DR.GRACE KANYI-H58/80612/2015

DISSERTATION

USE OF ROBSON CLASSIFICATION TO ANALYZE CONTRIBUTORS TO THE CAESEREAN SECTION RATES AND ASSOCIATED EARLY MATERNAL AND PERI-NATAL OUTCOMES AT THE PUMWANI MATERNITY HOSPITAL FOR THE YEAR 2016

(DESCRIPTIVE RETROSPECTIVE COHORT STUDY)

PRINCIPAL INVESTIGATOR:

DR.GRACE NYAWIRA KANYI, MBChB

SENIOR HOUSE OFFICER

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DECLARATION

This is to certify that this research is my original work. It has never been presented in any other university and was developed under the supervision and approval by senior lecturers and presented to the faculty of obstetrics and gynecology, school of medicine, University of Nairobi. The relevant literature has been quoted for the parts where reference has been made from other sources.

Signature…… Date……

Dr. GRACE NYAWIRA KANYI

Department of Obstetrics and Gynecology, University of Nairobi.

CERTIFICATE OF SUPERVISION

This is to certify that this research study was undertaken and written by Dr. Grace N. Kanyi **under our supervision and was submitted with our approval as part fulfillment of the degree of Master of Medicine in Obstetrics and Gynecology.**

Professor S.B.O.Ojwang',MBChB, M.MED(OBSGYN)DIP.GYN.ONCOLOGIST

Professor, Department of Obstetrics and Gynaecology

Consultant, Obstetrician, Gynecologist and Oncologist,

University of Nairobi

Signature…… Date:……

Dr. Weston Khisa, MBChB, M.Med (OBSGYN)

Honourary Lecturer, Department of Obstetrics and Gynaecology,

University of Nairobi, Consultant Obstetrician and Gynecologist

Kenyatta National Hospital,

Signature…….. Date……..

CERTIFICATE OF AUTHENTICITY

This is to certify that this research study was undertaken and written by Dr. Grace N. Kanyi and supervised by faculty in the department of Obstetrics and Gynecology, University of Nairobi.

PROFESSOR OMONDI OGUTTU, MBChB, M.Med (obsgyn), PGDRM

Associate Professor,Department of Obstetrics and Gynaecology,

Consultant, Obstetrician and Gynaecologist.

Chairman, Department of Obstetrics and Gynecology, University of Nairobi.

Signature---------- **Date**----------

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DEDICATION

This is to my family, led by the most amazing dad any daughter would have ever asked for-Amos Kanyi Muraya, who has forever cheered me on, even when at times, he was the only one on my team. Dad I am eternally lucky to be your daughter. My beautiful hearted mother-who would always just make a phone call to crack me up, no matter how hard the going got. Your laughter made the hardest of days manageable and the highest mountain conquerable. To my sisters, Njeri, Wachinga, Muthoni and to my brother Muraya, thank you for being patient with the demands of my study timelines.

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To my late aunt Muthoni and to my cousin Muraya-you are truly missed and remembered each day. You are a constant reminder that Time is the only true privilege we have ……

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ABBREVIATIONS

Apgar - Appearance, Pallor, Grimace, Activity, Respiration

CS - Caesarean Section

FIGO - International Federation of Obstetrics and Gynecology

KDHS - Kenya Demographic Health Survey

MMR - Maternal mortality rate

MSF - Medecins Sans Frontieres

PMH - Pumwani Maternity Hospital

PPH - Post Partum Haemorraghe

RCOG - Royal College of Obstetricians and Gynecologist

SDG - Sustainable Development Goals

WHO - World Health Organization

OPERATIONAL DEFINITIONS

Apgar score: The evaluation of an infant's physical condition at birth usually performed at 1-5 minutes after birth, including heart rate, respiratory rate, muscle tone, reflex irritability and color, described by Dr. Virginia Apgar in 1952.

Breech presentation: When the buttocks (podalic) of the infant is in the lower pole of the uterus

Caesarean section: Delivery of the baby and the placenta through an incision made into the abdominal wall and the uterus

Cephalic presentation: The fetal head is the presenting part

Gestation: The period of time between conception and birth

Maternal mortality: Refers to maternal deaths that occur during pregnancy, childbirth, or within 42 days of termination of pregnancy, irrespective of duration and site of pregnancy

Multi-gravida: A woman who has had at least one prior delivery.

Multi-para: A woman who has had two or more pregnancies resulting in viable offspring

Neonatal death: Death of a live born baby within 28 days of life.

