	Points
A- Severity of sleep apnea based on sleep study (or clinical indicators if sleep study not available). Point score (0-3)	
Severity of OSA	
None	0
Mild	1
Moderate	2
Severe	3
B-Invasiveness of surgery and anesthesia. Point score (0-3)	
Type of surgery and anesthesia	
Superficial surgery under local or peripheral nerve block anesthesia without sedation	0
Superficial surgery with moderate sedation or general anesthesia	1
Peripheral surgery spinal or epidural anesthesia	1
Peripheral surgery with general anesthesia	2
Airway surgery with moderate sedation	2
Major surgery, general anesthesia	3
Airway surgery, general anesthesia	3
C-Requirements for post operative opioids. Point score (0-3)	
Opioid replacement	
None	0
Low dose oral opioids	1
High-dose oral opiods, parenteral or neuraxial opioids	3

STOP-BANG questionnaire

The STOP-BANG questionnaire (23) as illustrated in (Table 2.5) was developed by Chung in 2008 in Toronto, Canada. It was validated using sleep studies. The STOP-BANG questionnaire consists of eight yes/no questions. The origin of this acronym can be seen in table 2.5 (STOP-BANG, Snoring, Tiredness, Observed apnoea, Pressure, BMI, Age, Neck cicumference, Gender). A score of 1 is given to a yes response and 0 for a no response. The score ranges from 0 to 8. A score greater than or equal to 3 has a 93% specificity and 100% sensitivity for predicting the probability of OSAS in moderate and severe cases respectively. Its simplicity and ease of administration as well as validation in the surgical population make it a useful screening tool, especially in an environment where there are communication, time and budget constraints that do not afford us the luxury of complicated questionnaires or expensive sleep studies. (23)

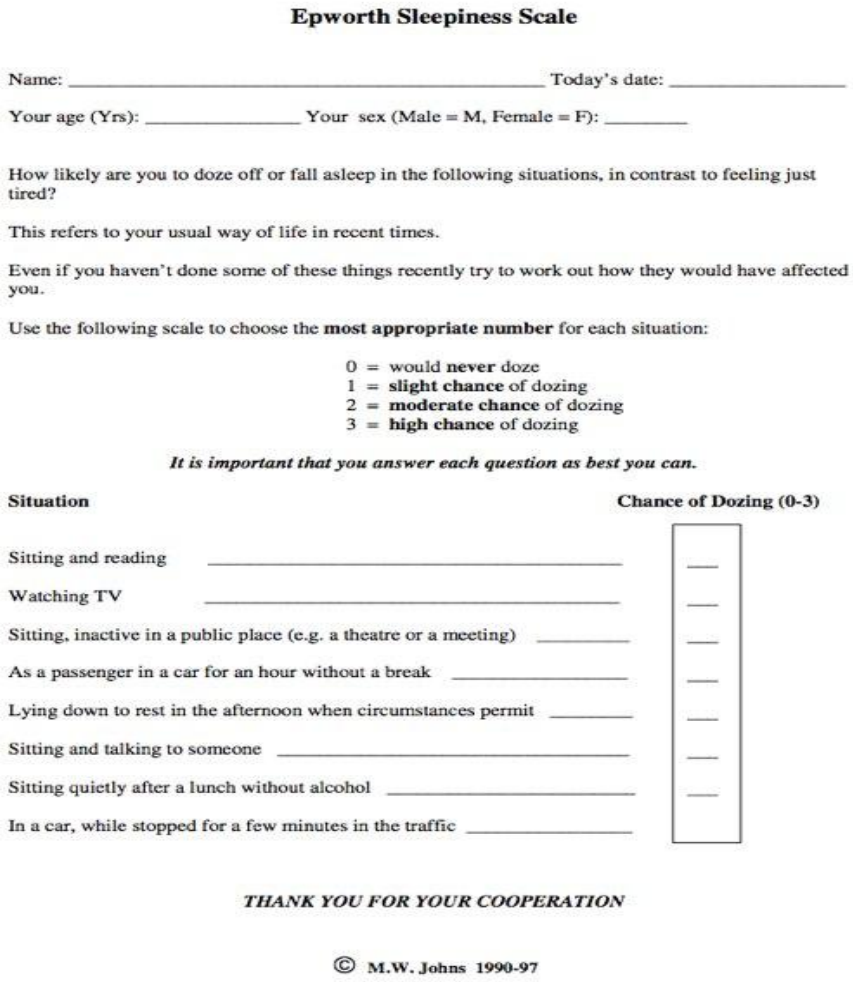
Table 2.5 STOP-BANG Questionairre (23)

STOP-BANG Sleep Apnea Screening Tool	YES	NO
1. Do you **SNORE** loudly (louder than talking or loud enough to be heard through closed doors)?		
2. Do you often feel **TIRED**, fatigued, or sleepy during daytime?		
3. Has anyone **OBSERVED** you stop breathing during your sleep?		
4. Do you have or are you being treated for high blood **PRESSURE**?		
5. **BMI** more than 35?		
6. **AGE** over 50 years old?		
7. **NECK** circumference > 15.75 inches? (39.375cm)		
8. Male **GENDER**?		

Epworth sleep scale

The Epworth Sleepiness Scale (Figure 2.2) was created by Murray Johns at the Epworth Sleep Centre in Australia. It is a simple, self administered questionnaire which provides a measurement of the general level of daytime sleepiness. The individual is asked on a scale of 0 to 3 to score the likelihood of falling asleep in eight different situations. Although it has the advantage of being brief and simple, the score is subjective and may convey

symptoms of fatigue rather than purely excessive daytime sleepiness. Arbitrarily, a score of >10 has been suggested as being an indicator of ESS, but on an individual basis, the ESS cannot be used as a diagnostic tool for OSAS in isolation. Detailed history and polysomnography is recommended. Whether an ESS score can predict health outcomes is not clear, but it is popular due to its simplicity. (101)



Epworth Sleepiness Scale

Name: _____ Today's date: _____

Your age (Yrs): _____ Your sex (Male = M, Female = F): _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the **most appropriate number** for each situation:

0 = would **never** doze
1 = **slight chance** of dozing
2 = **moderate chance** of dozing
3 = **high chance** of dozing

It is important that you answer each question as best you can.

