THE EFFECT OF MATERNAL WEIGHT ON MISOPROSTOL INDUCTION OF LABOUR AT RAHIMA MOOSA MOTHER AND CHILD HOSPITAL

Dr Matefo Eileen Tsekeli

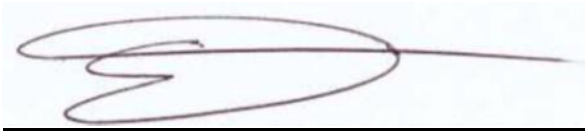
A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Masters in Medicine

Johannesburg 2019

Declaration

I, Matefo Eileen Tsekeli, declare that this Research Report is my own, unaided work. It is being submitted for the Degree of Masters in Medicine (MMed) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

_____



_____

(Signature of candidate)

23rd day of January 2020 in Johannesburg

Abstract

Background

Maternal obesity has become an epidemic that obstetricians manage daily. Obese women not only face long-term chronic medical conditions but they are also at an increased risk of developing maternal and neonatal adverse outcomes. In South Africa the proportion of reproductive age women who are overweight or obese is around 75%. This results in a large number of overweight or obese women requiring induction for pregnancy related medical conditions.

Methods

This was a retrospective comparative study looking at all normal, overweight and obese women who underwent induction of labour with oral misoprostol and their outcomes at Rahima Moosa Mother and Child Hospital between 01 July 2017 to 31 October 2017.

Results

The study included 185 women. Thirty-eight women had a normal BMI, 61 were overweight and 86 women were classified as obese. Of the medical conditions evaluated in the study participants, only gestational hypertension (p=0.02) and gestational diabetes (p=0.02) suggested a significant difference between the normal, overweight, obese groups.

In this study there were only 11 cases of failed induction of labour (5.9%). Seven of the 11 (8.1%) were found to be in the obese group. A total of 56.8% (n=105) of participants gave birth vaginally (NVD) and 43.2% (n=80) had a caesarean section performed. There was no significant difference (p=0.22) seen between the different BMI categories and the delivery outcomes observed. Seventeen babies were admitted to NICU, six in the obese group, seven in the overweight group and four in the normal BMI group. There was no statistical significant difference noted in the various BMI groups (p=0.19).

Conclusion

This study yielded a minimal difference between those who achieved normal vaginal delivery and those who had caesarean section between normal, overweight and obese women. Gestational hypertension and gestational diabetes were the only two conditions yielding a statistically significant difference in all the three BMI groups.

Acknowledgements

I would like to express my gratitude to the following people

1. Dr Susan Branch, my supervisor for her continuous support and patience through the process of the MMed
2. Christian Nyaundi for help with statistics

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ANC	Antenatal clinic
APH	Antepartum hemorrhage
APL	Active phase of Labour
APLS	Antiphospholipid syndrome
AROM	Artificial rupture of membranes
BMI	Body Mass Index
CI	Confidence interval
cm	Centimeter
CEO	Chief Executive Officer
CPD	Cephalopelvic disproportion
DVT	Deep vein thrombosis
END	Early neonatal deaths
FDC	Fixed dose combination
FSB	Fresh stillbirths
g	gram
GDM	Gestational diabetes mellitus
HELLP	Hemolysis, elevated liver enzymes, low platelet count
HIV	Human Immunodeficiency virus
ICU	Intensive care unit
IL-1β	Interleukin 1 beta
IL-6	Interleukin 6
IOL	Induction of labour
IQR	Inter-quartile range
IUFD	Intrauterine fetal death
IUFDs	Intrauterine fetal deaths
IUGR	Intrauterine growth restriction
kg	Kilogram
kg/m^2	Kilogram per meter squared
LPL	Latent phase of Labour

mcg	Microgram
MOU	Midwife obstetric unit
MSB	Macerated stillbirths
MUAC	Mid Upper Arm Circumference
NICE	National Institute for Health and Care Excellence
NICU	Neonatal intensive care unit
NTD	Neural tube defects
NVD	Normal vaginal delivery
OR	Odds ratio
PGE2	Prandin gel
POH	Poor obstetrics history
PPH	Post-partum hemorrhage
PPROM	Preterm premature rupture of membrane
PROM	Premature rupture of membrane
RMMCH	Rahima Moosa Mother and Child Hospital
RPC	Red packed cells
RVD	Retroviral disease
SD	Standard deviation
TNF-∝,	Tumour Necrosis Factor alpha
TTN	Transient Tachypnoea of the newborn
UK	United Kingdom
VEGF	Vascular Endothelial Growth Factor
VTE	Venous thromboembolism

Chapter 1 Introduction

Obesity is a state of malnutrition with far reaching health consequences for men, women and children. The degree of malnutrition can be quantified using the body mass index (BMI), which takes into account a patient's height and weight. A normal BMI is considered to be within 20 to 24.9 kg/m^2. Overweight is between 25 and 25.9 kg/m^2. Obesity is defined as having a BMI of 30 kg/m^2 or greater. Within the general category of obesity, there are three classes of increasing BMI that reflect increasing health risk; lowest risk is a BMI of 30 to 34.9 kg/m^2 (Class 1); medium risk is a BMI of 35.0- 39.9 kg/m^2 (Class 2) and highest risk is a BMI of 40 kg/m^2 or greater (Class 3) (1).

1.1 Prevalence of Obesity

Obesity is a worldwide epidemic. The prevalence is found to be higher in wealthy countries, but it is also seen to be increasing in developing countries, with severe consequences (2). Pregnancy is a well-recognized obesity trigger (3). It is shown that parous women have a higher incidence of obesity than nulliparous women (3). The incidence of maternal obesity is increasing worldwide and is associated with short and long-term complications for both mothers and babies during pregnancy, delivery and the post-delivery period (2). The prevalence of women with Class II and Class III BMI at any point in pregnancy in the United Kingdom (UK) is 4.99% (4). More than half of all pregnant women in the US are considered obese, with 8% being considered extremely obese (5).

Many developing countries are now experiencing a double burden of malnutrition (underweight women) together with an increased incidence of maternal overweight and obesity (2). The results of a systematic review and meta-analysis of 16 studies by Onubi *et al*. on maternal obesity in Africa showed that the prevalence of obesity ranges between 6.5 and 50.7% (2). In addition, sub-Saharan Africa has the highest global neonatal mortality rate and the slowest progress in reducing maternal mortality as set out in the millennium development goals (2). Approximately, one in four maternal deaths result from pre-existing medical conditions including obesity, hypertension and diabetes (2).

Studies conducted in Ghana, Egypt, Tanzania, and Nigeria using pre-pregnancy or first trimester measurements suggest obesity prevalence between 9.0 and 17.9% (2). Those using 'booking dates' (antenatal registration) imply 6.5 - 44%, while third trimester reports indicate prevalence between 14.0 and 50.7% (2). The study by Adebami *et al*. done in Nigeria, while not specifying gestational age, reported a prevalence of 17.8% (6). Two other studies done in South Africa using 'BMI adjusted for gestational age' reported obesity prevalence at 33.1 and 33.5%, respectively (2). The study with the highest prevalence was measured among pregnant women scheduled for caesarean section (7).

A study by Koyanagi *et al.* assessing maternal obesity at booking in seven countries: obesity prevalence was estimated as 6.5% in the Democratic Republic of Congo, up to 31.7% in Nigeria (8). Also, of note in the same study, maternal obesity (using BMI measured in first trimester) increased from 2.4 to 7.3% over a nine year period in Tanzania (2).

1.2 Obesity in pregnancy

Obesity in pregnancy has been shown to be associated with a longer gestation and a significantly increased risk of post-term delivery, which contributes to the greater need for induction of labour for prolonged pregnancy (9).

Maternal obesity increases the risk of a number of pregnancy complications (10). There is an increased risk of hypertensive disorders during pregnancy, including preeclampsia, with an odds ratio (OR) of between two and three (11). The risk increases linearly as BMI increases (9). Maternal obesity is also associated with an increased risk of diabetes, both pre-gestational and gestational diabetes mellitus (GDM). Compared with normal weight women (BMI less than 25 kg/m^2), a recent meta-analysis of 20 studies demonstrated that the OR of developing GDM was 2.14 (95% CI, 1.82-2.53), 3.56 (95% CI 3.05-4.21) and 8.56 (95% CI 5.07-16.04) among overweight, obese, and severely obese women respectively (10). These two conditions are more likely to require IOL for medical reasons.

There is study done in Canada in 2014 by Vinturache *et al.* on perinatal outcomes of term infants of overweight and obese mothers (12). It explored the relationship between outcomes such as infant birth weight, Apgar score, admission to neonatal intensive care unit (NICU) and newborn duration of hospitalization compared to maternal BMI prior to pregnancy (12). The study found that 10% of the infants were macrosomic, 1.5 % had a low Apgar score (less than 7 at five minutes), 6% were admitted to intensive care and 96% were discharged within 48 hours after delivery (12).

A study by Usha Kiran *et al*. found babies born to women with BMI more than 30 kg/m^2 appeared to be at an increased risk of birth trauma, more babies required admission to the neonatal unit and were more likely to require assistance with feeding and maintenance of body temperature (13). Problems associated with obesity (gestational hypertension and diabetes) may lead to medically indicated preterm birth (1).

1.3 Challenges with BMI in Pregnancy

The body mass index (BMI, kg/m^2) is currently the gold standard used to measure body fatness. However, in our setting pregnancy-associated weight gain and oedema, as well as late booking into antenatal care, throws into doubt the reliability of using the BMI to assess nutritional status in pregnancy. Mid-upper arm circumference (MUAC) has been used for many years to assess for malnutrition in children less than 5 years and several studies have shown a correlation between MUAC and BMI in adults (14).

The MUAC is a much simpler anthropometric measure than the BMI and is much easier to perform on a patient who is acutely unwell, bed bound or sedentary. An important advantage of using MUAC as a measure of pregnancy weight is that there is minimal change in the MUAC during pregnancy so as a result it may be a better indicator of pre-pregnancy body fat and nutrition than BMI (14) .

It has been found that MUAC strongly correlates with BMI in pregnancy up to 30 weeks of gestation. This was shown in women attending Metro West maternity services in the Western Cape. It was also found that in low-resource settings, the simpler MUAC measurement could reliably be substituted for BMI to assess nutritional status (14).Induction of labour

1.4 Induction of Labour

Induction of labour is a relatively common obstetric procedure. In 2004 and 2005, one in every five deliveries in the United Kingdom were as a result of induction (15). Induction of labour is often necessary for obstetric and medical reasons including preeclampsia, pre-gestational and gestational diabetes mellitus and postdates pregnancies. In the absence of other obstetric or medical indications, obesity alone is not an indication for induction of labour and a normal birth should be encouraged (15)

The NICE clinical guideline on inducing labour in 2008 found that, when labour was induced using pharmacological methods (whether or not surgical induction was also attempted), less than two thirds of women gave birth, with about 15% having instrumental delivery and 22% having emergency caesarean sections. Induction of labour has a large impact on the health of women and their babies and so needs to be clinically justified (15).

Induction of labour is associated with many obstetric complications, such as uterine tachysystole, fetal decelerations and non-reassuring fetal heart rates patterns on cardiotocography, meconium stained liquor, as well as an increased risk of uterine rupture (16). Caesarean section is associated with an increase in maternal morbidity and mortality. The greatest risk morbidities occur in women who have caesarean section after prolonged labour or prolonged rupture of membranes. Although this holds true in women of all weights, obese women in particular tend to have increased rates of complications in this setting (16).

In a study on the effect of maternal obesity on the rate of failed induction of labour by Wolfe *et al*. it was desired, given the risks associated with induction of labour, to quantify the rate of failed induction by obesity class and to specifically stratify by nulliparity, history of vaginal delivery, and fetal birthweight (16). This was done in order to be able to counsel patients on the likelihood of success when induction of labour is recommended for obese patients. The study demonstrated that obese women are twice as likely to experience a failed induction when compared to women of normal weight. In addition, the degree of obesity greatly affects the rate of failed induction with class III women who have a 2.89

adjusted odds ratio. The parity of the patient including the fetal weight also play an important role in the prediction of the induction outcome. It was concluded in this study that these finding were important in assisting the clinician in counselling obese women regarding the likely outcomes of induction (16).