Nullipara: A woman who has never delivered before.

Para: The number of past pregnancies.

Peri-natal: Occurring at, or near the time of birth.

Post-partum hemorrhage: Primary PPH means blood loss of more than 500 mls after vaginal delivery and more than 1000mls after caesarean delivery, within 24 hours of delivery. For caesarean delivery, moderate PPH is when the blood loss is between 1000mls-2000mls.Severe PPH post caesarean section is when the blood loss is more than 2000mls.

Primigravida: A woman who is pregnant for the first time.

Term Pregnancy: A pregnancy that has reached 37 weeks or more of gestation.

ABSTRACT

Background: There has been growing concern over increasing Caesarean Section (CS) rates due to potential increase in maternal and perinatal risks. Globally, CS rates have increased from 6% in 1990 to 19% in 2014 while this rates was at 7% , 4% and 9% in Africa, East Africa and Kenya respectively as of 2014. In 2011, the World Health Organization (WHO) proposed the ten-step Robson Classification system as a global standard for assessing, monitoring and comparing CS rates within health-care facilities over time, and between facilities. We used the Robson classification to analyze the CS rates in a busy County Maternity Hospital in Kenya and its association with early maternal and perinatal outcomes.

Objective: To analyze CS rates and selected early pregnancy outcomes in a busy County Maternity Hospital in Kenya, using the Robson classification.

Methodology:

Study design: A descriptive one -year retrospective cohort study in which records of 499 women who underwent caesarean section between 1st January 2016 to 31st December 2016 were reviewed.

Study Setting: Pumwani Maternity Hospital in Nairobi County in Kenya.

Data analysis: All women were categorized into Robson groups. We estimated the relative size, the CS rate and the absolute and relative contributions made by each Robson group to the overall CS rate and the association of each group with selected early maternal and perinatal outcomes. Differences were analyzed through chi-square and the Z-test with a significance level of <0.05. Data were analysed using STATA-version 12.

Results: The Robson groups with the highest contribution to the CS rates were low risk women: Group **1**(the nulliparous, at term, single gestation, spontaneous labour), Group **5** (all multi-parous women, at least one previous uterine scar, single gestation, cephalic, at term), and Group **3** (multi-parous, no uterine scar, at term, single gestation, cephalic, spontaneous labour) at **36%**,

24% and **24%** respectively. The early pregnancy outcomes: Apgar scores <7 at 5 minutes, severe postpartum haemorrhage, maternal and neonatal death within 24 hours, were similar across all the 10 Robson groups.

Conclusion

Robson classification was easily applied and identified low-risk women as the largest contributors to the CS rates at Pumwani Maternity Hospital. Additional studies should evaluate indications for CS and identify strategies for reducing CS in this low-risk obstetric population.

1.0: INTRODUCTION

1.1 Background Information

A Caeserian-Section (C-Section) is a high-quality life-saving surgical procedure that allows pregnant women, their offspring, and their families to continue leading healthy productive lives. A C-Section is amongst the common major surgical procedures with rising rates both locally and internationally (1). The number of C-Sections as a percentage of all live births is used as an indicator for measuring the availability and utilization of this life saving obstetric service.

Recently there has been a growing concern over the increasing rates of C-Section both in developed and developing countries (2). C-sections are associated with increased risk for blood transfusions, surgical site infections, hysterectomy and maternal mortality compared to vaginal delivery (3). The uterine scar increases the risk of abnormal placentation such as placenta praevia placenta - accretta, placenta-increta, placenta-percerta, uterine rupture in subsequent pregnancies, caesarean hysterectomies and intra-abdominal adhesions. These risks are increased with repeated C-sections (4).

The cost of C-Section is higher in private hospitals as compared to public hospitals. This then represents an expenditure on a health resource which could be considered an economic drain if the procedure was not medically indicated. Health insurance companies in Kenya are on record to footing close to 61% of the total cost of health costs accrued from C-sections.

World-wide, there is an alarming increase in C-Section rates and this has become a major public health concern. However, in order to propose and implement effective measures to reduce the C-Section rates, it is first essential to conduct a root cause analysis by identifying what groups

of women are undergoing C-Sections and investigate the underlying reasons in different settings.

The International Federation of Obstetricians and Gynecologist, (5) via a FIGO positional paper dated September 2018, declared the current rise as an epidemic and proposed various measures to mitigate this rise, among them implementing the Robson classification in all obstetric units globally (5).