Situation	Chance of Dozing (0-3)
Sitting and reading	___
Watching TV	___
Sitting, inactive in a public place (e.g. a theatre or a meeting)	___
As a passenger in a car for an hour without a break	___
Lying down to rest in the afternoon when circumstances permit	___
Sitting and talking to someone	___
Sitting quietly after a lunch without alcohol	___
In a car, while stopped for a few minutes in the traffic	

THANK YOU FOR YOUR COOPERATION

© M.W. Johns 1990-97

Figure 2.2 Epworth Sleepiness Scale (101)

Polysomnography

Polysomnography is the gold standard for diagnosis and assessment of severity of OSAS. Sleep is divided into rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep. It begins with NREM, during which period the electroencephalogram shows slowing down of brain waves. When approximately two hours of sleep has completed, brain activity increases and REM sleep begins. There are between 4 to 6 sleep cycles a night, with the REM portion of sleep lengthening with each cycle.

Polysomnography is able to monitor the stages of sleep as well as the sleep cycles and can then determine when sleep patterns are disrupted and possible reasons for these disruptions. Polysomnography is non-invasive, painless and carries few complications. Patients prepare for the test by omitting alcohol and caffeine from their diets in the 24 hours prior to polysomnography. It requires an overnight stay at a sleep laboratory where numerous complex recordings are taken. These include electroencephalogram, electrooculogram, submental electromyogram, electrocardiogram, ribcage and abdominal excursion, oro-nasal airflow measurements, oxyhaemoglobin saturation and non-invasive blood pressure monitoring. The results are then analysed and summarised using indices for OSAS severity.

The apnea hypopnea index (AHI) is a popular index used which is an indication of the number of apnoeas per hour of total sleep time and the number of hypopnoeas per hour of total sleep time. The American Society of Anesthesiologists regards an AHI of 0 to 5 as normal, 6 to 20 is suggestive of mild OSAS, 21 to 40 moderate OSAS, and greater than 40 as severe OSAS. (Table 2.6) While PSG is the gold standard, it is costly and time consuming, limiting its use. (27, 29, 36, 96, 102)

Table 2.6 Severity of OSA (29)

Severity of OSA	AHI
None	0-5
Mild OSA	6-20
Moderate OSA	21-40
Severe OSA	>40

2.13 Anaesthetic management of OSAS

The peri-operative management of patients is critical in patients with OSAS. OSAS predisposes patients to a greater than normal risk of peri-operative complications. (31, 33, 103) Patients who are undiagnosed as having OSAS pose the biggest threat as they are sub-optimally prepared and thus at increased risk of adverse events. (31) Attention to detail and careful preparation ensuring a safe anaesthetic is imperative. Peri-operative complications associated with OSAS are numerous. These range from higher rates of

reintubation, oxygen desaturations, cardiac arrhythmias, myocardial injury, delirium, unplanned ICU transfers and longer hospital stays to nearly fatal respiratory complications and even unexpected deaths which have been reported post operatively, especially in patients with OSAS that was unrecognised or inadequately treated peri-operatively. (4, 104)

Pre operative evaluation

The pre operative assessment starts by having a high index of suspicion in patients who are obese and have a body habitus suggestive of OSAS. This includes BMI of 35 kg/m2, neck circumference greater than 39 cm, craniofacial abnormalities affecting the airway, anatomical nasal obstruction and tonsils nearly touching in the midline. Pre operative questionnaires like the STOP BANG questionairre can be used to screen patients at risk and assess the need for further testing. Polysomnography is expensive and not easily available. Confirmed diagnosis pre operatively is unlikely, a presumptive diagnosis thus needs to be made. Pre operative initiation of CPAP should be considered especially in cases of severe OSAS. Once suspicion has been raised, a baseline function is needed. The grading of the severity of OSAS is important . Associated complications of OSAS need to be screened for, including hypoxaemia, arrhythmias, myocardial infarction and apnoeas. (31, 33) Associated co-morbidities need to be screened for, including, diabetes, and hypertension. All of which make the peri-operative management more complicated. (4)

Physical examination pre operatively should pay particular attention to the evaluation of the airway, nasopharyngeal space, neck circumference, tonsil size and tongue volume (98). The patient and their family as well as the attending surgeon should be informed of the suspicion of OSAS as well as the associated peri-operative risks. (29)

The decision to perform day case surgery should be carefully considered with the risks and benefits taken into consideration. Factors to be taken into consideration are type of surgery, for example lithotripsy, minor orthopaedic surgery and superficial surgery which may be suitable for day case procedures. The type of anaesthesia given should also be taken into consideration, with local or regional anaesthesia considered safer for outpatient surgery than general anaesthesia. The patients functional status and co-morbidities also need to be taken into consideration as a patient who is at high risk of

morbidity may not be suitable for day case procedures for even the most minor of surgical procedures. (29)

Patients on CPAP should be encouraged to continue using their CPAP and to bring in their machines to be used pre operatively and post operatively as it has been found to decrease the number of post operative adverse events. The pre operative use of mandibular advancement devices or oral appliances should also be encouraged as should pre operative weight loss. (29)

Premedication is usually omitted in these patients. Sedative, analgesic and anaesthetic agents used peri-operatively play a major role in the development of sleep disordered breathing during the post operative period. (33)

Intra operative management

Difficulties are often encountered with airway management. (31) Intra operatively patients with OSAS have a higher risk for morbidity and mortality due to potential difficulty in maintaining a patent airway. (33) They should have a well thought out plan for their analgesia. Opioid sparing strategies should be employed where possible. Use of non steroidal anti inflammatory drugs and multimodal analgesia should also be employed. The use of regional anaesthesia when possible should be considered. The American Society of Anesthesiologists task force on peri-operative management of patients with OSAS agreed that the use of local anaesthesia or peripheral nerve blocks rather than general anaesthesia improves outcomes in patients undergoing peripheral surgery. Controversy surrounds whether or not opioids should be used in epidurals. (28, 29)

Effects of sedatives, analgesics and anaesthetic agents play an important role in upper airway dynamics. Anaesthetic and sedative drugs are central nervous system depressants, which inhibit respiration. Sedation and anaesthesia, similar to the changes that occur in sleep, reduce functional residual capacity and predispose to atelectasis. (33) In comparison with normal individuals patients with OSAS seem to be more sensitive to the effects of sedation and anaesthesia (31). Phasic pharyngeal muscle contraction is

markedly reduced by REM sleep and the administration of narcotic analgesia predisposing to airway collapse (33).