1.5 Methods of Induction of labour

Methods available for induction of labour include non-pharmacological cervical ripening, mechanical modalities, surgical methods as well as pharmacological cervical ripening methods (17). Pharmacological modalities include prostaglandins, misoprostol, mifepristone, relaxin, and oxytocin. Prostaglandins act on the cervix to enable ripening by a number of different mechanisms. They alter the extracellular ground substance of the cervix, and PGE2 increases the activity of collagenase in the cervix. They cause an increase in elastase, glycosaminoglycans, dermatan sulphate, and hyaluronic acid levels in the cervix resulting in cervical ripening. A relaxation of cervical smooth muscle facilitates dilatation. Prostaglandins allow for increase in intracellular calcium levels, causing contraction of myometrial muscle. Risks associated with the use of prostaglandins include uterine hyperstimulation and maternal side effects such as nausea, vomiting, diarrhoea and fever (17).

Misoprostol is a synthetic prostaglandin E1 analogue that has found to be a safe and inexpensive agent for cervical ripening although it is not labelled by the United States Food and Drug Administration for the purpose (17). Clinical trials indicate that the optimal dose and dosing interval is 25 mcg intravaginally every four to six hours (18). Higher doses or shorter dosing intervals are associated with a higher incidence of side effects, especially hyperstimulation syndrome, defined as contractions lasting longer than 90 seconds or more than five contractions in ten minutes. Risks also include tachysystole, defined as six or more uterine contractions in ten minutes for two consecutive ten minute periods, and hyper-systole, a single contraction of at least two minutes duration. Finally, uterine rupture in women with previous caesarean is also a possible complication, limiting its use to women who do not have a uterine scar (17).

The Cochrane reviewers concluded that the use of misoprostol resulted in an overall lower incidence of caesarean section. In addition, there appears to be a higher incidence of vaginal deliveries in 24 hours of application and a reduced need for oxytocin augmentation (19). Additional review of the literature indicates that misoprostol is an effective agent for cervical ripening (17).

The definition of failed induction of labour is controversial, there is a lack of a generally accepted definition. In the teaching hospitals of the University of the Witwatersrand it is defined as failure to establish labour after two cycles of oral misoprostol (20). Uterine rupture, due to excessive uterine stimulation, at the time of induction is unusual but may occur as a complication after induction of labour (15).

1.6 Maternal Obesity and induction of labour

Obese women are more likely to require induction and to have a failed induction of labour (21). A high BMI is often associated with a decreased likelihood of spontaneous onset of labour at term. This is due to several biological dysfunctions of labour that obese women experience. The myometrium has decreased gap junction formation, decreased oxytocin receptor expression, decreased myometrial action potential size and duration, and lipotoxicity leading to increased reactive oxygen species. This results in reduced contractility of the myometrium and abnormal uterine function in obese women. There is also disrupted cervical ripening, altered placental preparation for labour, oestrogen/progesterone signalling changes, and prostaglandin E2 insensitivity. There is a decrease in normal spontaneous rupture of membranes (21).

A study by Ruhstaller in 2015 showed the rate of induction of labour rose steadily between the 1990s and 2000s to a peak of 23.8% in 2010. In obese women this rate is significantly increased and is positively correlated to the class of obesity. In class 1 obesity the induction of labour rate is 30.4%, while 34.0% of women with class 3 obesity required an induction of labour (22).

Obesity is associated with an increased rate of failed induction of labour requiring caesarean delivery, specifically for nulliparous obese women. The odds ratio of failed induction of labour is significantly higher among women with BMI greater than 30 kg/m^2. The rate of failure of induction also increases progressively with increased classes of obesity. Women with class 1 and 2 obesity who underwent induction of labour required a caesarean delivery 20.2% and 24.2% of the time, respectively, whereas women with a BMI of 40 to 50 kg/m^2 had a failed induction rate of 31.6% and as high as 63.2% in women with a BMI more than 60 kg/m^2 (22).

Together with the increased risk of failed of labour induction, other factors including narrowing of the birth canal by increased maternal pelvic soft tissue, fetal macrosomia and cephalopelvic disproportion increase the risk of caesarean and operative vaginal delivery (23).

With such high rates of failure and significant consequences for both the mother and infant providers would likely be interested in knowing if there are specific labour induction agents or methods that are more likely to result in a vaginal delivery for an obese patient. Unfortunately, there are only a few studies that have specifically compared the outcomes of different induction methods for obese women. Misoprostol (PGE1) appears to be a more effective induction agent than dinoprostone (PGE2) in obese women. There is also a difference in the labour progression and medication requirements when comparing non-obese to obese women who receive misoprostol (22). A study by Pevzner *et al*. in 2009 showed obese women take longer to deliver than non-obese women by up to four hours for morbidly obese patients (24). Additionally, obese and morbidly obese women receiving misoprostol had a higher rate of caesarean delivery for all indications, 29.8% and 36.5%, respectively, than non-obese women receiving misoprostol, 21.3%. In conjunction with having an increased rate of labour induction failure, obese women have higher utilization of oxytocin than normal weight women (22).

With regards to prostaglandin induction of labour, the failure of induction and the need for caesarean section occurs in 3.9% of obese class I and II women and in 5.7% of women with class III obesity. In another study of Oral misoprostol for induction of labour the rate

was 20.2% and 24.2%, respectively. Also women with a BMI of 40-50 kg/m^2 had a failed induction rate of 31.6% and women with a BMI of more than 60kg/m^2 presented an induction of labour failure rate as high as 63.2%. These facts reveal a gap in the knowledge about specific labour induction agents or methods more likely to result in vaginal delivery in obese patients. It is thought that the volume of distribution for administered prostaglandin or oxytocin is greater in obese women when compared to lean women. As a result, obese women may need more oxytocin or prostaglandin to reach the effective concentration in the body (25).

In a study, by Wolfe *et al.,* on the effect of maternal obesity on the rate of failed induction of labour, it was again demonstrated that obese women are twice as likely to experience a failed induction when compared to women of normal weight. The parity of the patient including the fetal weight was also shown to play an important role in the prediction of the induction outcome. The findings of this study are important in assisting the clinician in counselling of obese women regarding the likely success of induction (16).

Chapter 2 Aim and Objectives

2.1 Problem statement

Maternal obesity has become an epidemic that obstetricians manage daily. Obese women not only face long-term chronic medical conditions but they are also at an increased risk of developing maternal and neonatal adverse outcomes (21) .

In South Africa the proportion of reproductive age women who are overweight or obese is approximately 75% (26). This results in a large number of overweight or obese women requiring induction for pregnancy related medical conditions. At the Rahima Moosa Mother and Child Hospital, oral misoprostol is used for induction of labour at 20 mcg two hourly for 12 doses per cycle over a 24 hour period. This mode of induction of labour is cheap and effective. It is easily stored at room temperature with few systemic side effects. The absence of local data looking at the effect of maternal obesity on induction of labour necessitates this study.

2.2 Study Objectives

2.2.1. To describe the demographics of women undergoing induction of labour at Rahima Moosa Mother and Child Hospital.

2.2.2 To describe maternal outcomes of induction of labour with oral misoprostol in normal and overweight compared to obese women.

2.2.3 To describe neonatal outcomes of babies born to obese women after induction of labour with oral misoprostol.

Chapter 3 Methods

3.1 Study Setting

Rahima Moosa Mother and Child Hospital (RMMCH) is a regional academic hospital situated in Newclare, Johannesburg. Approximately 700 normal vaginal deliveries and 400 caesarean section deliveries are performed each month including both high and low risk pregnancies. The hospital serves a population of approximately 200 000 people from region A, B and C. These include: Midrand, Diepsloot, Randburg, Northcliff, Rosebank, Parktown, Northgate and Roodepoort. This is an urban population, low to middle-income therefore most are dependent on state health care services. The hospital receives referrals from two midwife obstetric units (MOU's) and 20 clinics. There are no secondary hospitals within the region thus all high-risk pregnancies are referred to RMMCH.

Inductions are conducted in a separate room in the antenatal ward. It contains four beds, thus only four patients are induced at any one point in time. This ensures that fetal monitoring is performed adequately and these patients are assessed frequently throughout the induction process. Inductions may also take place in a high care area for high risk pregnancies (including severe pre-eclampsia, eclampsia). Patients who require continuous fetal monitoring are induced in labour ward.

Protocols regarding induction of labour which have been drawn up by the Department of Obstetrics and Gynaecology of the University of the Witwatersrand are followed at RMMCH (Appendix B). Failed induction of labour is the inability to achieve the active phase of labour according Banos *et al.* (27).

3.2 Study Design

This was a retrospective comparative study looking at all women who underwent induction of labour with oral misoprostol and their outcomes.

3.2.1 Study Population

The study included all women who underwent induction of labour with oral misoprostol at Rahima Moosa Mother and Child Hospital between 01 July 2017 and 31 October 2017. The sample size was that of convenience. Around eighteen women underwent induction of labour per week, for a period of four months, and therefore a sample size of about 288 was expected.

3.2.2 Inclusion Criteria

All women who received oral misoprostol (200 mcg in 200mL water: given 20mL 2-hourly orally for 12 doses or until labour starts) for induction of labour during the study period, singleton pregnancies including live babies and intrauterine fetal deaths (IUFDs) were included, at 37 to 41 weeks gestation, cephalic presentation, pre-labour rupture of membranes. All high-risk pregnancies were also included.

3.2.3 Exclusion Criteria

Preterm inductions (less than 37 weeks) were excluded from the study. Induction of labour using other forms of induction i.e. prandin gel (PGE2), bulb catheter, oxytocin, artificial rupture of membranes (AROM) were also excluded.

3.3 Data Collection

There is no patient register kept for patients induced at RMMCH. Therefore, all records of patients who delivered from the period 01 July 2017 – 31 October 2017 had to be reviewed. This was achieved by obtaining the birth registry and pulling files from records of all deliveries which occurred during the study period. Details of the neonatal outcomes were retrieved from the maternal records and the neonatal registry. All data was captured on a data sheet (Appendix A) under the following categories: maternal characteristics, outcomes of induction of labour, delivery outcomes and neonatal outcomes.

3.4 Data Analysis

All data was captured from data sheets using Redcap and then exported to Microsoft Excel. Stata 11 software was used for statistical analysis. Continuous data were tested for normality. Where applicable the data are presented as means and standard deviations. Categorical data are presented as proportions and frequencies. The Chi-squared test was used to assess the relationship between categorical variables. A 95% confidence interval was used to analyze all data. A p-value of less than 0.05 was deemed significant.

3.5 Definitions

The Body Mass Index (BMI) was classified according to WHO guidelines and was determined and interpreted as follows:
Below 18.5 kg/ m^2 = Underweight; 18.5-24.9 kg/ m^2 = Normal weight; 25.0-29.9 kg/ m^2 = Overweight; Greater than 30.0 kg/ m^2 = Obese.

3.6 Ethics Approval

The research protocol was submitted and approved by the University of Witwatersrand's Human Research Ethics committee (M180327) (Appendix C) and institutional approval was obtained from the CEO of Rahima Moosa Mother and Child Hospital.

3.7 Funding

Costs for the study were minimal as the study was a retrospective study. Costs included stationery and printing costs which were covered by the principal investigator.

Chapter 4 RESULTS

4.1 Sample Size

There were 4203 deliveries in total, 3080 files were found and 1128 files were not found. Of the 3080 patient records found, 271 patients were induced with oral misoprostol. A total of 89 patients were excluded as they did not fit the inclusion criteria. A final total of 189 patients were analyzed.

A total of 271 patient records were reviewed that were induced with oral misoprostol during the period from 01 July 2017 – 31 October 2017. However, a total of 86 (31.7%) patients had to be excluded. Of the patients excluded: 57 patients were excluded due to no height being recorded on the antenatal card; 9 patients were excluded due to the concurrent use of prandin gel and oral misoprostol; 12 patients went into spontaneous labour prior induction with oral misoprostol; 3 patients were less that of 37 weeks of gestation; 1 patient had received misoprostol concurrent with a catheter bulb for IOL, and 4 patients were classified as having an underweight BMI.

4.2 Summary of medical characteristics of participants

A total of 185 women were therefore included in this study: 38 women were classified with a normal BMI, 61 women were overweight, and 86 women were obese. Figure 4.1 shows the BMI categories of all the current study participants.