1.2 History of Caeserian Sections

A C-section refers to the delivery of a fetus, the placenta and fetal membranes through an abdominal and uterine incision from 28 weeks of gestation and above. C-Sections have been part of human culture since ancient times. The earliest documented survival of a child delivered via a C-Section was in approximately 508BC, which described the birth of Gorgias.

According to the Greek mythology, Apollo removed Asclepius, founder of religious medicine, from his mother's womb. It is commonly believed that Julius Caesar was delivered via a caesarean section. Roman law under Caesar decreed that all women who could not deliver vaginally be delivered via C - section; his intent then was to increase the population. During this period the procedure was carried out with the intent of saving the child and not the mother. In 1500 Nufer carried out the first modern C - Section, with good outcomes for both the mother and the fetus (6). In 1610, Trautmann performed a well-documented C - Section, but the patient succumbed to post-operative sepsis on day 25 (6). During this time, the operation remained crude at its best: the patient was mostly restrained, as there was no anesthesia, para-median incisions were used to open the anterior abdominal wall, the uterine incision was made depending on the ease of access to the uterus provided by the skin incision. The uterine musculature was not re approximated.

Closure of the abdominal incision slowly evolved over time, from choosing to leave the wound open, to pressure dressing and then to full closure of the anterior abdominal wall. As time progressed some sutured the uterine wall to the anterior abdominal wall. The first report of uterine closure was in 1769 (6).

From 1878 to present, several modifications of the caesarean operation were made. The Porro operation was popular then in England and the US. The procedure entailed a laparotomy followed by a hysterotomy followed by supra-cervical hysterectomy and bilateral salpingo-oophorectomy (6). The rationale then was that by doing so, complications such as hemorrhage and sepsis would decrease. As such the mothers who underwent this procedure suffered from the effects of pre-mature menopause and the attendant sterility.

The first step toward the C - Section as it's done today was described by Sanger (6). He preserved the uterus, fallopian tubes and the ovaries. His procedure entailed a 2-cm wide wedge resection on the anterior uterine wall. He did so with the intent to have a thick edge of myometrium adjacent to the peritoneum and a thin edge adjacent to the endometrial cavity. These modifications allowed the serosal edges to be incorporated into the closure with interrupted silk sutures.

Further modifications emerged, to make the procedure safer. In 1876, Lister introduced pre-operative anti-microbial preparation, and included shaving of the operative field and applying anti-septic solutions to the operative field. The technique of laparotomy and site of uterine incision were vigorously debated and modified. Johnson in 1786, first described the lower uterine segment incision. In 1908, Selheim suggested that a lower uterine segment incision,

would decrease blood loss during surgery and decrease blood loss in the event of uterine dehiscence, as opposed to an incision made in the contractile segment of the uterus (6) .

1.3 Epidemiology of Caeserian Sections

C-Section rate is defined as the number of caesarean deliveries over the total number of live births, expressed as a percentage. In 1985, the WHO considered the ideal rate for C–Sections to be between 10% and 15% (7). This was based on the following statement made in Fortaleza Brazil: ”There is no justification for any region to have a rate higher than 10-15%”.This rate was arrived at from review of data mainly from Northern European countries, that demonstrated good maternal and peri-natal outcomes with this rate of C-Sections (7).

At population level C-Section rates higher than 15% are not associated with reductions in maternal and new-born mortality rates (7). Health care C-Section rates vary widely depending on the differences in the obstetric complications as well as clinical management protocols across various facilities. Therefore, population based recommended C-Section rates cannot be applied as the ideal rate at the hospital level. Since there has been a growing trend in increase of C-Section rates both in developing and the developed countries ,there is need to implement a standardized tool to monitor the performance of this surgical procedure (2). When medically justified caesarean sections can effectively prevent maternal and peri-natal morbidity and mortality (8).

Betran et al (2016) analyzed C-Section trends from 1990-2014 (1). He analyzed data from 150 countries to estimate global and regional C-Section rates. World-wide, the C-Section rates increased from 6% in 1990 to 19% in 2014. The average global rate of C-Sections as of 2014 was 18.6%, ranging from 6.0% to 27.2% in the least developed and most developed regions respectively (9). Latin America and the Caribbean region had the highest C-Section rates at

40.5%. Africa recorded the lowest rates of 7.3% with the lowest rates recorded from Western Africa at 3%, while the rate in East Africa was 3.9% (9).