Patients with increased peri-operative risk from OSAS should be extubated only when fully awake and reversal of neuromuscular blockade has been confirmed. Patients should also be placed in a semi upright position for extubation and recovery. The American Society of Anesthesiologists task force also agree that general anaesthesia with a secured airway is preferable to deep sedation for superficial procedures especially when procedures involve the upper airway. (29)

All the considerations with obese patients must also be taken into account including positioning and protection of pressure points. (27)

Post operative management

Post operatively a high care bed must be secured. OSAS patients are prone to respiratory depression and desaturation post operatively due to the sedative effects of anaesthetic agents combined with analgesic agents which are respiratory depressants. This necessitates the need for monitoring in the post operative period. Continuous oximetry reduces the risk of peri-operative complications. Supplemental oxygen should be administered to keep levels at baseline oxygenation and discontinued when they can maintain baseline oxygenation on room air. If frequent or severe airway obstruction or hypoxaemia occurs during post operative monitoring, initiation of CPAP should be considered. Supplemental oxygen may increase the duration of apnoeic episodes and may hinder detection of atelectasis, transient apnoea and hypoventilation by pulse oximetry. The supine position should be avoided when possible during recovery. The type and extent of surgery has significant impact on disturbances of sleep architecture in the post operative period. (30, 31, 33, 104)

Analgesia post operatively should be carefully monitored, as reduced doses of opioids need to be used as regular doses may render the patient apnoeic. (27)

2.14 Conclusion

In this chapter the literature pertaining to obesity and OSAS was discussed. The definitions, prevalence, pathophysiology, risk factors, diagnosis, sequelae, and anaesthetic considerations of obesity and OSAS were delved into.

Chapter Three: Research methodolgy

3.1 Introduction

This chapter will discuss the problem statement, aims and objectives, ethical considerations, research methodology and the validity and reliability of this study.

3.2 Problem statement

Obesity is associated with increased co-morbid conditions and increased morbidity and mortality among patients undergoing surgery (34). OSAS is associated with further perioperative morbidity and mortality (29), and is under diagnosed in a large number of patients (3, 5, 20). Finkel et al (4) in 2009 described an 82% prevalence of undiagnosed OSAS among American adults presenting for surgery. Obesity and OSAS have implications for the anaesthetic management of patients (25, 28, 30, 35, 36). It is therefore important for the anaesthetist to know the occurrence of obesity and OSAS in the patient population presenting for surgery.

The occurence of obesity and the risk of OSAS among patients at Chris Hani Baragwanath Academic Hospital (CHBAH) who present for elective surgery is unknown.

3.3 Aim and objectives

3.3.1 Aim

The aim of this study was to describe the occurrence of obesity and risk of OSAS in adult patients going for elective surgery at the J.D. Allen and the Gynaecology Theatre Complex, at CHBAH.

3.3.2 Objectives

The primary objectives of this study were to:

- describe the BMI of adult patients undergoing elective surgery
- describe the risk of OSAS using the STOP-BANG questionnaire.

The secondary objectives of this study were to:

- compare the BMI with risk of OSAS
- compare the BMI with gender
- compare the BMI with age
- compare the risk of OSAS with gender
- compare the risk of OSAS with age.

3.4 Ethical considerations

The study was approved by the Human Research Ethics Committee (Medical) (Appendix 4) and the Post Graduate Committee of the University of Witwatersrand (Appendix 5). Written consent to undertake the study was sought from the Medical Advisory Commitee of CHBAH (Appendix 6). The operating theatre nursing managers were informed of the study.

Adult patients presenting for elective surgery were invited to take part in the study. The researcher explained the study to the patients and those agreeing to participate received an information letter (Appendix 2) and were asked to sign informed consent (Appendix 3). The patient information letter detailed the nature of data collection and reasons for the study.

When patients were concerned about their weight, they were informed of the dietetics department at CHBAH, who run a weight management programme, so that their problem could be further addressed. No patients were followed up as to their participation in the weight management programme.

The data collection was anonymously done as each patient was allocated a study number. A list with the study numbers and the patients' names were kept in a seperate file and only the study numbers were used on the data collection sheets. Confidentiality was ensured as only the reasearcher and supervisor had access to the data. The data will be stored securely for six years after completion of the study.

This study was carried out in accordance with The Declaration of Helsinki (39) and the South African Good Practice Guidelines (40).

3.5 Research methodology

3.5.1 Research design

A prospective, contextual, descriptive study design was utilised.The study was prospective as it measured variables that occurred during the course of the study. In prospective studies data is first collected and then outcome is measured (105). The study was contextual as it took place only in a specific location (105), in this case CHBAH. A descriptive design aims to describe a situation or identify problems through observation, description or classification without manipulating variables. (105) This study described the occurrence of obesity and risk of OSAS in adult patients going for elective surgery at the J.D. Allen and the Gynaecology Theatre Complex, at CHBAH.

3.5.2 Study population

The study population was adult patients presenting to CHBAH for elective surgery in the disciplines of:

- general surgery
- orthopaedic surgery
- plastic and reconstructive surgery
- maxillo-facial surgery
- urological surgery
- gynaecological surgery
- otorhinolaryngology and
- neurosurgery.

3.5.3 Study sample

Sample size

In consultation with a bio-statistician using nQuery Advisor, a sample size of 250 patients was needed to yield a sample size of approximately 100 obese patients assuming a 40% prevalence of obesity among this population. With a sample size of approximately 100 obese patients, a two sided 95% confidence interval for the proportion of patients with

risk of OSAS using the large sample normal approximation will extend 0.1 from the observed proportion for an expected proportion of 0.5.