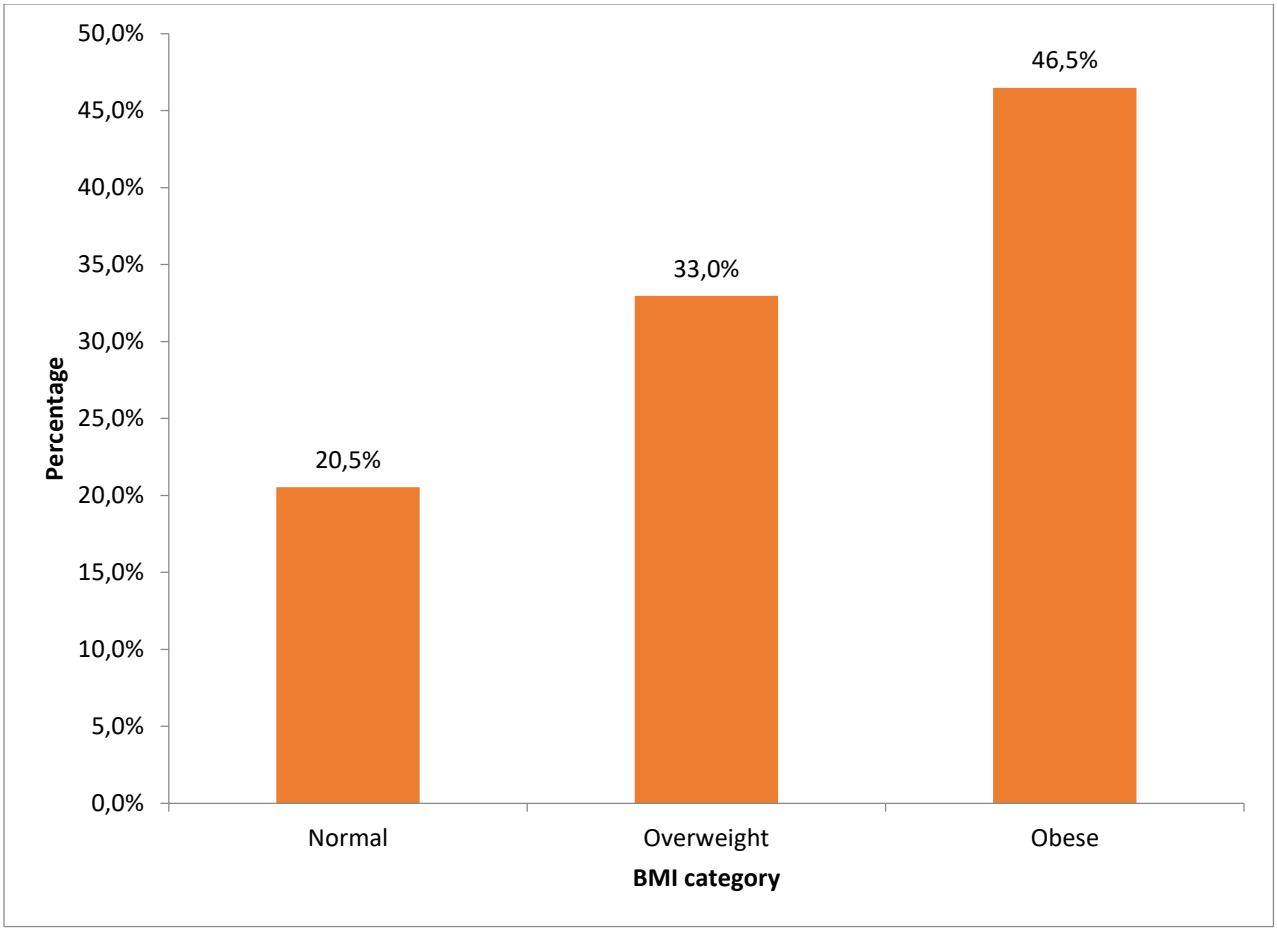


Figure 4.1 Categories amongst the study participants (N=185)

Table 4.1 below provides a summary of the demographics and medical data collected from all the study participants as represented on their antenatal cards. Participants were predominantly African (n=162) 87.6%, with the least prevalent races being Asian, Caucasian and Indian (n=4) 2.2% respectively. The age range of the study participants was 15 to 43 years with a median age of 28 years. Obese patients were the eldest category of patients in the study with a mean age of 30.3 years (SD = 6.2 years) and the youngest were the normal BMI category with 25.7 years (SD = 5.2 years).

Almost all women (n=183) 98.9% were booked at the antenatal clinic (ANC) with the gestational age booking range of 5 to 38 weeks. A majority of the women used dates (n=115) 62.2% to determine gestational age, followed by booking palpation (n=65) 35.1%; with a minority (n=5) 2.7% of women using sonar (both early and late).

At the time of booking most women had a median maternal weight was 76kg, median maternal height of 160cm, and median BMI was 29.6 kg/m^2.

Table 4.1 General characteristics of the study participants (N=185)

Characteristics	**Normal BMI 18.5-24.9 kg/ m^2 n= 38 (20.5%)**	**Overweight BMI 25.0-29.9 kg/ m^2 n= 61 (33.0%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n= 86 (46.5%)**	**Total N=185 (100%)**	**p-value**
Age (years) Mean (standard deviation)	25.7 (5.2)	26.3 (6.0)	30.3 (6.2)	28.0 (6.3)	0.001
Ethnicity					
• African	32 (84.2%)	54 (88.5%)	76 (88.3%)	162 (87.6%)	
• Asian	0 (0%)	1 (1.6%)	3 (3.5%)	4 (2.2%)	0.55
• Caucasian	1 (2.6%)	1 (1.6%)	2 (2.3%)	4 (2.2%)	
• Coloured	4 (10.5%)	4 (6.6%)	3 (3.5%)	11 (5.9%)	
• Indian	1 (2.6%)	1 (1.6%)	2 (2.3%)	4 (2.2%)	
Gestational age at booking (weeks) Mean (standard deviation)	19.1 (7.8)	19.7 (8.1)	20.4 (8.0)	19.9 (8.1)	0.63
Maternal weight at booking (kg) Mean (standard deviation)	55.3 (7.0)	70.2 (7.2)	90.1 (13.2)	76.4 (17.3)	0.001
Maternal height at booking (cm) Mean (standard deviation)	158.8 (7.0)	159.5 (6.3)	158.4 (7.1)	158.9 (6.8)	0.70
BMI at booking (value) Mean (standard deviation)	22.9 (6.9)	27.5 (1.6)	35.9 (5.0)	30.5 (7.2)	0.001

The medical conditions of patients as reported on the antenatal card, or prior to induction of labour in the patient file, are presented in table 4.2. No patients reported cardiac issues. Approximately one third (n=63) 34.1% of the study participants reported that they were suffering from any of the listed medical conditions. Within these 63 study participants (obese: n=42; overweight: n=15; normal: n=6), the most prevalent reported medical condition was gestational hypertension (n=24) 38.1%, preeclampsia (n=16) 24.4% and chronic hypertension (n=11) 17.5%. Gestational hypertension (n=17) 40.5%, gestational diabetes (n=9) 21.4%, preeclampsia and chronic hypertension (n=8) 19.0% respectively were the most prevalent conditions listed by the affected 42 obese patients. Overweight patients (n=15) suffered mostly with gestational hypertension (n=6) 40.0% and preeclampsia (n=4) 26.7%, and chronic hypertension (n=3) 20.0% whilst patients with normal BMI (n=6) reported that they suffered mostly from preeclampsia (n=4) 66.7%.

Of the medical conditions evaluated, only gestational hypertension (p=0.02) and gestational diabetes (p=0.02) suggested an association between medical condition and BMI group.

Table 4.2 Medical conditions of patients recorded on the antenatal card and identified prior to the induction of labour (N=185)

Medical Indications	Normal BMI 18.5-24.9 kg/ m^2 n= 38 (20.5%)	Overweight BMI 25.0-29.9 kg/ m^2 n= 61 (33.0%)	Obese BMI ≥ than 30.0 kg/ m^2 n= 86 (46.5%)	Total N=185 β (100%)	P value
Chronic Hypertension	0 (0%)	3 (4.9%)	8 (9.3%)	11 (5.9%)	0.11
Epilepsy	0 (0%)	0 (0%)	1 (1.1%)	1 (0.5%)	0.56
Gestational Diabetes	0 (0%)	1 (1.6%)	9 (10.5%)	10 (5.4%)	0.02
Gestational Hypertension	1 (2.6%)	6 (9.8%)	17 (19.8%)	24 (13.0%)	0.02
Preeclampsia	4 (10.5%)	4 (6.6%)	8 (9.3%)	16 (8.6%)	0.67
Pregestational Diabetes	0 (0%)	0 (0%)	1 (1.1%)	1 (0.5%)	0.56
Other*	1 (2.6%)	2 (3.3%)	4 (2.3%)	7 (3.8%)	0.92
None	32 (84.2%)	46 (75.4%)	44 (51.2%)	122 (65.9%)	<0.001

*** - Listed other conditions by patients: Normal BMI= hypothyroidism (n=1); Overweight BMI = HELLP (n=1) and previous DVT (n=1); Obese BMI = RVD (n=1), APLS (n=1), HELLP (n=1), Diabetes Type II (n=1)**

β – certain instances more than one medical condition may have been listed by a participant and recorded.

At the time of attendance to the antenatal clinic, women were subjected to a panel of blood analyte profile testing which included: haemoglobin levels, Rhesus factor, Syphilis and HIV testing. The mean haemoglobin level of all patients was 12.0 g/dl (SD = 1.5 g/dl). Overall obese BMI category of women had haemoglobin levels of 12.2 g/dl (SD = 1.5 g/dl), overweight BMI was 12.0 g/dl (SD = 1.4g/dl), and the normal BMI category was 11.6 g/dl (SD = 1.6 g/dl). A majority of the women (n=184) 97.3% had a positive blood Rhesus factor. Only (n=3) 1.6% of the women tested positive for syphilis but (n=34) 18.3% tested positive for HIV. Of the HIV positive women, only one patient reported they were not on antiretroviral therapy. A majority (n=27) 79.4% of the HIV positive women were on efavirenz (600 mg) + emitrictabine (200 mg) + tenofovir (300 mg) which is a Fixed Dose Combination preparation (FDC). The profile of the outcomes of the blood test results of

all participants within their respective BMI categories is provided in Figure 4.2.