Based on the data from 121 countries, the trend analysis demonstrated that between 1990 and 2014, the global average C-Section rate increased by 12.4% (from 6.7% to 19.1%), with an average annual rate of increase of 4.4%. For the same analysis Africa recorded an average increase of 4.5% (from 2.9% to 7.4%) (9).This analysis demonstrated that the C-Section rates for Guinea and Nigeria decreased while that of Zimbabwe maintained the same rate. All other countries analyzed demonstrated an increase in the C-Section rates at different levels. In Africa, Egypt, Tunisia and Morocco witnessed the largest rise. C-Section rates in Egypt rose from 4.6% to 51.8% over a 24 year period.

A multi-country study conducted between 2010-2011 by Medecins Sans Frontieres (MSF), in Sub-Saharan Africa (SSA), reported an overall C-Section rate of 6.2%, with prior caesarean delivery accounting for 14% (3). In Tanzania, repeat C-Sections accounted for 34% of all elective surgical deliveries carried out at the referral hospital in 2010 (10).

The Kenya Demographic Health Survey (KDHS) of 2014, reported a national C-S rate of 8.7% up from the one reported in KDHS 2008/9 of 6.2%.The survey of 2014 demonstrated a wide variation of C-Section rates per region. With the highest rate being reported in Nairobi county having a rate of 20.7% and the lowest rate in North-Eastern region with a rate of 2.9% (11)

1.4 Classification of Caeserian Sections

C-Section rates are a measure of the level of access to and utilization of this intervention. Traditionally, C-sections have been classified as either emergency or elective C-Sections. This

classification has been found to be too simplistic and does not factor in the urgency of the C-section (12).

Classification of the urgency of C-Section is currently the most consistent method approved by the Royal College of Obstetricians and Gynecologists (RCOG) as well as the Royal College of Anaesthetists (RCOA) in the UK (12). DN Lucas et al (13) proposed the following classification which has since been adopted by RCOG, where instead of Grades 1-4,the classifications are named Categories 1-4 (in the RCOG guideline),but with similar descriptions. (12).

Table 1: Classification of urgency of Caeserian Sections (13)

Classification	Indication
Category 1: **Emergency Caesarean section**	Immediate threat to the life of woman or fetus. Examples: Placental abruption, Uterine rupture
Category 2: **Urgent Caesarean section**	Maternal or fetal compromise which is not immediately life threatening Examples: Three previous C-Sections at 38 weeks, Meconium stained liquor, Non-Reassuring CTG
Category 3: **Scheduled Caesarean section**	Needing early delivery,but no maternal or fetal compromise. Examples: Pre-eclampsia, Pre-term IUGR
Category 4: **Elective Caeseran section**	At a time to suit the woman and maternity team. Examples: Breech presentation, nulliparous

1.5 Indications for Caeserian Sections (14)

Table 2: Indications of Caeserian Section, adapted from Zoe Penn et al, 2001

Indications	Examples
Maternal	Absolute: 1. More than 2 previous caesarean sections. 2. Obstructive lesions in the lower genital tracts.
Fetal	1. Abnormal lie or non vertex presentations 2. Multiple pregnancies: the first twin in a non-vertex presentation 3. Higher order multiples 4. Some congenital anomalies e.g. fetal anterior wall defects, fetal myelomeningocele 5. Vasa-praevia 6. Fetal macrosomia > estimated fetal weight > 5.0kgs 7. Fetal compromise 8. Maternal infections such as Primary Genital Herpes
Maternal-Fetal	1. Placenta-praevia 2. Obstructed labor

As outlined above, the indications' for C-Sections are mostly influenced by the clinical scenario. The decision to carry out the surgery is a joint decision between the health care provider and the patient, after evaluating the advantages and disadvantages of spontaneous vaginal delivery and a C-Section. This is the most frequent classification in most obstetric units.

C-Section for maternal request, in the absence of any obstetric indication is on the rise, particularly in high socio-economic status. It could reflect increased participation of the woman in the decision making process. Nearly all public health hospitals in Kenya have been classifying their C-Sections by the simple nature of either an emergency or elective category and by indication.

1.6 Outcomes of Caeserian Sections

C-Section is the commonest obstetric operative procedure worldwide. When judiciously and medically indicated, this procedure improves the health outcomes of both the neonate and the mother. However, when used in-appropriately the potential harm may exceed its potential benefits.

With the dramatic rise in the C-Section rates, associated maternal morbidity and mortalities have also been documented. Although the operation has over the years continued to become safer with advancements in anaesthesia and the surgical aspects being constantly appraised, continued efforts by the obstetrician to ensure that caesarean deliveries are not performed for in-appropriate indications would help reduce the complications.