Sampling method

A convenience sampling method was used. Convenience sampling is referred to as "availability" sampling and it involves the choice of readily available participants or objects for the study (105). Patients presenting to CHBAH for elective surgery on the days that the reasearcher collected data were invited to partake as they were readily accessible.

Inclusion and exclusion criteria

Inclusion criteria for this study were:

- adult patients 18 years and older
- presenting for elective surgery
- able to stand upright.

Exclusion criteria for this study were:

- patients declining to participate in the study
- and those with any medical condition which increases extracellular fluid and thus weight, for example ascites, cardiac failure, and renal failure.

3.5.4 Data collection

The data was collected over a period of 16 days, 2 weeks of which were consecutive in September 2013 and the remaining 2 days a week later during the month of October 2013. The patients were sourced from two operating theatre complexes. For logistical reasons data was collected from the patients presenting for gynaecological surgery in the late afternoon the day before their surgery, in their respective wards. Any patients, from other elective surgical lists, already in the ward on the evening before their surgery also had their data collected. Data was collected from all other patients on the morning of their surgery in a private space in the operating theatre reception.

Adult patients presenting for elective surgery were invited to take part in the study. The researcher explained the study to the patients and those agreeing to participate received an information letter (Appendix 2) and were asked to sign informed consent (Appendix 3).

The following data was collected and recorded on the data capture sheet:

- demographic data
- weight
- height
- neck circumference
- STOP-BANG questionnaire.

The weights of patients were measured by the researcher using the same scale for all patients. This was a calibrated electronic Seca® scale obtained from the dietetics department at CHBAH. The scale was placed on a flat surface. Patients were weighed wearing a light weight theatre gown, to ensure weights closest to actual weight.

The patient's heights were measured by the reseacher using the same tape measure and identical method in order to standardise the results. The patients were asked to stand against a wall. A ruler held at 90 degrees to the wall was used to mark off the height. The straight line distance was then measured perpendicular to the floor using the tape measure. To measure neck circumference, the tape measure was placed around the patients neck just below the thyroid cartilage by the researcher (106).

The STOP-BANG questionnaire, consisting of eight questions with yes/no answers was completed by the researcher for each patient. Each yes answer is weighted one point. A score of equal to or greater than 3 confers a high risk of OSAS. An interpretor was not needed as all patients sampled were proficient in English.

3.5.5 Data analysis

All data recorded was captured on a Microsoft Excel spread sheet. The data was analysed in consultation with a bio-statistician using Stata version 13. Descriptive and inferencial statistics were used. Catergorical variables were summarised using frequencies and percentages. Continuous variables were summarised using means and standard

deviations and medians and interquartile ranges depending on the distribution of the data.

3.6 Validity and reliability of the study

Botma et al (107) defined the validity of a study as “the degree to which a measurement represents a true value” and the reliability of the study as “the consistency of the measure achieved”. This study was valid and reliable in that:

- an appropriate study design was used
- sample size was calculated in consultation with a bio-statistician
- the researcher collected all the data from patients
- the same equipment was used for all the patients
- standardised methods of measuring weight, height and neck circumference were used (76, 106)
- the BMI was measured using the internationally accepted formula (37)
- The STOP-BANG questionnaire which is a validated screening tool was used to assess the risk of OSAS in patients (23)
- data analysis was done in consultation with a bio-statistician.

3.7 Summary

In this chapter the problem statement, aims and objectives, ethical considerations, research methodology and the validity and reliability of this study were discussed. Discussion of the research methodology included the research design, study population, study sample, data collection and data analysis.

Chapter Four: Results and discussion

4.1 Introduction

This chapter presents the results of the study, as defined by the objectives, and a discussion thereof.

The primary objectives of this study were to:

- describe the BMI of adult patients undergoing elective surgery
- describe the risk of OSAS using the STOP BANG questionnaire.

The secondary objectives of this study were to:

- compare the BMI with risk of OSAS
- compare the BMI with gender
- compare the BMI with age
- compare the risk of OSAS with gender
- compare the risk of OSAS with age.

4.2 Attaining the study sample and approach to data analysis

A total of 250 patients were needed for the study as determined by a bio-statistician. The data was collected over a period of 16 days, 2 weeks of which were consecutive in September 2013 and the remaining 2 days a week later during the month of October 2013. All 250 patients sampled were included in the study. Obesity was defined as a BMI ≥ 30 kg/m^2. A STOP-BANG score ≥ 3 conferred a risk of OSAS.

4.3 Demographic Data

Of the 250 patients in the study 153 (61.2%) were females and 97 (38.8%) males. There were 223 (89.9%) patients of black ethnicity. Other ethnic groups were, coloured 15 (6%), whites 10 (4%) and Indian 2 (0.8%). When broken down into age groups ≥ or < 40, 52 (53.6%) males and 112 (73.2%) females were ≥ 40 years old. Table 4.1 demonstrates this.

Table 4.1 Demographic data

	Number	Percentage
Gender		
Male	97	38.8 %
Female	153	61.2 %
Ethnicity		
Black	223	89.2 %
Coloured	15	6 %
White	10	4 %
Indian	2	0.8 %
Age		
< 40	86	34.4
≥ 40	164	65.6%

4.4 Description of BMI

The first primary objective was to describe the BMI of adult patients undergoing elective surgery. Of the sample, 81 (32.4%) patients had a BMI of ≥ 30 and were classified as obese. There were 69 (27.6%) obese females and 12 (4.8%) obese males in the study sample. The gender distribution by BMI classification for the sample is shown in Figure 4.1.