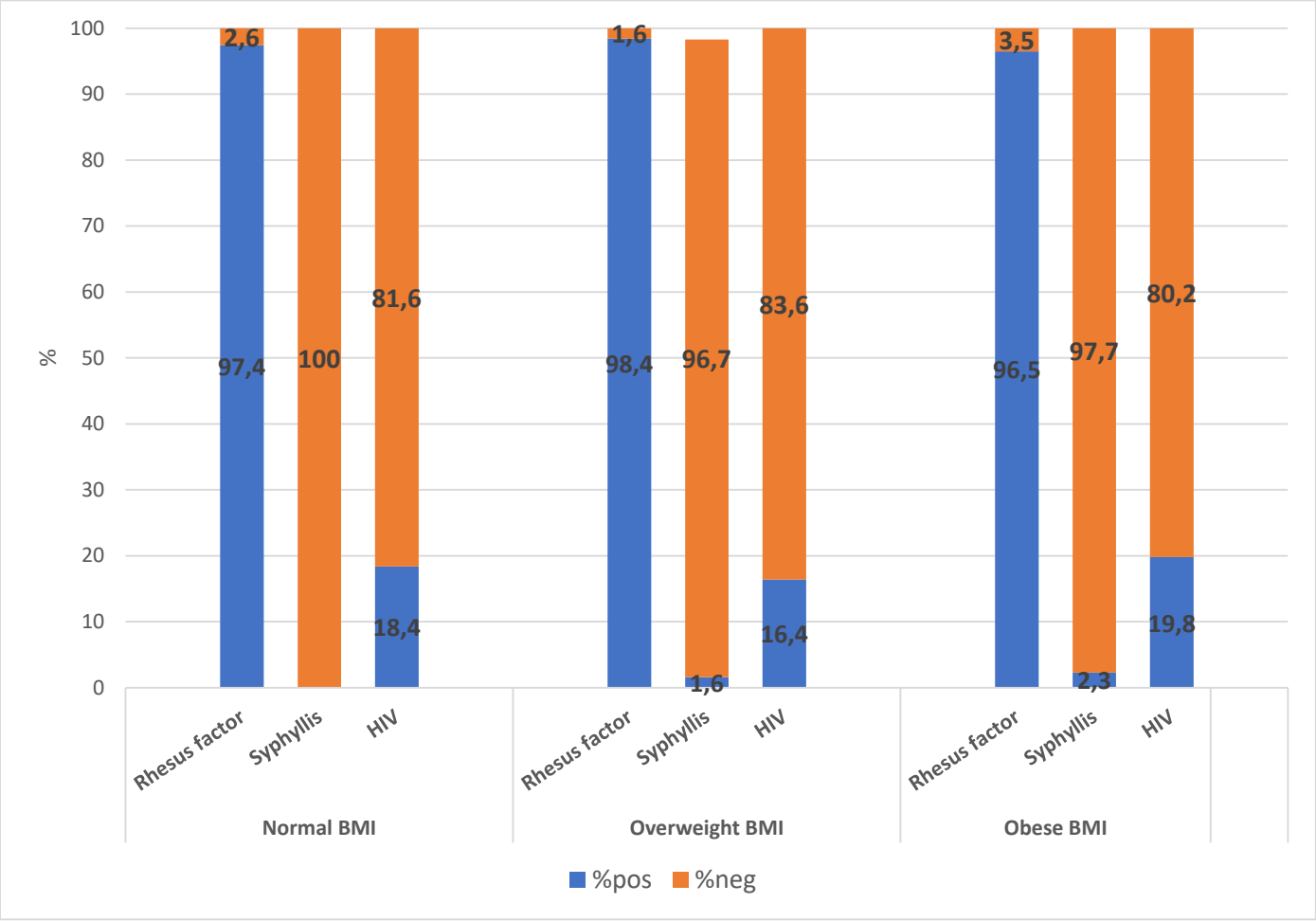


Figure 4.2 Profile of blood analyte testing of study participants (N=185)

4.3 Indications for Induction of Labour (IOL)

All women had oral misoprostol administered to induce labour. Table 4.3 highlights the number of maternal, fetal and combination (maternal and fetal) indications by participants. Less than 10% of women (in all BMI categories) had both maternal and fetal indications. Overall no notable differences were seen in the proportion of fetal indications seen in particular BMI categories of women, however two thirds of the normal BMI category highlighted women who had fetal indications.

Table 4.3 All indications of induction of labour (N=185)

Indications of induction of labour	**Normal BMI 18.5-24.9 kg/ m^2 n= 38 (20.5%)**	**Overweight BMI 25.0-29.9 kg/ m^2 n= 61 (33.0%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n= 86 (46.5%)**	**Total n=185 (100%)**
Maternal	14 (36.8%)	29 (47.5%)	42 (48.8%)	85 (45.9%)
Fetal	23 (60.5%)	29 (47.5%)	36 (41.9%)	88 (476%)
Maternal and fetal	1 (2.6%)	3 (4.9%)	8 (9.3%)	12 (6.5%)

4.3.1 Maternal indications

Of the 85 (45.9%) women who presented with maternal only indications for IOL; 49 women (57.6%) presented with a medical condition, and 36 women (43.3%) presented with prelabour rupture of membranes.

Table 4.4 highlights the proportion of women who experienced 10 different maternal indications in all respective BMI categories. Reviewing each BMI category, women were found to mostly suffer from preeclampsia (n=4) 66.7% within the normal BMI category; and gestational hypertension (n=4) 33.3% in the overweight category and (n=13) 41.9% obese categories. No issues relating to cardiac disease were noted in any patients.

Table 4.4 Maternal indication for induction of labour (medical condition) (n=49)

Medical condition of mothers who were induced	Normal BMI 18.5-24.9 kg/ m^2 n= 6 (12.2%)	Overweight BMI 25.0-29.9 kg/ m^2 n= 12 (24.5%)	Obese BMI ≥ than 30.0 kg/ m^2 n= 31 (63.3%)	Total n=49 (100%)*
APLS	0 (0%)	0 (0%)	1 (3.2%)	1 (2.0%)
Chronic Hypertension	0 (0%)	3 (25%)	6 (19.4%)	9 (18.4%)
Epilepsy	0 (0%)	0 (0%)	1 (3.2%)	1 (2.0%)
Gestational Diabetes	0 (0%)	1 (8.3%)	6 (19.4%)	7 (14.3%)
Gestational Hypertension	1 (16.7%)	4 (33.3%)	13 (41.9%)	18 (36.7%)
Hypothyroidism	1 (16.7%)	0 (0%)	0 (0%)	1 (2.0%)
Preeclampsia	4 (66.7%)	3 (25%)	6 (19.4%)	13 (26.5%)
Pregestational Diabetes	0 (0%)	0 (0%)	1 (3.2%)	1 (2.0%)
Previous DVT	0 (0%)	1 (8.3%)	0 (0%)	1 (2.0%)

* **in certain instances, one patient may have experienced more than one type of medical condition.**

4.3.2 Fetal indications

There were a total of four primary fetal indications noted i.e. Fetal Macrosomia, Oligiohydramnios, IUGR and post-dates, in the study population (refer to table 4.5). There a further six minor indications noted in some women and listed under the “other” category. A total of (n=17) 19.3% of the study population experienced a fetal indication other than post-dates and no cases of macrosomia were noted.

A Fishers exact test was applied to test for any significant association between the fetal indicator variable and BMI categories (excluding IUGR and Macrosomia variables which had no recorded data). No significant association between the remaining variables and the various BMI categories (p=0.46).

Table 4.5 Fetal indications for induction of labour (n=88)

Fetal indications	Normal BMI 18.5-24.9 kg/ m^2 n= 23 (26.1%)	Overweight BMI 25.0-29.9 kg/ m^2 n= 29 (33.0%)	Obese BMI ≥ than 30.0 kg/ m^2 n= 36 (40.9%)	Total n=88 (100%)	P value
IUGR	0 (0%)	1 (3.4%)	0 (0%)	1 (1.1%)	0.16
Oliogohydramnios	0 (0%)	2 (6.9%)	1 (2.8%)	3 (3.4%)	0.38
Post Dates	21 (91.3%)	20 (69.0%)	30 (83.3%)	71 (80.7%)	0.18
Other*	2 (8.7%)	6 (20.7%)	5 (13.9%)	13 (14.8%)	0.75

* **Fetal Indications Other category ~ Normal: Previous IUFD (n=2); Overweight: Polyhydramnios (n=1), reduced fetal movement (n=2), and previous IUFD (n=3); Obese: Fetal Tachycardia (n=1), APH at term (n=1), IUFD (n=3).**

4.3.3 Maternal and Fetal indications

There were a total of 11 women who had both maternal and fetal indications for IOL (i.e. 6 different indications). There was 1 patient, with a normal BMI, who suffered from scoliosis and the indication for induction was post-dates. The remaining 91.7% of these women [overweight (n=3) and obese (n= 7) BMI category of women] had a medical condition as an indication for IOL. These women also had a variety of fetal indications as well and are represented in figure 4.3.

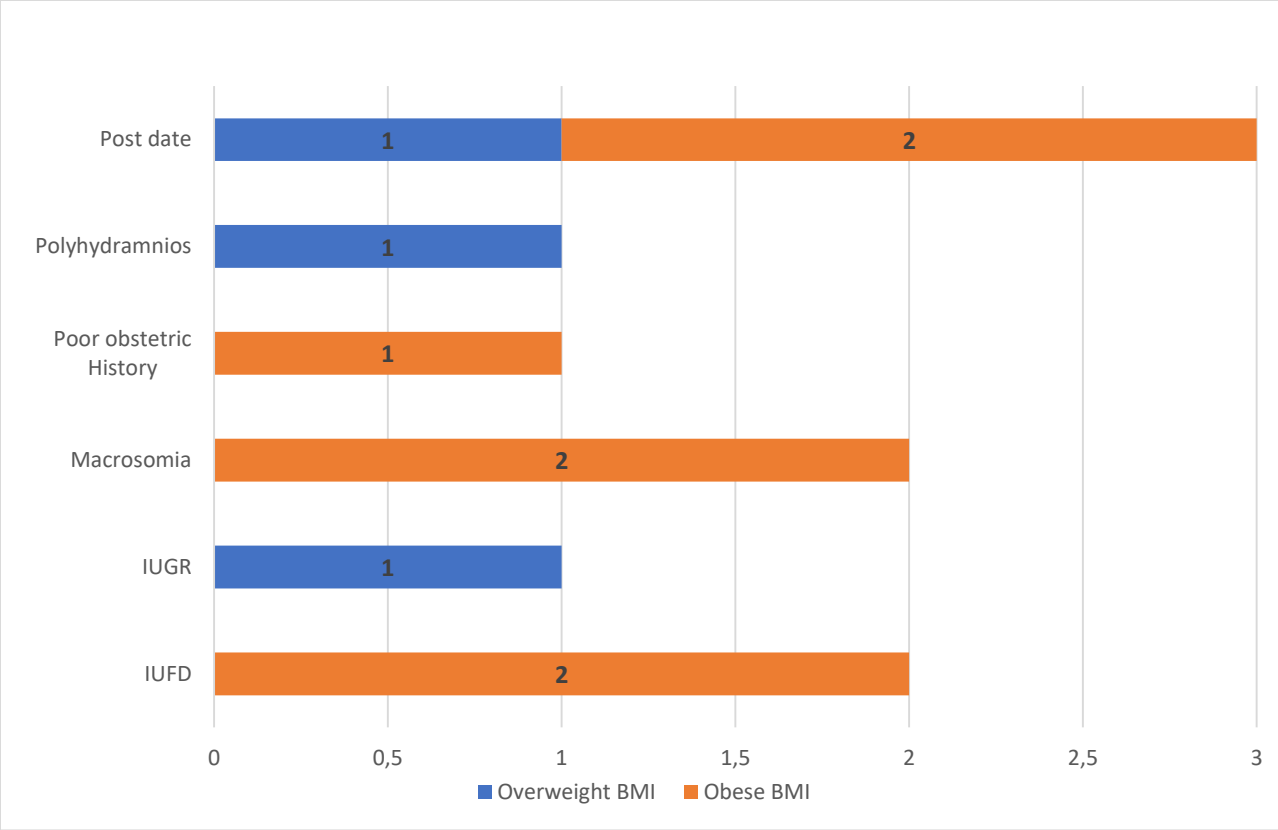


Figure 4.3 Fetal indications in women who experienced both maternal and fetal indications for IOL (n=11)

*** IUGR = intrauterine growth retardation; IUFD=intrauterine fetal demise**

4.4 Outcomes of Induction of labour (IOL)

Table 4.6 highlights the outcomes of induction of labour (IOL) in the study group. The median Bishop score for all women was 4 (inter-quartile range [IQR]: 2 – 5).

The minority of the women were in labour for more than 25 hours (n=38) 20% or not in labor at all (n=36) 19.5%. There was no significant statistical association between the amount of time taken to achieve labour between the various BMI classes of women (p=0.58).

No more than two cycles of Misoprostol were administered to women and the majority of women did not have a failed induction.

Table 4.6 Outcomes of induction of labour (N=185)

Characteristics	**Normal BMI 18.5-24.9 kg/ m^2 n= 38 (20.1%)**	**Overweight BMI 25.0-29.9 kg/ m^2 n= 61 (32.3%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n= 86 (45.5%)**	**Total N=185 (100%)**	**p-value**
Bishop score Median (inter-quartile range)	4 (3-6)	4 (3-5)	3 (2-4.8)	4 (2 – 5)	0.02
Number of cycles of oral misoprostol					
• One	35 (92.1%)	57 (93.4%)	76 (88.4%)	168 (90.8%)	0.62
• Two	3 (7.9%)	4 (6.6%)	10 (11.6%)	17 (9.2%)	
In labour:					
• Not in labour	7(18.4%)	9 (14.8%)	20 (23.3%)	36 (19.5%)	0.58
• 24 hours or less	23 (60.5%)	39 (63.9%)	49 (57.0%)	111 (60.0%)	
• 25 – 48 hours	6 (15.8%)	9 (14.8%)	10 (11.6%)	25 (13.5%)	
• 49 – 72 hours	2 (5.3%)	2 (3.3%)	2 (2.3%)	6 (3.2%)	
• Above 72 hours	0 (0%)	2 (3.3%)	5 (5.8%)	7 (3.8%)	
Failed induction					
• No	37 (97.4%)	58 (95.1%)	79 (91.2%)	174 (94.1%)	0.41
• Yes	1 (2.6%)	3 (4.9%)	7 (8.1%)	11 (5.9%)	

4.5 Delivery outcomes

The delivery outcomes of the women were tabulated and presented in table 4.7. There was no significant difference (p=0.22) seen between the different BMI categories and the delivery outcomes observed.