Maternal morbidity and mortality have been a major public health concern across the globe. Despite maternal mortality falling by 45% since 1990, globally more than 800 maternal deaths are reported per day, with 99% of these deaths occurring in low and middle income countries (14). SSA region contributes to 62% of the reported global deaths. The lifetime risk of maternal death is 1/38 in Sub-Saharan Africa, compared with 1/3700 in high income countries (15). The risk of a mother dying after a C-Section is three times the risk of maternal death after vaginal delivery (16).

Every year, approximately 300,000 women die in child birth; 99% of them being from Low-Middle-Income countries. Sobhy S et al via the Lancet, in March 2019, after conducting a review of 12 million pregnancies between 1990 and 2017, concluded that maternal deaths

following C-Sections were 100 times more in the low-middle income countries compared to high income countries. This review indicated that women undergoing emergency C-Sections were twice likely to die than women undergoing elective C-Sections in Sub-Saharan Africa. The odds of this maternal death occurring were 12 fold if this life saving surgical procedure was conducted for a mother in second stage of labor as opposed to the first stage of labor. Similarly, perinatal deaths increased by 5 fold with emergency C-Sections vs elective C-Sections and 10 fold when undertaken in the second vs the first stage of labor. A third of all the maternal deaths were attributed to post-partum hemorrhage (17). A WHO analysis reported that of women who delivered by C-Section, 62.5% experienced a severe maternal outcome, compared to 37.5% who had vaginal deliveries (18).

Post-partum haemorrhage is the major cause of maternal mortality globally with an incidence of 2-11%. Accoridng to the WHO, 10.5% of births are complicated by PPH. PPH accounted for 26.7% of the severe maternal outcomes and hypertensive disease accounted for 25.9% (2). A study conducted in Senegal and Mali established that intra-partum C-sections was associated with a higher risk of maternal morbidity and mortality as well as increased risk of neonatal death as >24 hours of life (18). This study illustrated that C-Sections is associated with improved outcomes, but may also contribute to the exacerbation of others (19).

The rising rates of C-Sections has immediate consequences on the lives of women, their families, hospital facilities and a country in terms of volumes and costs. World leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 SGDS. An essential

component of maternal health is incorporated in Goal Number 3,which includes a reduction of the global MMR to less than 70 per 100,000live births by 2030 (7).

Kenya is evolving from a low to middle income country. Despite this milestone, our country is still ranked among the ten countries that contributes to 60% of global maternal mortality recording over 6000 maternal deaths annually (20). The maternal mortality rate at the close of MGDS in 2015 was 510 deaths per 100,000 live births, way below the target set for MDG5.For every woman who dies in child birth in Kenya, it is estimated that another 20-30 suffer from serious injuries or disability due to the complications accrued from child-birth. Majority of these deaths occur just before, during or after birth (7).

Neonatal mortality refers to death before one month of age. Recent global estimates are between 2.9 to 3.6 million deaths per year, with 50% of the deaths occurring within the first 24 hours. Birth asphyxia accounts for about 25% of these deaths (21). Dr Virginia Apgar in 1952 devised a rapid scoring system, now referred to as the APGAR score. This scoring system provides a rapid method of assessing the clinical status of the newborn infant at time intervals of one, five and ten minutes.

APGAR scores of less than 7 at five minutes is the most commonly used indicator to identify birth asphyxia in low-middle income resource settings, like Kenya. A low 5 minute APGAR score confers an increased relative risk of neonatal encephalopathy, and subsequent cerebral palsy, which is reported to be as high as 20-fold to 100-fold over that of infants with a 5 minute APGAR score of 7-10 (20). A 5-minute APGAR score of 0-3, correlates with neonatal mortality as reported in several large studies (22).

In SSA, neonatal deaths increased from 37% to 40% in 2010 (23). The neonatal mortality rate in Kenya (KDHS 2014) was 22 per 1000 live births. It has been suggested that access to emergency obstetric care, including C-Sections, could reduce the maternal mortality by 10-15 % (8). Birth asphyxia is one of the leading causes of newborn deaths, as demonstrated by data at the Kenyatta National Hospital, one of the national referral hospitals' in Kenya. Maalim et al carried out a study at the Kenyatta National Hospital's new-born unit. He reported that peri-natal asphyxia had a poor outcome with a mortality rate of 31% by day 7 of life.6.7% of the remaining babies were discharged home with neurologic sequelae (24).