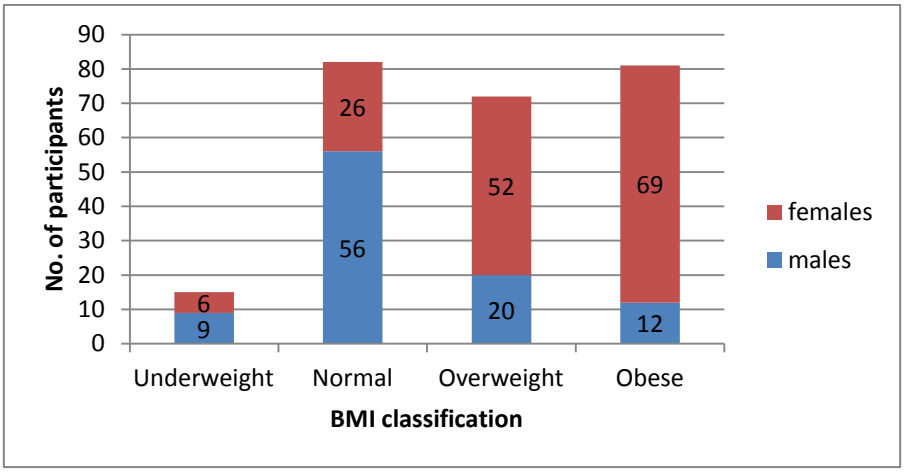


Figure 4.1 Gender distribution by BMI classification

4.5 Risk of OSAS

The second primary objective was to describe the risk of OSAS using the STOP-BANG questionaire. A STOP-BANG score of < 3 was attained by 205 (82%) patients and ≥ 3, indicating a risk for OSAS, in 45 (18%) patients. Of these 45 patients 22 (48.9%) had a BMI of < 30 and 23 (51.1%) had a BMI ≥ 30.

4.6 BMI and the risk of OSAS

The first secondary objective was to compare BMI with the risk of OSAS. A Chi-square test revealed statistically significant relationships between BMI and risk of OSAS, with lower risk being associated with a lower BMI (χ^2 [1] = 8.77, p = 0.003). This is shown in Table 4.2.

Table 4.2 Relationship between BMI and risk for OSAS

	OSAS		
BMI	**At risk**	**Not at risk**	**Total**
≥ 30	23	58	81
< 30	22	147	169
Total	45	205	250

(p = 0.003)

Of the 81 obese patients, 23 (28%) were at risk of OSAS and of the 169 non obese patients 22 (13.02%) were at risk of OSAS.

4.7 BMI and gender

The next secondary objective was to compare BMI with gender. A Chi-square test revealed a statistically significant relationship between BMI and gender in the sample with a lower BMI being associated with being male (χ2 [1] = 29.03, p = 0.001). This is shown in Table 4.3.

Table 4.3 Relationship between BMI and gender

	Gender		
BMI	**Male**	**Female**	**Total**
≥ 30	12	69	81
< 30	85	84	169
Total	97	153	250

(p = 0.001)

Of the 81 patients who were found to be obese 12 (14.81%) were male and 69 (85.18%) were female.

4.8 BMI and age

The third secondary objective was to compare BMI and age. A Chi-square test revealed a statistically significant relationship between BMI and age. Obesity was associated with age older than 40 years (χ^2 [1] = 10.10, p = 0.001). This is shown in Table 4.4.

Table 4.4 Relationship between BMI and age group

	Age group		
BMI	**Age ≥ 40**	**Age < 40**	**Total**
≥ 30	61	20	81
< 30	97	72	169
Total	158	92	250

(p = 0.001)

4.9 Risk of OSAS and gender

The fourth secondary objective was to compare risk of OSAS with gender. A Chi-square test revealed a statistically significant relationship between risk of OSAS and gender. A lower risk of OSAS associated with being female (χ^2 [1] = 8.32, p = 0.004). This is shown in Table 4.5.

Table 4.5 Relationship between risk of OSAS and gender

	OSAS		
Gender	**At risk**	**Not at risk**	**Total**
Male	26	71	97
Female	19	134	153
Total	45	205	250

(p = 0.004)

4.10 Risk of OSAS and age

The fifth secondary objective was to compare risk of OSAS and age. A higher risk of OSAS is associated with an older age.

A Chi-square test revealed a statistically significant relationship between risk of OSAS and age. A higher risk of OSAS was associated with being ≥ 40 years of age (χ^2 [1] = 18.70, p = 0.001). This is shown in Table 4.6.

Table 4.6 Relationship between risk of OSAS and age

	OSAS		
Age	**At risk of OSAS**	**Not at risk of OSAS**	**Total**
≥ 40	42	116	158
< 40	3	89	92
Total	45	205	250

(p = 0.001)

4.11 Discussion

Obesity occurence and risk of OSAS in surgical patients at CHBAH had not previouly been investigated. It is important to determine these as the anaesthetic management needs to be tailored to both these conditions. These conditions also carry an increased morbidity and mortality peri-operatively. Screening for high risk can also help identify these patients and then provide them with counselling about lifestyle changes and nutritional advice they may have not otherwise received.

There is a paucity of literature on the occurrence of obesity in the surgical population globally. This is futher compounded by the fact that many studies were conducted in

patient populations that had specific characteristics, for example going for bariatric surgery. The global trends of obesity in the general population however, has been well studied. This study showed the occurence of obesity in the study population to be 32.4%. The United Nations produced a report in 2013 ranking countries in terms of their level of obesity. Mexico was ranked first with a 32.82% rate of obesity followed by the USA 31.83% and Syria with 31.64 % (46). Our population was thus on par with the most obese nations in the world

In 2012 the World Federation of Obesity released statistics showing that 10.6% of males and 39.2% of females were obese. In 2002 The South African Demographic Health Survey found 29% of men and 56% of women were classified as either overweight or obese. This was consistant with our findings of a higher percentage of obese females.

Factors that should be taken into consideration in our study were that the patients sampled were mainly from the South of Johannesburg, the majority being from the suburb of Soweto. This is a largely lower socio economic group. It is recognised that as communities become more urbanised their rate of obesity increases as unhealthy food, high in fat, is often cheaper and more easily available (62). Financial constraints in many families lead to diets consisting mainly of starchy carbohydates that are cheaper and more easily available. The societal and cultural considerations should also be taken into account. In this setting being well fed is reflected by your size and obesity may be seen as a sign of affluence and a man's ability to take care of his wife rather than a health risk. Higher weights are also associated with being HIV negative. In the African culture wide hips and big buttocks in a woman are seen as desirable characteristics by men and as a sign of fertility. Education in this population may also not be optimal. Education about a balanced diet, the need for exercise and the risks of obesity may not be well known or understood. (50, 51, 69)

There are few studies internationally that have attempted to document the occurrence of OSAS in the general population. The problems encountered in comparing these studies were that different questionnaires and screening tools were used in each study to assess the risk of OSAS. There is an incidence that ranges between 9 to 26% among these

studies. Very few studies documenting the prevalence of OSAS in the surgical population were identified.(4, 5, 20)

The estimated prevalence of OSAS in the American population is thought to be about 20% (4, 5). In the surgical population the risk of OSAS is thought to be higher. Finkel et al (4) studied the risk of OSAS in adult surgical patients and found 23.7% of patients to be at risk. This study used the apnoea risk evaluation system OSAS screening questionnaire. In our study population a risk of OSAS was found to be 18% which was considerably lower than that found by Finkel. We did however use a different screening questionnaire.