Table 4.7 Delivery outcomes of study participants (N=185)

Delivery outcome	**Normal BMI 18.5-24.9 kg/ m^2 n= 38 (20.1%)**	**Overweight BMI 25.0-29.9 kg/ m^2 n= 61 (32.3%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n= 86 (45.5%)**	**Total N=185 (100%)**	**P value**
Normal Vaginal Delivery	26 (68.4%)	31 (50.8%)	48 (55.8%)	105 (56.8%)	0.22
Caesarean section	12 (31.6%)	30 (49.2%)	38 (44.2%)	80 (43.2%)	

Only 8 cases (67.6%) of post-partum Hemorrhage (PPH) were found as a complication of delivery with only 4 women being provided with blood products (refer to Table 4.8).

Table 4.8 Cases of Post-partum hemorrhage in study participants (n=12)

Post-partum Hemorrhage (PPH)	**Normal BMI 18.5-24.9 kg/ m^2 n=3 (25 %)**	**Overweight BMI 25.0-29.9 kg/ m^2 n=5 (41.6%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n=4 (33.3%)**	**Total n= 12 (100%)**
PPH post NVD	1 (33.3%)	2 (40%)	2 (50%)	5 (42.6%)
PPH post Caesarean section	1 (33.3%)	2 (40%)	0 (0%)	3 (25%)
Packed Red cells given	1 (33.3%)	1 (20%)	2 (50%)	4 (33.3%)

No hysterectomies were performed in the study participants, and there were no incidents of uterine ruptures nor uterine dehiscence.

4.5.1 Normal Vaginal delivery (NVD)

Of the total number women in the study who delivered vaginally (NVD), 41 (61.2%) had a perineal tear, 24 (35.8%) had an episiotomy and only 2 (3.0%) women had a vacuum assisted delivery. Figure 4.4 presents the individual medical outcomes of NVD within each female BMI category.

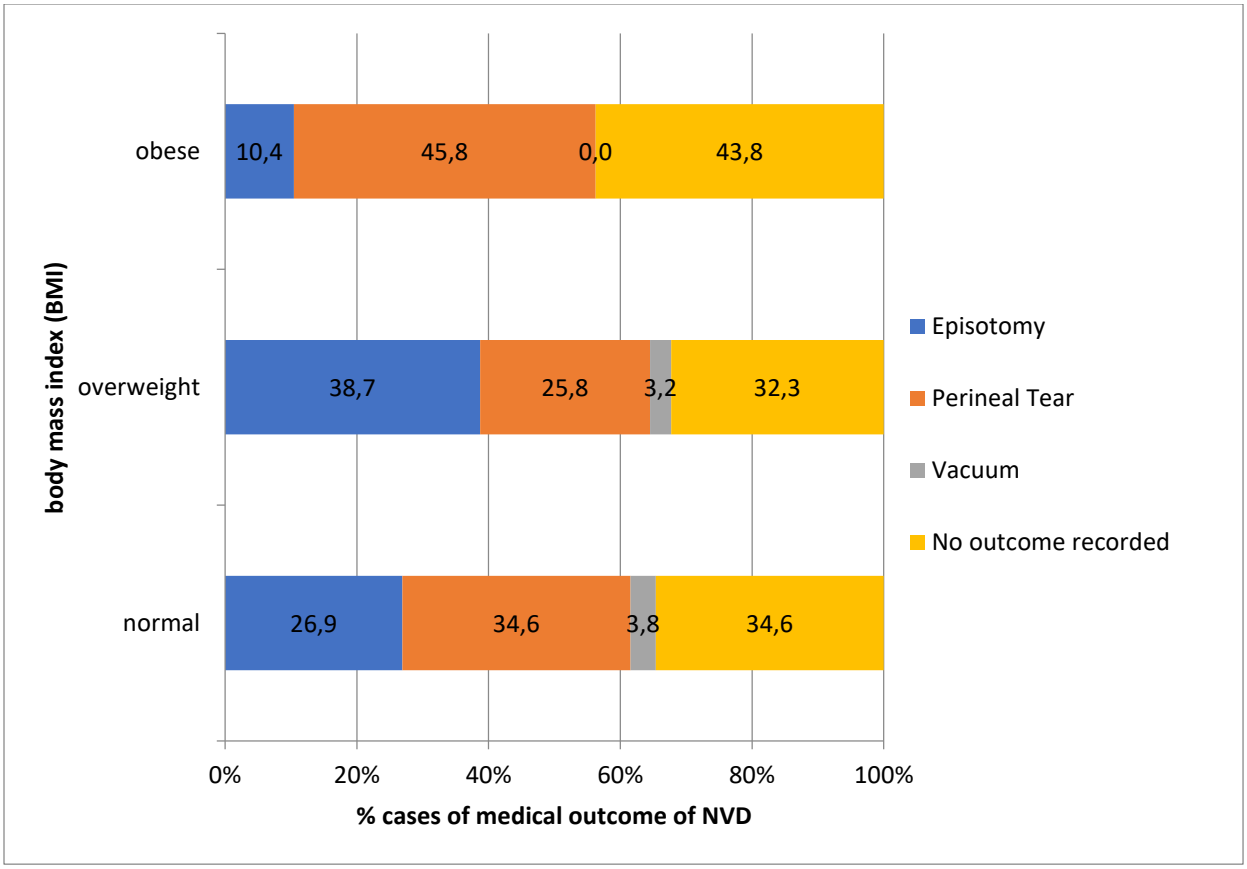


Figure 4.4 Detailed delivery outcomes for Normal Vaginal Delivery (NVD) cases of all BMI categories (n=105)

Perineal tears (n=39/105; 37.1%) were seen only during normal delivery within all BMI categories. The majority of tears, in all three BMI categories, were first degree (n=37/39; 94.9%).

4.5.2 Caesarean delivery

Table 4.9 summarizes all indications evaluated in (n=80) 43.2% patients undergoing a caesarean section and in certain instances multiple indications were noted in a single patient. A total of nine indications were noted with a further four minor categories noted under “other”. No patients however recorded APH or delayed second stage as an indication.

A total of (n=64) 75.0% of patients undergoing a caesarean section experienced fetal distress followed by poor progress (n=11)13.8%, cephalopelvic disproportion (n=10) 12.5% and failed IOL (n=9)11.3%. If there was fetal distress, the CTG description in the file was “pathological” in (n=41) 63.3% of cases, followed by “non-reassuring” (n=13) 20.0% and then “suspicious” (n=10) 15.0%. No significant association ($p< 0.69$) was found between the various BMI categories in those who developed fetal distress.

Of the fetal distress cases, (n=29) 45.3% cases occurred after induction in active phase of labour and (n=25) 39.1% after induction not in labour. The minority of women experienced fetal distress after induction in latent phase of labour (n=6) 9.4%, before induction (n=3) 4.7%, and after induction second stage of labour (n=1) 1.6%. No significant association ($p < 0.42$) was identified between women in the various BMI categories and the point at which fetal distress was observed.

Table 4.9 Indications for women who underwent a caesarean section (n=80)

Indication for Caesarean section	Normal BMI 18.5-24.9 kg/ m^2 n= 12 (14.8%)	Overweight BMI 25.0-29.9 kg/ m^2 n= 30 (37.0%)	Obese BMI ≥ than 30.0 kg/ m^2 n= 38 (46.9%)	Total n=80 † (100%)	P value
Cephalopelvic disproportion	1† (8.3%)	6† (20%)	3† (7.9%)	10† (12.5%)	0.14
Failed augmentation	1 (8.3%)	3† (10%)	0 (0%)	4† (5.0%)	0.12
Failed induction of labour	1 (8.3%)	2† (6.7%)	6† (15.8%)	9† (11.3%)	0.43
Failed operative delivery	0 (0%)	0 (0%)	1 (2.6%)	1 (1.3%)	0.56
Fetal distress	10† (83.3%)	23† (76.7%)	27† (71.1%)	60† (75.0%)	0.65
Poor progress	0 (0%)	2† (6.7%)	9† (23.7%)	11† (13.8%)	0.04
Prolonged latent phase of labour	1† (8.3%)	0 (0%)	0 (0%)	1 (1.3%)	0.17
Other[Θ]	0 (0%)	1 (3.3%)	3† (7.9%)	4† (5.0%)	0.80

Θ - other listed conditions for BMI categories ~ Overweight BMI: compound presentation (n=1); Obese BMI: Failed IOL (n=1), deteriorating maternal condition (n=1), macrosomia (n=1).

† – certain patients had multiple indications listed

4.6 Neonatal outcomes

The mean birthweight for all neonates (n=185) was 3114.1g (SD=504g). Mothers within the obese BMI category (n=86) had a mean neonate birthweight of 3146.38g (SD = 466.23g), the overweight BMI category had a mean neonate birthweight of 3094.8g (SD = 574.6g), whilst mothers in the normal BMI category had neonates with a mean birthweight of 3071.95g (SD = 472.5g). There was no significant association found between the neonate birthweight and the mothers BMI category (p=0.22).

A total of 9 macrosomic babies (n=9) 4.8% were recorded with a mean birth weight of 4212.8g (SD = 126.6g). These babies were born to a majority of women in the overweight BMI group (n=5) 55.6% and obese BMI group (n=3) 33.3%.

The median Apgar at 1 minute was 9 (IQR: 8 – 9) and the median Apgar at 5 minutes was 10 (IQR: 10 – 10). There were no significant association seen between the Apgar scores in the various BMI categories (p=0.84) for Apgar score at 1 minute and (p=0.90) for Apgar score at 5 minutes.

A large proportion of the neonates (n=173) 93.5% were born alive. A total of 12 babies were born dead (normal: n=2; overweight: n=2; obese: n=8) and were classified as macerated stillbirths.

A total of 17 babies (n=17) 9.2% experienced a neonatal complication after delivery. The neonatal complications for these neonates are tabulated in Table 4.10. There were no incidents of Cephalohaematoma nor birth trauma recorded

These 17 neonates were admitted to the ICU, with all neonates ultimately discharged alive (100%). Six of these babies (n=6) 35.3% were in born to mothers in the obese group, 7 (n=7) 41.1% were in the overweight group, and 4 were born to mothers in the normal BMI category. There was no significant association seen between the neonates admitted to ICU and the BMI categories of the mothers (p=0.19).

In addition, other neonatal outcomes included 4 women (normal: n=1; overweight: n=2; obese: n=1) with big babies and 1 obese woman who had a neonate who developed neonatal jaundice.

Table 4.10 List of neonatal outcomes after delivery (n=17)

Neonatal complications	**Mothers Normal BMI 18.5-24.9 kg/ m^2 n= 5 (29.4%)**	**Mothers Overweight BMI 25.0-29.9 kg/ m^2 n= 6 (35.3%)**	**Mothers Obese BMI ≥ than 30.0 kg/ m^2 n= 6 (35.3%)**	**Total N=17 (100%)**
• Hypoxic Ischaemic Encephalopathy	1 (20.0%)	0 (0%)	0 (0%)	1 (5.9%)
• Meconium aspiration	1 (20.0%)	0 (0%)	2 (33.3%)	3 (17.6%)
• TTN	1 (20.0%)	4 (66.7%)	1 (16.7%)	6 (35.3%)
• Respiratory distress	2 (40.0%)	2 (33.3%)	3 (50.0%)	7 (41.2%)

Fetal blood gas results were available in 40 cases (n=40) 21.2%. The median blood gas pH was 7.3 (IQR: 7.2 – 7.3), the median blood gas bicarbonate was 19.0 (IQR: 16.3 – 20.5) and the median blood gas lactate was 3.6 (2.3 – 6.2) for all study participants. Table 4.11 summarizes the mean blood gas analysis results of neonates tested.