Ngugi et al in 2009 conducted a prospective cross sectional study to establish the pattern of perinatal morbidity and mortality among babies delivered by C-Section at Pumwani hospital. In his study asphyxia and respiratory distress were the leading morbidities: 8.9% of the live births had severe asphyxia, while 32.8% of had moderate asphyxia; among the sick babies on day 7, 55.6% had complications of asphyxia. His study posted an early neonatal mortality rate of 161.9 and a crude peri-natal mortality rate of 276.2 per 1000 with asphyxia accounting for 60% of these early neonatal deaths (25).

Peri-natal mortality ratio, birth asphyxia, and maternal mortality ratio were chosen to characterize early peri-natal and maternal outcomes. This study aimed to compare the C-Section rate and these targeted outcomes, for each of the ten groups in the Robson classification. Peri-natal mortality ratio is defined as the total number of still-births and early neonatal deaths occurring at hospital within seven days after birth per 1000 deliveries. Birth asphyxia is described as the number of live births with an APGAR score of <7 at five minutes per total number of live births. To estimate maternal outcomes, the maternal mortality ratio (number of maternal deaths per 100,000 live births).

2.0 LITERATURE REVIEW

2.1 Background

With the increasing rates of C-Sections across various countries, there has been an urgent and a widespread concern over the associated morbidities and complications, as well as, long term effects of this surgical procedure. It is however difficult to determine optimal rates for institutions, especially referral hospitals. Setting up optimal rates needs to consider the possibility of unmet need for C-Sections as well as the detrimental effects this would have on the gains made on improved maternal and peri-natal health (10). It has been suggested that C-Section rates should no longer be thought of as being too high or too low but rather whether they are appropriate or not, after taking into consideration all relevant information (9).

Before any health institution can propose and implement effective measures to monitor the C-Section trends, an appropriate and universally acceptable classification system of the C-Sections is required. In 2011, Maria RT carried out a systematic review to identify the main classification systems that exist for classifying C-Sections and to analyze the advantages and the deficiencies of each system (4). Close to 27 classifications systems have been described in literature to assess caesarean sections (4). These analyze C-Sections based on:

Indication based classification systems: Classification of caesarean sections based on Indications for C-Sections are the most frequent types. This classification answers the Question- **Why** was /is the C-Section performed. 12 different classification groups are in this category. However, all the 12 models in this classification system have categories that are not mutually exclusive and have low reproducibility.

Degree of urgency of the caesarean section: This classification system basically answers the question of –**When or How** quickly the prescribed C-Section is to be done so as to get better maternal and peri-natal outcomes depending on the clinical scenario. 5 different classification systems fall in this category. This classification system provides a better means of communication among the team members working in the maternity unit. A major weakness of this classification system is the lack of clear and unambiguous definitions, so as to minimize inter-rater reproducibility, comparability and interpretation. The most widely used is that Proposed by Lucas et al which has also been adopted by RCOG (12).

Women based classification system: 4 various classification systems are in this category, with the Robson classification being the one preferred and adopted by WHO as from 2011. This classification system provides information on-**Who** is/are undergoing C-sections. This classification system provides information on maternal and pregnancy characteristics. The main draw-back for this classification is failure to provide information as to why the C-Section was done. Denk et al in 2006, proposed an eight group classification system that grouped the mothers broadly into those that with primary C-Sections and those with Repeat C-Sections (4).

Clealry et al in 1996, had a one category classification system (4). This group of women were identified as the "standard primipara" in Australian literature. This group of women were first time mothers, aged between 20-34 years, of >155cm.The pitfall of this classification was its non-inclusivity especially for the African population. Lieberman et al 1998, had a three group classification system based on parity and prior C-Section. Of the four classification systems, the ten group Robson classification system stands out for its mutual exclusivity and inclusivity, simplicity, reproducibility and robustness.

2.2 The Robson Classification system

Dr Michael Robson in 2001 proposed what is now known as the Robson classification (27). The classification stratifies women according to their basic obstetric characteristics, allowing a comparison of C-Section rates with fewer confounding factors. This classification allows for comparison of C-Section rates across different facilities, regions and countries in a useful and action oriented manner.

The Robson classification is a ten group classification system using ten -10- mutually exclusive and totally inclusive categories for caesarean section, meaning that all women can only be classified into one group.