It is widely thought that OSAS is under diagnosed (3, 5, 108, 109). Finkel et al's (4) study looked at the prevalence of undiagnosed OSAS and found that 82% of patients screened had undiagnosed OSAS. This diagnosis was made based on using home sleep studies. Unfortunately due to lack of resources and difficulty in obtaining home sleep study devices we could not determine the prevalance of undiagnosed OSAS in our population.

It was of interest is to note in our study even patients that were not obese, were still at risk of OSAS.There were 23 (28%) obese patients who were at risk of OSAS and 22 (13.02%) non obese patients who were at risk of OSAS. This highlights the point that OSAS can be present outside the setting of obesity.Further support of this is provided by a Japanese study where Isiguro (110) found that facial skeletal abnormalities could also lead to OSAS even in the absence of obesity.

The risk of OSAS is usually higher in males, older age and obesity (111). Our study found this to be true with a lower risk associated with lower BMI ($p = 0.003$) and female gender ($p = 0.004$). A higher risk was associated with age ≥ 40 ($p = 0.001$).

Although there was a high occurence of obesity in the females there was a lower risk of OSAS. Of the females screened 12% were at risk of OSAS compared to 29% of males. This could be due to their body habitus. Although there was a greater percentage of obese females they carried their weight mainly in the abdominal area, hips and thighs and had neck circumferences that were lower.

OSAS is a well known association of obesity (19). In obese patients often there are para-pharyngeal fat deposits that increases pharyngeal collapsibility predisposing to OSAS. Increased abdominal wall deposits found in obese patients also decrease lung volumes, particularly functional residual capacity (FRC) which can directly influence upper airway size, contributing to upper airway narrowing and predisposing patients to OSAS, which affects anaesthetic practice (19) Obesity hypoventilation syndrome also effects the control of breathing and further attenuates OSAS. (32)

Hiestand et al (3) published data from the National Sleep Foundation poll which showed that 57% of obese individuals were at risk of OSAS. (3) Our study found that among the obese patients, 28% were at risk of OSAS which was significantly lower.

4.12 Conclusion

In this chapter the results of the study as defined by the objectives were presented followed by a discussion of the results.

Chapter Five: Summary, limitations, recommendations and conclusions

5.1 Introduction

In this chapter a summary, the limitations, reccommendations and conclusions of the study are presented.

5.2 Summary of the study

5.2.1 The aim of the study

The aim of this study was to describe the occurrence of obesity and risk of OSAS in adult patients going for elective surgery at the J.D. Allen and the Gynaecology Theatre Complex, at CHBAH

5.2.2 Objectives of the study

The primary objectives of this study were to:

- describe the BMI of adult patients undergoing elective surgery
- describe the risk of OSAS using the STOP BANG questionnaire.

The secondary objectives of this study were to:

- compare the BMI with risk of OSAS
- compare the BMI with gender
- compare the BMI with age
- compare the risk of OSAS with gender
- compare the risk of OSAS with age.

5.3 Methodology of the study

A prospective, contextual, descriptive study design was utilised. The study population was adult patients presenting to CHBAH for elective surgery in the disciplines of general surgery, orthopaedic surgery, plastic and reconstructive surgery, maxillo-facial surgery, urological surgery, gynaecological surgery, otorhinolaryngology and neurosurgery. In

consultation with a bio-statistician a sample size of 250 patients was needed to yield a sample size of approximately 100 obese patients assuming a 40% prevalence of obesity among this population. A convenience sampling method was used. Inclusion criteria for this study were adult patients 18 years and older, presenting for elective surgery and able to stand upright. Exclusion criteria for this study were patients declining to participate in the study and those with any medical condition which increases extracellular fluid and thus weight.

5.4 Main findings and summary of the study

This study confirms that 3 of the 8 risk factors for OSAS from the STOP-BANG questionnaire were present in the sample, namely obesity, age and gender. The occurrence of obesity, BMI ≥ 30, was found to be 32.4%. The risk of OSAS using the STOP-BANG sleep apnoea questionnaire was found to be 18%. When looking at the relationship of obesity and OSAS, 28% of obese patients were found to be at risk of OSAS. A lower BMI was associated with male gender (p=0.001) and age less than 40 years (p=0.001). Lower risk of OSAS was associated with lower BMI (p=0.003) and female gender (p=0.004). Higher risk of OSAS was associated with age ≥ 40 years (p=0.001).

5.5 Limitations of the study

The study was contextual and focused only on patients presenting for surgery at CHBAH, which services mainly the black population of Soweto. The results of the study may not be generalised to other communities.

The risk of OSAS was only assessed by using the STOP-BANG questionnaire, and no formal diagnosis of OSAS was made, due to financial constraints.

Convenience sampling was used which may have lead to over or under estimation of certain variables in the population.

The sample size was not calculated to accommodate the secondary objectives. The results of these objectives should therefore be interpreted with caution.

5.6 Recommendations from the study

5.6.1 Recommendations for clinical practice

A high index of suspicion of OSAS in obese and non obese patients must be entertained in patients presenting for surgery, as both obesity and OSAS are associated with a higher risk of peri-operative morbidity and mortality. Patients should have anthropometric measurements routinely done, from which BMI should be extrapolated. Patients should also be questioned about snoring and the STOP-BANG questionnaire should be routinely used in pre operative assessments. Patients at risk should be treated as having OSAS, as in our setting there are no resources to diagnose OSAS and a high proportion of OSAS has been found to be undiagnosed. The peri-operative management of these patients must be modified to limit the use of opioids and place these patients in a high care environment post operatively so that desaturations, hypopnoeas and apnoeas may be detected. The patients should also be referred to a sleep physician for further management and be counselled adequately about their condition. Obese patients should be referred to the dieticians to ensure that they are well informed.