Table 4.11 Summary of mean blood gas analysis results of neonates tested (n=40)

Blood gas test result	**Normal BMI 18.5-24.9 kg/ m^2 n= 5 (12.5%)**	**Overweight BMI 25.0-29.9 kg/ m^2 n= 18 (45%)**	**Obese BMI ≥ than 30.0 kg/ m^2 n= 16 (40%)**	**Total n=40 (100%)**	**p-value**
Blood gas pH	7.304	7.271	7.252	7.269	0.53
Blood gas base access	3.2	6.4	6.8	6.1	0.13
Blood gas bicarbonate	20.1	18.3	17.9	18.4	0.33
Blood gas lactate	3.2	4.7	4.5	4.5	0.46

Chapter 5 Discussion

5.1 Maternal Demographics

This Study done at Rahima Moosa Mother and Child Hospital confirms that maternal obesity is a major public health concern in Johannesburg. This problem is increasing in many African countries but to a different extent between each country. When BMI is measured in the third trimester, it is found that obesity levels tend to be higher (up to 50.7%); however when measured in the first trimester, obesity levels in Africa are comparable (up to 17.9%) with some of the developed countries, where about one in five pregnant women are obese (2). In the UK, one third of the pregnant population has a BMI of greater than 30.0 kg/ m^2 (13). In the United States more than one-third of reproductive aged women are obese, and 7.6% of those women are extremely obese (16).

Different studies measure obesity at different time points, using different measures and cut-off points. Some studies use BMI adjusted for gestational age, some studies look at pre-pregnancy weight and booking BMI, and some use third trimester BMI for diagnosing maternal obesity (2). In this study the booking BMI was used to diagnose maternal obesity as all of the patients had a record of their weight at booking.

In this study we found using the booking BMI that 46.5% of women were obese, 33.0% were overweight, 20.5% were reported to be of normal weight. It was found that most of the study participants were classified as obese. A study done by Basu *et al.* showed that the prevalence of obesity is high in South African women and is associated with increased risk of complications. This study was a retrospective study of 767 pregnant women and they found among the study population that 337 (44.0%) were obese or morbidly obese (28)

In our setting however, at Rahima Moosa Mother and Child Hospital, BMI is currently the gold standard used to calculate body fatness. This poses a problem as we cannot accurately assess pre-pregnancy weight. This coupled with late booking for antenatal care questions the reliability of using BMI to assess body fat or nutritional status in pregnancy. A preferred method is MUAC as it is a better indicator of pre-pregnancy fat

and nutrition than BMI. For this reason, the use of MUAC has been introduced as one of the routine anthropometric measurements at the antenatal booking visit in South Africa. It is recorded in the standardized maternity case record as recommended by the current South African maternity care guidelines (14).

The mean age of the study participants was found to be 28.0 years of age. The obese patients were found to be the eldest group of patients with a mean age of 30.3 years of age. The youngest group of patients were those with a normal BMI with a mean age of 25.7 years of age. It was found in the UK that increasing age is an added risk factor for obesity, and one can note a similar trend in this study (13). In Africa, maternal obesity is found to be higher in older, multiparous women and among urban settlements but it is not associated with wealth (2). Obesity was previously thought to be a disease of the affluent in developing settings but recently it has been shown to be a disease of both the rich and the poor (2).

A large majority of women in this study were African (87.6%), followed by coloured women at (5.9%), with Asian, Caucasian and Indian each only 2.2% respectively. In the UK it has been previously reported that South-Asian and Afro-Caribbean women are more likely to be obese as compared to the native British population (13). In America it is found that obese women are more likely to be African American (16).This is similar in this study in that 88.3% of the African women were found to be obese. No comment can be made regarding demographics in this study as they largely reflect the population served by Rahima Moosa Mother and Child Hospital.

An increased BMI is associated with an increased risk of medical complications (16). Studies done in America, Europe and the UK found that women suffering from obesity were more likely to develop gestational diabetes (10, 23, 29, 30), This increase was found to be between three and eight fold (23).These findings were found to be similar to an Australian study of 14,230 pregnancies, which indicated that the odds of developing gestational diabetes were 2.95 times higher in the obese population (BMI 30.01-40.00)

as compared to those with a normal BMI (31).

In America it is shown that maternal obesity is associated with an increased risk of hypertensive disorders of pregnancy, including preeclampsia (10). Obesity is also associated with an increased risk of diabetes, both pregestational to normal weight women (10). Most of the observational studies that have been done since 1996 have been able to show a direct correlation between maternal BMI and the risk of preeclampsia (32).

A Swedish study of 805,275 women delivering between the year 1992 and 2001 established that 2.8% of women with obesity had preeclampsia compared to 1.4% with a normal BMI (33). This difference was even more evident in the Australian study reported by Callaway *et al* where the prevalence of gestational hypertension or preeclampsia was 2.4% in normal weight women and 9.1% in obese women (31). In this study of the effect of maternal weight on misoprostol induction of labour at Rahima Moosa Mother and Child Hospital: gestational hypertension (40.5%), gestational diabetes (21.4%), preeclampsia and chronic hypertension (19.0%) respectively were the most prevalent conditions noted in obese patients. However, the prevalence of preeclampsia was noted to be much higher in the normal BMI group at 66.7%.

Of all the medical conditions evaluated as part of the maternal outcomes, only gestational hypertension (p=0.02) and gestational diabetes (p=0.02) highlighted a significant difference between the normal BMI, overweight and obese groups. Both these conditions were reported more in the obese group as opposed to the other two groups. One patient in the obese group reported pre-gestational diabetes.

5.2 Maternal Outcomes

In this study we reviewed indications for induction of labour which were mostly either maternal (45.9%) or fetal indications (47.6%). In a minority of cases there were both fetal and maternal indications for induction of labour (14.1%). The most common maternal indication for induction of labor was that of prelabour rupture of membranes (PROM) and

this was found mostly in the normal BMI group (57.1%) and overweight group (58.6%). Medical condition was the most common indication for induction of labour in the obese group (73.8%). The most common fetal indication for induction of labour was post-dates. This occurred in 71 patients (80.7%). Post-dates was noted more in the obese category (83.3%). A Fishers exact test was applied to the fetal indicator variables and found that there was no significant association between the remaining variables and the various BMI categories (p=0.46).

Five patients in the obese group were induced for intrauterine fetal death and two patients in the obese group were induced for fetal macrosomia. Several mechanisms have been suggested for the reason why obese women have an increased risk of intrauterine fetal deaths, some of which include the increased risk of developing hypertensive disorders and gestational diabetes in pregnancy (10). There was no significant difference in the different BMI groups (p=0.29) in those who had a fetal indication or a maternal indication for IOL.

Obese women have higher rates of gestational diabetes and therefore tend to have macrosomic babies (34). Obese women are also thought to have higher rates of post-term pregnancy (34). These findings were similar in this study although only two patients were induced for fetal macrosomia as an indication for induction of labour.

Obese pregnant women are more likely to have a medical indication for delivery and therefore labour induction prior to the onset of spontaneous labour (34). A study by Usha Kiran *et al.* observed increased rates of postdates, induction of labour, caesarean section, macrosomia and shoulder dystocia in women with increased BMI (13). Arrowsmith *et al.* also found that obesity to be a significant risk factor for post-term delivery. They also demonstrated that obese women tend to require induction of labour and because of this they have increased rates of caesarean delivery (9). Denison *et al.* found that a higher maternal BMI in the first trimester and a greater change in the BMI throughout the pregnancy is associated with a longer gestation and an increased risk of postdates pregnancy (35).

In the United States, there is some evidence reported that induction of labour is likely to

be unsuccessful in women with a high BMI. In a retrospective population cohort study of 80,887 women, it was found that women with a BMI of at least 40kg/m^2 had a 29% risk of unsuccessful labour induction compared with a 13 % risk among women of a normal weight (36). A study done by Ruhstaller on induction of labour in the obese patient showed that women with class 1 and 2 obesity who undergo labour induction require a caesarean section 20.2% and 24.2% of the time respectively, whereas women with a BMI of 40 to 50 kg/m^2 have a failed induction rate of 31.6% (22).

In this study there were 11 cases of failed induction of labour and seven (8.1%) were noted to be in the obese BMI group. There was no significant difference in the three BMI groups (p=0.41) for failed induction of labour. It is thought that a low Bishop Score on admission, nulliparity and a fetal weight of >4000g are all significantly associated with an increased likelihood of having a failed induction (22).

There is evidence suggesting that misoprostol is more effective than dinoprostone for cervical ripening in women with obesity. Misoprostol when used for cervical ripening may also be more effective in women with obesity because of the physiologic changes in prostaglandin expression that may decrease the response to dinoprostone in some women. There also may be some pharmacokinetic or pharmacodynamic differences in how these prostaglandins function in women with obesity (36, 37). This might explain why there was no significant difference between the BMI groups for failed induction of labour.

Vinayagam *et al.* showed that there was an increased incidence of delivery by caesarean section in obese patients. These findings were also found to be consistent with other trials (38). Crane *et al.* studied over 20 000 subjects, and they came to a conclusion that an increased pre-pregnancy weight was associated with an increased risk of people being delivered by caesarean section (39). More recently, Lynch *et al.* studied over 5000 subjects, in a retrospective cohort study, and this study showed that there is a two- to threefold increase of delivery via caesarean section in obese women. This same study found that there was a reduction in the successful vaginal delivery rate with increasing BMI (40). Arrowsmith *et al.* did a large retrospective analysis of nearly 30 000 women being induced for postmaturity. These authors found that a significantly higher proportion

of obese women being induced ended up with a caesarean section when compared to normal weight controls (9).

In contrast, this study showed that more women delivered via normal vaginal delivery (56.8%) as compared to caesarean section (43.2%). There was no statistical significance noted in the various BMI groups (p=0.22). It was also noted that more women in the obese group (55.8%) delivered normally compared to 44.2% who delivered via caesarean section.

The indication for caesarean section was mostly fetal distress (75.0%). Poor progress was noted in 13.8% of cases and most was noted to be in the obese group: nine of eleven cases. Cephalopelvic disproportion was noted in 12.5% of cases: more in the overweight than obese category.

The increased risk of postpartum hemorrhage in an obese patient may be explained by the presence of excessive bleeding from the placental site due to a relatively larger implantation area of the placenta which is usually associated with large for gestational age babies (30). Vinayagam *et al.* demonstrated that there is an increased incidence of primary postpartum haemorrhage in the obese population (38). Such findings have been reported in other studies with larger cohorts (13). Similarly, there have been studies of large cohorts that have not shown an increased incidence of postpartum haemorrhage in obese patients (9). It is important to remember that blood loss documented at the time of delivery is an estimation, therefore a subjective value that is open to bias (38). One possible mechanism that may increase the risk of bleeding in obese patients is the malfunction in uterine contractility secondary to increased cholesterol and Leptin (38).

In this study PPH was reported only in eight cases. Five were post a normal vaginal delivery (normal BMI n=1; overweight BMI n=2; obese BMI n=2) and three cases were post caesarean section (normal BMI n=1; overweight BMI n=2).There were no hysterectomies performed and no cases of uterine rupture reported.

Of the women who had a normal vaginal delivery, 61.2% sustained a perineal tear, 35.8% needed an episiotomy. Perineal tears were found more in the obese group (45.8%) and episiotomies were performed more in the overweight group (38.7%). Two vacuum

assisted deliveries were performed, one in the normal BMI group and one in the overweight group. A high maternal BMI is thought to be a risk factor for assisted delivery in both spontaneous and induced labour (41). Also a high BMI is associated with big babies, shoulder dystocia therefore leading to both maternal and neonatal trauma (13). In contrast, in this retrospective comparative study high maternal BMI did not affect the instrumental delivery rates nor was there any significant maternal and neonatal trauma.