Table 3: The Robson Classification

Group 1	**Nulliparous, single, cephalic,>37weeks,sponatenoues labor**
Group 2	Nulliparous, single, cephalic, >37 weeks, induced labor or Delivered by caesarean section before labor.
Group 3	Multi-parous women, no previous uterine scar, single, cephalic >37 weeks, spontaneous labor.
Group 4	Multi-parous women, no previous uterine scar,>37 weeks, either had induced labor or were delivered by elective caesarean section.
Group 5	All multi-parous women, at least one previous uterine scar, single, cephalic,>37 weeks gestation
Group 6	All nulliparous women, single, breech pregnancy (all nulliparous women with breech presentation)
Group 7	Multi-parous women, single, breech, Including women with previous uterine scars. (all multi-parous women with breech presentation)
Group 8	All women with multiple pregnancies ,including women with previous uterine scars (all multiple pregnancies)
Group 9	All women with a single pregnancy, transverse, oblique, including women with previous uterine scars. (all abnormal lies)
Group 10	All women with single, cephalic, <37 weeks, including women with previous scars.

To date about 73 countries have used the Robson classification, including four countries in Africa: Tanzania, Ghana, South-Africa and Senegal (27). Those who have used it praise it for its simplicity, robustness, reproducibility, flexibility, clinical relevant classification and categorizes women prospectively which in turn allows implementation and evaluation of interventions targeted at specific groups.

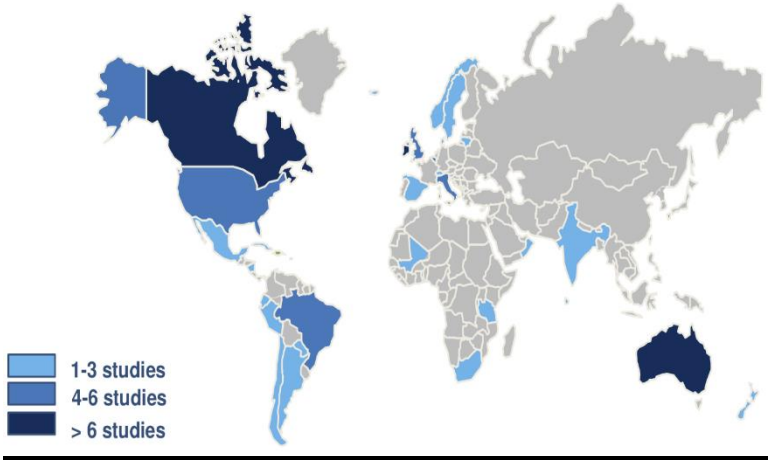


Figure 1: Distribution of the 73 articles on Robson's classification according to country of origin

About 4 countries in Africa have used the Robson classification to analyze their C-Section rates: Samba et al in Ghana, conducted such a study at Korle –Bu Teaching hospital in Accra over a12 month period in 2015. He recorded a –Section rate of 46.9%.The key drivers he identified to this C-Section rate were: group- 5, with 11.2%, group-4 with 5.7% and group- 2 with 5.4% (28).

Magatte M et al in 2013, carried out a similar study in Senegal at the Philippe Senghor Health center in Dakar. He reported a C-Section rate of 18.2%. The groups contributing to the reported C-Section rate were: Group-5 at 20.5%, group-1 at 34.2% and group-3 at 17.6% (28). V Makhanya et al conducted a 3 month survey at the Lower Umfolozi War Memorial District Hospital in 2015, using the Robson classification. He reported a C-Section rate of 42.4%, with group 1-contributing 27.4%, group 5-17.2% and group 3-15.2% (27).

As such The Robson classification adds meaning to the reported C-Section rate; it provides additional information on the key drivers to the observed C-section rate reported. As such, it

can be used to monitor C-Section trends and effectiveness of interventions targeted at reducing the C-Section rate across specific groups. The Robson classification shifts focus to specific groups, prompting Obstetricians and policy makers to come up with programs and /or interventions to help reduce C-Section rates as per the specific groups.

Various studies have been conducted on the C-Section rates in Kenya, two of such studies have been conducted at the Pumwani Maternity Hospital: P Gichangi et al in 2001, carried out a study to assess the rate of C-Section as a process indicator of safe motherhood programmes in Kenya. His study documented a significant rise in the rate of C-Section at the PMH from 4% in 1983 to 9% in 1997 (30).

Ngugi et al in 2009 conducted a prospective cross sectional study to establish the pattern of perinatal morbidity and mortality among babies delivered by C-Section at Pumwani hospital. He reported a C-section rate of 17.7% (25). It is important to note, that none of the two studies applied the Robson classification in their study.