5.6.2 Recommendations for further research

Similar studies carried out at various hospitals around the country will give a more holistic view of the burden of disease. While the occurrence of obesity has been identified in a previous study in 2002 (50), there is no current data regarding this. There is also no data regarding the burden of obesity in the surgical population.

A study should also be conducted to validate the use of the STOP-BANG questionnaire in the South African surgical patient population.

There are no South African studies identified documenting OSAS, either in the general population or the surgical population to assess the burden of disease. More formal studies could be undertaken.

5.7 Conclusion

Obesity is a multi-system disease and has far reaching effects on all body systems. OSAS is associated with a constellation of problems. Obesity and OSAS are thus associated with significant morbidity and mortality. Anaesthetists need to be aware of both conditions and actively screen for them. When either or both conditions have been identified it is important to carefully tailor an anaesthetic plan to prevent morbidity and mortality. In our study we showed that the surgical population have an occurrence of obesity comparable to the most obese nations in the world. Our study also showed a risk of OSAS of 18% which was comparable to other studies in the USA. Obesity and OSAS is a growing concern in our population and more awareness of these conditions and their complications needs to be created.

List of abbreviations

OSAS- obstructive sleep apnoea syndrome

WHO- world health organisation

CHBAH- Chris Hani Baragwanath Academic Hospital

BMI- body mass index

USA- United States of America

NHS-National Health Statistics

TNF α- tumour necrosis factor alpha

CDC- Centers for Disease Control and Prevention

REM- rapid eye movement

ESS- Epworth Sleepiness Scale

NREM- non-rapid eye movement

REM- rapid eye movement

API- apnea hypopnea index

CPAP- Continuous positive airway pressure

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Appendix 1: Data collection sheet

Participant number _____

Gender	
Male	
Female	
Age	
Ethnicity	
Black	
White	
Asian	
Other	

Anthropometric data	
Height (m)	
Weight (kg)	
BMI (kg/m^2)	
Neck (cm)	

STOP- BANG Sleep Apnea Screening Questionnaire	Yes	No
1. Do you SNORE loudly (louder than talking or loud enough to be heard through closed doors)?		
2. Do you often feel TIRED, fatigued, or sleepy during daytime?		
3. Has anyone OBSERVED you stop breathing during your sleep?		
4. Do you have or are you being treated for high blood PRESSURE?		
5. BMI more than 35?		
6. AGE over 50 years old?		
7. NECK circumference > 15.75 inches? (39.375cm)		
8. Male GENDER?		

≥3 yes answers: High-risk for OSA

<3 yes answers: Low-risk for OSA

Appendix 2 : Participant Information leaflet

Hello, my name is Kamini Naidoo. I am a registrar in the Department of Anaesthetics at the University of Witwatersrand. I am currently doing my Masters degree in Anaesthesiology. This page will assist you understanding my study. I would like to invite you to participate in my research study entitled “The occurrence of obesity and risk of obstructive sleep apnoea in adult patients presenting for elective surgery at an academic hospital”.

Before you agree to participate in this study, it is important that you understand the purpose of the study and what partaking will entail, and your right to withdraw from the study at any time. Should you not understand anything I will happy to answer any questions. You should not agree to take part unless you are satisfied about all the procedures involved.

If you decide to take part in this study you will be asked to sign this document to confirm that you understand the study.

The purpose of the study is to find how many people are overweight and snore among the patients presenting for surgery at Chris Hani Baragwanath Academic Hospital. The study will collect information from about 250 adult patients, patient over 18 years old, which need to have routine surgery. This will take about 15 minutes of your time.

If you agree to take part in this study, you will be taken to a private room where the measurement of your weight will be done. How tall you are will be measured. The distance around your neck will also be taken. All these results will be written on a page, but your name or any of your details will not be written down. These measurements will not be painful and will not harm you in any way. A short set of eight yes/no questions will also need to be answered. These will give an idea of whether you are likely to snore.

This information will help us to better treat patients coming for surgery as being overweight and snoring may have increased risk during surgery and anaesthesia. Should you be identified as being overweight you will be referred to the dieticians who will help you with a weight management programme.

Your participation in this study is entirely voluntary and you can decline to participate, or stop at any time, without stating any reason. Your withdrawal will not affect your access to other medical care.

This clinical study protocol has been submitted to the University of the Witwatersrand, Human Research Ethics Committee and written approval has been granted by that committee.

The study has been structured in accordance with the Declaration of Helsinki (last updated: October 2008), which deals with the recommendations guiding doctors in biomedical research involving human participants. A copy may be obtained from me should you wish to review it.

This study is sponsored by the Postgraduate Research Office at the University of the Witwatersrand, Faculty of Health Sciences. I do not have any financial or personal interests with this organisation that may bias my actions.

All information obtained during the course of this study, including hospital records, personal data and research data will be kept strictly confidential. Data that may be reported in scientific journals will not include any information that identifies you as a participant in this study.

The information might be inspected by the University of the Witwatersrand Human Research Ethics Committee (HREC). Therefore, you hereby authorise me to release your medical records and the University of the Witwatersrand, Human Research Ethics Committee (HREC). These records will be utilised by them only in connection with carrying out their obligations relating to this clinical study. Any information uncovered regarding your test results or state of health as a result of your participation in this study will be held in strict confidence. You will be informed of any finding of importance to your health but this information will not be disclosed to any third party in addition to the ones mentioned above without your written permission.

Appendix 3: Consent form

I hereby confirm that I have been informed by the study doctor, Kamini Naidoo, about the nature, conduct, benefits and risks of research study "The occurrence of obesity and risk of obstructive sleep apnoea in adult patients presenting for elective surgery at an academic hospital".