5.3 Neonatal Outcomes

In this study, the mean birth weight increased linearly with increasing BMI. There was no significant relationship between the neonate birthweight and the mothers BMI category (p=0.22). There were nine cases of fetal macrosomia with a mean birth weight of 4212.78g, of which five were in the overweight group, three were found to be in the obese group and one was in the normal BMI group (no significant statistical association was identified p=0.28). In the UK, increasing maternal BMI is usually associated with fetal macrosomia (9) and the mean birthweight is increased for moderately obese and extremely obese patients compared to a normal BMI group (30). Perlow *et al.* determined in the late 1980s that morbid obesity had a negative impact on perinatal outcome (42). They found that morbid obesity posed an increased risk of having a birthweight of more than 4500g (33, 42). A retrospective cohort study that was done in Iran in 2008-2009 showed that a BMI of > 30 kg/ m^2 increases one's chance of having a higher birthweight (4000 or higher) (43).

In this study, all babies were generally born with good Apgar scores. There were no significant differences seen between the Apgar scores in the various BMI categories (p=0.84) for Apgar score at 1 minute and (p=0.90) for Apgar score at 5 minutes. It is thought that neonates born to obese patients have a higher rate of low Apgar scores and are more commonly admitted to the neonatal intensive care unit (23). Vinayagam *et al.* did not demonstrate a difference in the admission rates to the neonatal ICU of babies born to obese women, but they did show an increased incidence of babies born with poor APGAR scores in obese women (38).

Seventeen babies were admitted to NICU, six in the obese group, seven in the overweight group and four in the normal BMI group. There was no statistical significant difference noted in the various BMI groups (p=0.19). A study done in Iowa in the U.S showed, even though there was no statistical significance, infants of born to obese women were 5.75 times more likely to be admitted to the neonatal intensive care unit than infants born to non-obese women. (p=0.059) (34).

In this study, of the neonatal complications, none of the babies suffered any birth trauma. The increased risk of developing neonatal trauma has only been reported in a few studies (13). Due to an increased chance of developing fetal macrosomia with a high BMI, there is a subsequent increased chance of developing shoulder dystocia and therefore neonatal trauma.

In Denmark, there is evidence to suggest that obese women have an increased risk of stillbirth and early neonatal death (44). Overweight and obese women are found to have increased odds ratios for late fetal death (45). Twelve babies were MSBs of which eight of those were in the obese group (no statistical association was identified p=0.19).

The cord blood pH in cases that it was available, was never <7.2. This study was similar to other research in that cord blood pH was never less than 7.2 or <7.0 (9)

There was no statistically significant relationship in the various neonatal outcomes evaluated in the maternal BMI groups

Chapter 6 Limitations

The study was a retrospective study therefore files which did not contain adequate data were excluded i.e. no height being recorded in order to calculate BMI. The study sample size was too small to adequately assess certain maternal complications such as PPH and

uterine rupture.

Of the 4208 deliveries only 3080 files were found therefore this sample may have not been representative of all inductions with oral misoprostol. This study did not assess parity as a demographic, which is an important factor to look at as it influences the outcome of induction of labour.

The fact that mid-upper arm circumference was not used may have played a role in the assessment of pre-pregnancy fat and the nutritional status of our overweight and obese women. Many women in South Africa book late in pregnancy. This affect the accuracy of BMI measured at the first antenatal visit. The MUAC has been introduced in South Africa as one of the anthropometric measurements on the maternity case record however, it is not the primarily used measure of body fatness at Rahima Moosa Hospital.

Chapter 7 Recommendations

This study adds to the body of literature regarding the influence of BMI on induction of labour in both low-risk and high-risk pregnancies. This study only looked at misoprostol as an induction agent and how obese women respond to this induction agent compared to overweight and normal BMI groups. Future research needs to be done comparing different induction agents to assess which drug is most appropriate and effective to be used in obesity. Additional analysis is needed of a larger sample which should include women who are preterm and after 28 weeks needing induction of labour, and to assess maternal and fetal outcomes in this group whilst comparing the three BMI groups. Most of the studies looked at in the literature are retrospective. Prospective studies are needed including all BMI categories, in order to further our knowledge of timing and choice of induction method best suited for each BMI category.

Chapter 8 Conclusion

This study demonstrated that a high BMI is associated with increased age, and is mostly noted in the African population compared to other racial groups. Maternal obesity is associated with an increased occurrence of gestational hypertension, gestational diabetes, preeclampsia and chronic hypertension. The most common reason that obese women undergo induction of labour is due to medical conditions complicating their pregnancies and postdates. More patients were found to deliver via NVD as opposed to undergoing a caesarean section. There was a minimal number of cases of a failed induction of labour. Babies born to obese mothers generally had good APGAR scores and admission to NICU were not increased among women undergoing induction of labour with oral misoprostol. The effect of maternal weight on misoprostol induction of labour at Rahima Moosa Mother and Child hospital was found to be minimal. Overweight and obese women had very similar outcomes to those of women with normal weight.

Chapter 9 References

1. The American College of Obstetricians and Gynecologists. Frequently asked questions pregnancy 2016 [Available from: https://www.acog.org/patients/FAQs/obesity-and-pregnancy [Accessed on 14 June 2018]

2. Onubi OJ, Marais D, Aucott L, Okonofua F, Poobalan AS. Maternal obesity in Africa: a systematic review and meta-analysis. J Public Health (Oxf). 2016;38(3):e218-e31. DOI: 10.1093/pubmed/fdv138 [Accessed on 14 June 2018]

3. Davis EM, Zyzanski SJ, Olson CM, Stange KC, Horwitz RI. Racial, ethnic, and socioeconomic differences in the incidence of obesity related to childbirth. Am J Public Health. 2009;99(2):294-9. DOI: 10.2105/AJPH.2007.132373 [Accessed on 12 June 2018]

4. Centre for Maternal and Child Enquiries UK. Maternal Obesity in the UK: findings from a national project 2010 [Available from: https://www.publichealth.hscni.net/sites/default/files/Maternal%20Obesity%20in%20the%20UK.pdf [Accessed on 14 June 2018]

5. Stuber TN, Kunzel EC, Zollner U, Rehn M, Wockel A, Honig A. Prevalence and Associated Risk Factors for Obesity During Pregnancy Over Time. Geburtshilfe Frauenheilkd. 2015;75(9):923-8. DOI: 10.1055/s-0035-1557868 [Accessed on 11 July 2019]

6. Adebami OO, G; Aderinsola, J. The Influence Of Maternal Socio-Economic And Nutritional Status On Foetal Malnutrition In Nigeria. Internet J Third World Med. 2006;4(1):1-6. DOI: 10.5580/fa1 [Accessed on 12 June 2018]

7. Edomwonyi NP, Osaigbovo PE. Incidence of obesity in parturients scheduled for caesarean section, intra-operative complications, management and outcome. East Afr Med J. 2006;83(4):112-9. DOI: 10.4314/eamj.v83i4.9425 [Accessed on 13 July 2018]

8. Koyanagi A, Zhang J, Dagvadorj A, Hirayama F, Shibuya K, Souza JP, et al. Macrosomia in 23 developing countries: an analysis of a multicountry, facility-based, cross-sectional survey. Lancet. 2013;381(9865):476-83. DOI: 10.1016/S0140-6736(12)61605-5 [Accessed on 20 June 2018]

9. Arrowsmith S, Wray S, Quenby S. Maternal obesity and labour complications following induction of labour in prolonged pregnancy. Br J Obstet Gynaecol. 2011;118(5):578-88. DOI: 10.1111/j.1471-0528.2010.02889.x [Accessed on 5 May 2018]

10. Leddy MA, Power ML, Schulkin J. The impact of maternal obesity on maternal and fetal health. Rev Obstet Gynecol. 2008;1(4):170-8. [Accessed on 12 October 2017]

11. Weiss JL, Malone FD, Emig D, Ball RH, Nyberg DA, Comstock CH, et al. Obesity, obstetric complications and cesarean delivery rate--a population-based screening study. Am J Obstet Gynecol. 2004;190(4):1091-7. DOI: 10.1016/j.ajog.2003.09.058 [Accessed on 19 July 2018]

12. Vinturache AE, McDonald S, Slater D, Tough S. Perinatal outcomes of maternal overweight and obesity in term infants: a population-based cohort study in Canada. Sci Rep. 2015;5:9334. DOI: 10.1038/srep09334 [Accessed on 12 October 2017]

13. Usha Kiran TS, Hemmadi S, Bethel J, Evans J. Outcome of pregnancy in a woman with an increased body mass index. Br J Obstet Gynaecol. 2005;112(6):768-72. DOI: 10.1111/j.1471-0528.2004.00546.x [Accessed on 28 September 2017]

14. Fakier A, Petro G, Fawcus S. Mid-upper arm circumference: A surrogate for body mass index in pregnant women. S Afr Med J. 2017;107(7):606-10. DOI: 10.7196/SAMJ.2017.v107i7.12255 [Accessed on 8 February 2020]

15. Inducing Labour Clinical Guideline CG70 National Institute for Health and Care Excellence [updated January 201723 July 2008]. Available from: https://www.nice.org.uk/guidance/cg70 [Accessed on 30 August 2018]

16. Wolfe KB, Rossi RA, Warshak CR. The effect of maternal obesity on the rate of failed induction of labor. Am J Obstet Gynecol. 2011;205(2):128 e1-7. DOI: 10.1016/j.ajog.2011.03.051 [Accessed on 20 July 2018]

17. Tenore JL. Methods for cervical ripening and induction of labor. Am Fam Physician. 2003;67(10):2123-8. [Accessed on 12 October 2017]

18. Goldberg AB, Greenberg MB, Darney PD. Misoprostol and pregnancy. N Engl J Med. 2001;344(1):38-47. DOI: 10.1056/NEJM200101043440107 [Accessed on 25 May 2018]

19. Hofmeyr GJ, Gulmezoglu AM, Pileggi C. Vaginal misoprostol for cervical ripening and induction of labour. Cochrane Database Syst Rev. 2010(10):CD000941. DOI: 10.1002/14651858.CD000941.pub2 [Accessed on 17 June 2018]

20. Witwatersrand Uot. Guidelines for obstetric care at referral hospitals in Johannesburg. Guidelines. Johannesburg: University of the Witwatersrand Press, Witwatersrand Uot; 2013 [Accessed on 17 June 2017].

21. Carlson NS, Hernandez TL, Hurt KJ. Parturition dysfunction in obesity: time to target the pathobiology. Reprod Biol Endocrinol. 2015;13:135. DOI: 10.1186/s12958-015-0129-6 [Accessed on 23 September 2017]

22. Ruhstaller K. Induction of labor in the obese patient. Semin Perinatol. 2015;39(6):437-40. DOI: 10.1053/j.semperi.2015.07.003 [Accessed on 18 October 2017]

23. Ramoniene G, Maleckiene L, Nadisauskiene RJ, Bartuseviciene E, Railaite DR, Maciuleviciene R, et al. Maternal obesity and obstetric outcomes in a tertiary referral center. Medicina (Kaunas). 2017;53(2):109-13. DOI: 10.1016/j.medici.2017.03.003 [Accessed on 12 December 2017]

24. Pevzner L, Powers BL, Rayburn WF, Rumney P, Wing DA. Effects of maternal obesity on duration and outcomes of prostaglandin cervical ripening and labor induction. Obstet Gynecol. 2009;114(6):1315-21. DOI: 10.1097/AOG.0b013e3181bfb39f [Accessed on 10 June 2018]

25. Ferreira IV, E.; Areia, A.L.; Maura, P. Induction of Labor in Obese women - What should we know? Percep Reprod Med. 2018;1(5):65-7. DOI: 10.31031/PRM.2018.01.000522 [Accessed on 20 May 2018]

26. Department of Health/South Africa, Medical Research Council/South Africa, ORC Macro. South Africa Demographic and Health Survey 2003. Pretoria, South Africa: Department of Health/South Africa; 2007 [Accessed on 14 June 2018].

27. Banos N, Migliorelli F, Posadas E, Ferreri J, Palacio M. Definition of Failed Induction of Labor and Its Predictive Factors: Two Unsolved Issues of an Everyday Clinical Situation. Fetal Diagn Ther. 2015;38(3):161-9. DOI: 10.1159/000433429 [Accessed on 10 May 2018]

28. Basu JK JC, Basu D. Obesity and its outcomes among pregnant South African women. . International Journal of Gynecology & Obstetrics. 2010;110(2):101-4. [Accessed on 10 May 2018]

29. Fitzsimons KJ, Modder J, Greer IA. Obesity in pregnancy: risks and management. Obstet Med. 2009;2(2):52-62. DOI: 10.1258/om.2009.090009 [Accessed on 30 October 2017]

30. Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, et al. Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. Int J Obes Relat Metab Disord. 2001;25(8):1175-82. DOI: 10.1038/sj.ijo.0801670 [Accessed on 18 June 2018]

31. Callaway LK, Prins JB, Chang AM, McIntyre HD. The prevalence and impact of overweight and obesity in an Australian obstetric population. Med J Aust. 2006;184(2):56-9. [Accessed on 5 May 2018]

32. O'Brien TE, Ray JG, Chan WS. Maternal body mass index and the risk of preeclampsia: a systematic overview. Epidemiol. 2003;14(3):368-74. DOI: 10.1097/00001648-200305000-00020 [Accessed on 5 May 2018]

33. Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. Obstet Gynecol. 2004;103(2):219-24. DOI: 10.1097/01.AOG.0000107291.46159.00 [Accessed on 5 May 2018]

34. Lin IH-F, A.J. Impact of obesity on rates of successful vaginal delivery after term induction of labor. Proceed Obstet Gynecol. 2015;5(2):4. DOI: 10.17077/2154-4751.1287 [Accessed on 8 July 2018]

35. Denison FC, Price J, Graham C, Wild S, Liston WA. Maternal obesity, length of gestation, risk of postdates pregnancy and spontaneous onset of labour at term. Br J Obstet Gynaecol. 2008;115(6):720-5. DOI: 10.1111/j.1471-0528.2008.01694.x [Accessed on 13 July 2018]

36. Ellis JA, Brown CM, Barger B, Carlson NS. Influence of Maternal Obesity on Labor Induction: A Systematic Review and Meta-Analysis. J Midwifery Womens Health. 2019;64(1):55-67. DOI: 10.1111/jmwh.12935 [Accessed on 10 May 2018]

37. Suidan RS, Rondon KC, Apuzzio JJ, Williams SF. Labor outcomes of obese patients undergoing induction of labor with misoprostol compared to dinoprostone. Am J Perinatol. 2015;30(2):187-92. DOI: 10.1055/s-0034-1381721 [Accessed on 11 July 2019]

38. Vinayagam D, Chandraharan E. The adverse impact of maternal obesity on intrapartum and perinatal outcomes. ISRN Obstet Gynecol. 2012;2012:939762. DOI: 10.5402/2012/939762 [Accessed on 20 July 2018]

39. Crane SS, Wojtowycz MA, Dye TD, Aubry RH, Artal R. Association between pre-pregnancy obesity and the risk of cesarean delivery. Obstet Gynecol. 1997;89(2):213-6. DOI: 10.1016/S0029-7844(96)00449-8 [Accessed on 5 May 2018]

40. Lynch CM, Sexton DJ, Hession M, Morrison JJ. Obesity and mode of delivery in primigravid and multigravid women. Am J Perinatol. 2008;25(3):163-7. DOI: 10.1055/s-2008-1061496 [Accessed on 20 July 2018]

41. Antonakou A, Papoutsis D, Tzavara C. Maternal obesity and its association with the mode of delivery and the neonatal outcome in induced labour: Implications for midwifery practice. Eur J Midwifery. 2018;2(April). DOI: 10.18332/ejm/85792 [Accessed on 17 June 2018]

42. Perlow JH, Morgan MA, Montgomery D, Towers CV, Porto M. Perinatal outcome in pregnancy complicated by massive obesity. Am J Obstet Gynecol. 1992;167(4 Pt 1):958-62. DOI: 10.1016/s0002-9378(12)80019-6 [Accessed on 5 May 2018]

43. Yazdani S, Yosofniyapasha Y, Nasab BH, Mojaveri MH, Bouzari Z. Effect of maternal body mass index on pregnancy outcome and newborn weight. BMC Res Notes. 2012;5:34. DOI: 10.1186/1756-0500-5-34 [Accessed on 5 May 2018]

44. Kristensen J, Vestergaard M, Wisborg K, Kesmodel U, Secher NJ. Pre-pregnancy weight and the risk of stillbirth and neonatal death. Br J Obstet Gynaecol. 2005;112(4):403-8. DOI: 10.1111/j.1471-0528.2005.00437.x [Accessed on 20 June 2018]

45. Cnattingius S, Bergstrom R, Lipworth L, Kramer MS. Prepregnancy weight and the risk of adverse pregnancy outcomes. N Engl J Med. 1998;338(3):147-52. DOI: 10.1056/NEJM199801153380302 [Accessed on 10 May 2018]

Appendix A: Data Sheet

Data Sheet

Study number _____

Maternal Demographics:

Age (years): _____

Ethnicity: African/caucasian/coloured/asian/Indian

Booking Status Booked

Unbooked

Gestational age at Booking _____weeks

Dates/Palpation/Early Sonar/Late Sonar

Booking bloods

Hb _____g/dL

Rh Positive/negative/unknown

RPR Positive/negative/unknown

HIV status Positive/negative/unknown

If HIV positive: CD4 count _____

Viral Load _____

ARVs Yes/No/Unknown

If Yes specify _____

Maternal weight at booking (Kg) _____

(Last recorded weight)

Maternal Height (cm)

BMI at Booking _____

Medical conditions: Gestational Hypertension

		Preeclampsia		
		Chronic Hypertension		
		Pregestational Diabetes		
		Gestational Diabetes		
		Cardiac disease		
		Epilepsy		
		Other		
		Specify _____		
Outcomes of Induction:				
Bishop Score				
Indication for IOL		Maternal/Fetal		
Maternal		Medical condition/Postdates/PROM/Other		
		If other: Specify _____		
Fetal		Macrosomia/Oligohydramnios/IUGR/Other		
		If other: Specify _____		
Fetal Distress		Yes/No		
If yes, at which point?				
Tachysystole		Yes/No		
If yes, after how many doses of miso?				
In Labour at 24 hours or less		Yes/No		
In labour at 25-48 hours		Yes/No		
In labour 49-72 hours		Yes/No		
No. of cycles Oral Misoprostol		0ne/two/more		
Failed Induction		Yes/No		
Delivery:				
Mode of Delivery	NVD		yes/no	Episiotomy
	Caesarean Section		yes/no	
	Assisted	Vacuum	yes/no	
		Forceps	yes/no	
Indication for CS:	Prolonged Latent Phase Of Labour			
	Poor Progress			
	Fetal Distress			
	APH			
	Failed Augmentation			

Failed Operative Delivery
Delayed Second Stage
Cephalopelvic Disproportion
Other
If other: specify _____

If fetal distress: description of CTG either on CTG or in the file

Blood gas where available:

Complications:	PPH	500-1000mls (NVD)
		1000mls or more (At C/S)
		Blood Transfusion (Volume+ Products given: RPC/FFPs/Plt/Cryo)
	TAH	Atonic Uterus
		PPH
		Other
	Vaginal Tear and Degree	NVD
		Vacuum Delivery
		Forceps Delivery
	Uterine Rupture	
	Other	

Fetal Factors:

Birth Weight in Grams:

Apgar at 1min:

0/1/2/3/4/5/6/7/8/9/10

Apgar at 5 min:

0/1/2/3/4/5/6/7/8/9/10

Fetal Outcomes:	Alive
	Cephalohaematoma
	Birth Trauma
	FSB
	Hypoxic Ischemic Encephalopathy

Neonatal Outcomes:

Early Neonatal Death	Cause of Death
Neonatal ICU Admission	Outcome

Appendix B: University of the Witwatersrand Protocol for Induction of Labour

WITS PROTCOL FOR INDUCTION OF LABOUR

INDUCTION OF LABOUR WITH A LIVE BABY

Frequent indications for induction of labour with a live baby include prolonged pregnancy, hypertension and prelabour rupture of membranes. Contraindications are placenta praevia, breech, transverse lie, fetal distress, previous caesarean section and parity≥5: elective delivery for these must be by caesarean section.

CERVICAL ASSESSMENT

Prior to induction of labour, the cervix needs to be assessed for favourability. Use the Bishop score - a total ≥7 suggests that induction with amniotomy followed by oxytocin is likely to be successful

Bishop Score

Points	0	1	2	3
Cervical dilataion (cm)	<1	1-2	2-4	>4
Cervical Length (cm)	>4	2-4	1-2	<1
Station	-3	-2	-1	≥0
Cervical Consistency	Firm	Average	Soft	
Cervical Position	Posterior	Mid-Position	Anterior	

If the cervix is favourable for induction (Bishop score ≥7):

1. Admit the woman to labour ward
2. Ensure fetal well-being by NST
3. Perform artificial rupture of membranes
4. Start oxytocin infusion 2 hours later
5. Monitor the fetus with continuous CTG

If the cervix is not favourable for induction (Bishop score <7):

1. Admit the woman to the antenatal ward
2. Ensure fetal well being by NST
3. Start oral misoprostol with/without Foley catheter bulb induction
4. If the cervix is not favourable after 24 hours, give prostaglandin E2 1 mg into the posterior vaginal fornix every 6 hours, for 24 hours (At Rahima Moosa Mother and Child Hospital, we rest the patient for 24 hours and then repeat the next course)
5. Failed induction after 48 hours may necessitate caesarean section or further expectant management

Preparation of the cervix with a Foley catheter bulb

This is a good non-pharmacological and safe alternative to oral misoprostol or vaginal prostaglandin E2, particularly for women with previous CS or parity ≥5

1. Pass a 30 mL bulb Foley catheter through the internal cervical os and inflate the bulb to 50 mL
2. Put the bulb on traction by sticking the catheter to the inner thigh

3. Check for expulsion of the bulb every 12 hours
4. If the bulb won't expel, consider infusing extra-amniotic saline at 50 mL/hour, for a maximum 24-36 hours (in labour ward)
5. When the bulb is expelled, the cervix is favourable for amniotomy

Induction of labour with oral misoprostol

1. Presentation must be cephalic
2. Parity must be 4 or less
3. The cervix must be assessed as unfavourable for induction
4. There must be no history of previous caesarean section or uterine surgery
5. Make up the misoprostol solution as follows: Dissolve 1 tablet of misoprostol 200 mcg in 200 mL tap water in a clean brown plastic bottle (1 mcg/mL). Shake well before each dose is given. Discard any unused solution after 12 hours
6. 6.Give oral misoprostol 2-hourly for up to 24 hours or until labour starts:
    - Dose: 20 mL (20 mcg) 2 hourly x 12 doses
7. Before each oral dosage, check for contractions. If there are ≥3 painful contractions in 10 minutes, or maternal distress, assess the cervix and do a CTG
8. If the cervix is ≥3 cm dilated, transfer the woman to labour ward
9. If the cervix is<3cm dilated,continue oral misoprostol 2-hourly and repeat the cervical assessment in 2-4 hours
10. Do not give oxytocin <6 hours after the last dose of oral misoprostol
11. If the cervix is not favourable after 24 hours, stop misoprostol and consider
12. repeat misoprostol dosage, Foley catheter bulb induction, or other methods
13. If tachysystole (6 contractions in 10 minutes for at least 20 minutes) or
14. hypertonus (contraction lasting for 2 minutes) occurs:
    a. Place the woman in a left lateral position
    b. Perform a CTG tracing, Do not rupture membranes
15. 13. If there is evidence of fetal distress on CTG:
    a. Place the woman in a left lateral position
    b. Give salbutamol 250 mcg IV over 2 minutes

c. Consider emergency caesarean section if there is no improvement

16. 14. When the woman is in labour, monitor the fetus with continuous CTG

Medical supervision of labour induction

The woman must be assessed by a doctor at least twice each day in the antenatal ward (morning and evening) during misoprostol or bulb induction

Appendix C: Ethics approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr ME Tsekeli

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M180327

NAME: (Principal Investigator)	Dr ME Tsekeli
DEPARTMENT:	School of Clinical Medicine Department of Obstetrics and Gynaecology Rahima Moosa Mother and Child Hospital
PROJECT TITLE:	The effect of maternal weight on Misoprostol induction of labour at Rahima Moosa Mother and Child Hospital
DATE CONSIDERED:	06/04/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr S Branch
APPROVED BY:	Professor CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	25/07/2018

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

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **March** and will therefore be due in the month of **March** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix D: Turnitin report