I have also received, read and understood the above written information (Participant Information Leaflet and Informed Consent) regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

PARTICIPANT:

Printed Name Signature / Mark or Thumbprint Date and Time

I, Kamini Naidoo, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

STUDY DOCTOR:

Printed Name Signature Date and Time

TRANSLATOR / OTHER PERSON EXPLAINING INFORMED CONSENT……**(DESIGNATION):**

Printed Name **Signature** **Date and Time**

Appendix 4 : Ethics approval letter

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Kamini Naidoo

CLEARANCE CERTIFICATE	**M120745**
PROJECT	The Prevalence of Obsesity and Obstructive Sleep Apnoea Syndrome in Adult Patients Presenting for Elective Surgery at an Academic Hospital
INVESTIGATORS	Dr Kamini Naidoo.
DEPARTMENT	Department of Anaesthesiology
DATE CONSIDERED	27/07/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

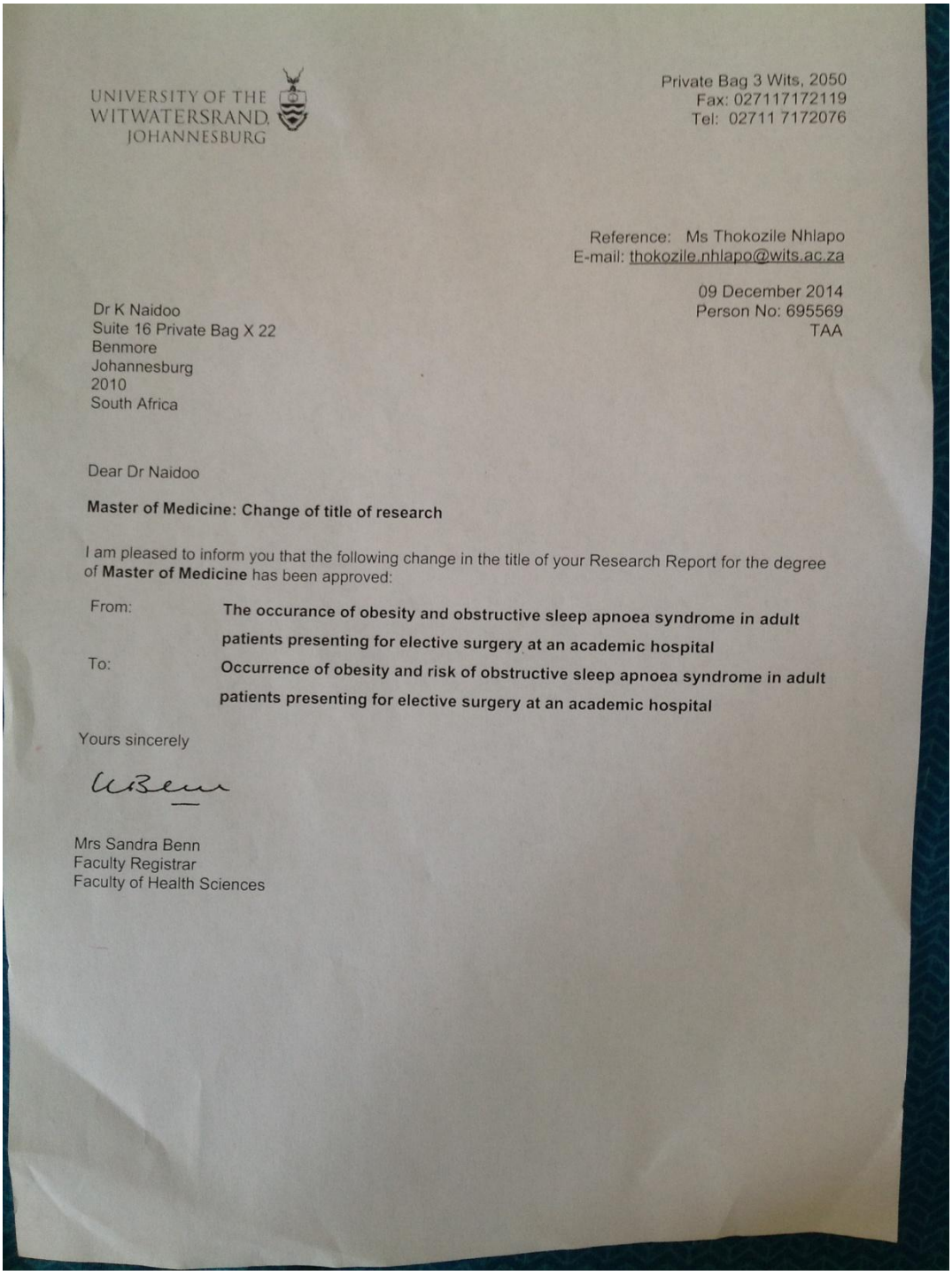
DATE 27/07/2012 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Ms Juan Scribante

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix 5: Post graduate approval letter



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 December 2014
Person No: 695569
TAA

Dr K Naidoo
Suite 16 Private Bag X 22
Benmore
Johannesburg
2010
South Africa

Dear Dr Naidoo

Master of Medicine: Change of title of research

I am pleased to inform you that the following change in the title of your Research Report for the degree of **Master of Medicine** has been approved:

From:	**The occurance of obesity and obstructive sleep apnoea syndrome in adult patients presenting for elective surgery at an academic hospital**
To:	**Occurrence of obesity and risk of obstructive sleep apnoea syndrome in adult patients presenting for elective surgery at an academic hospital**

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 6: Permission to conduct research

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 07 May 2013

TITLE OF PROJECT: The prevalence of obesity and obstructive sleep apnoea syndrome in adult patients presenting for elective surgery at an Academic Hospital

UNIVERSITY: Witwatersrand

Principal Investigator: Dr K Naidoo

Received by: K Naidoo

Department: Anaesthesiology

Date: 17/5/2013

Supervisor (If relevant): Ms J Scribante/ Dr D Lines

Permission Head Department (where research conducted): Yes

Date of start of proposed study: May 2013
Date of completion of data collection: December 2013

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

.....
Recommended
On behalf of the MAC)
Date: 07 May 2013

.....
Approved/Not Approved
Hospital Management
Date: 09/5/2013