In 2014, the WHO after 3 years since it recommended Robson classification, conducted a systematic review of users' experience with the Robson classification. The review was aimed at assessing the pros and cons of its implementation and barriers. From this review, the following recommendations as regards the use of the Robson classification were made by a panel of experts convened by WHO, in Geneva, October 2014 (26): Every woman admitted into the obstetric unit for delivery must be categorized as per the Robson classification.

The ten groups can further be divided to analyze other variables like epidemiological data, costs, outcomes and indications within each of the ten groups. Whenever possible the results of the classification should be publicly available.

Marcos et al (2016) (30) used the Robson classification to assess C-Section rates in Brazil. He reported a C-Section rate of 51.9%, (42.9% in the public health care facilities and 87.9% in the private health sector). The Robson groups 2 (nulliparous, term, cephalic, induced or caesarean delivery before labor), 5 (multiparous, term, cephalic, previous C-Section) and 10 (cephalic, pre-term) had the highest impact on Brazil's C-Section rate in both public and private hospitals. These three groups accounted for more than 70% of C-Sections carried out in Brazil.

Keisuke et al (2017) (31) carried out a study in Australia, using the ten group Robson classification to identify strategies to optimize caesarean section rates. The C-Section rate was recorded at 23.5%.Women in Group-5 contributed 10.9% of the overall C-Section rates, Women in Group-2 had a C-Section rate of 24.5% and those in Group-1 (nulliparous, single, cephalic, term, spontaneous labor) had a rate of 11.9%.

In Tanzania, Helena Litorp used the Robson classification to analyze the increasing C-Section rates among low-risk groups. The C-Section rate reported for 2011 was 49% a rise from the 19% recorded in 2000.Women in Group-4 (33) had the highest increase of C-Section rates from 26% in 2000 to 91% in 2011. The Kenya Demographic Health Survey (KDHS) of 2014, reported the rate of C-Section in Kenya to be at 8.7%, indicating a rise from 6% in 2009 (34). The C-Section rate at the Agha-Khan University Hospital, a private tertiary teaching hospital, was reported to be 38% (35).

Since the introduction of the Robson classification in 2001, many facilities globally have implemented it in their routine clinical practice. The first systematic review was conducted by AP Betran in 2014 (36) with an intent to explore users' related pros and cons of the adoption, implementation and interpretation of this classification. The major findings of this systematic review are summarized as below:

2.2.1 Strengths of the Robson Classification system

The Robson classification has been hailed for its simplicity, reproducibility, robustness and flexibility. This classification has been found to be clinically relevant and allows for women to be classified prospectively, which in turn allows for implementation and evaluation of targeted interventions aimed at reducing C-Section rates per Robson Group. It is suitable for implementation even in low resource settings as the resources and variables needed to implement it are considered minimal and are already in place in every obstetric unit globally. Additionally, since this classification doesn't require the indication for the performance of C-Sections to be indicated, as this information may not be routinely collected and when it is, it's subject to variability among different obstetric units. Robson classification challenges the myths about the alleged drivers of a C-Sections such as breech deliveries and multiple gestations.

2.2.2 Weakness of the Robson Classification System

One of the major drawbacks of this classification, is its inability to provide crucial information as to the indications for the performance of C-Sections. It also doesn't factor in maternal and fetal factors that influence the decisions for C-Sections such as maternal medical conditions. The weakest point of its use is with the interpretation of results .To mitigate this, the implementation manual was released by Robson. However, this set of rules are yet to be validated and may not be applicable in all circumstances.

2.2.3 Recommendations for the Robson Classification system

The flexibility of this classification could be explored to allow for sub-divisions of the major 10 groups as well as merging of some groups to improve on sub-analysis of local practices. Merging of Robson Groups 1 and 2 to analyze all nulliparous women, while merging Robson groups 3 and 4 for multiparous women have been proposed by several authors. To provide, more in-depth analysis, several users proposed the indication, epidemiological data and outcomes for C-Sections be added across the ten groups.

3.0 STUDY JUSTIFICATION

Over the past 30 years since the WHO set the ideal rate for C-Sections as 10-15% at the population level, there has been a public concern over the increasing rates of C-Sections. The KDHS-2009 reported the C-Section rate to be at 6%, while the rate as reported in 2014 was at 8.7%. The National Hospital Insurance Fund (NHIF), in June 2017, raised a concern following a report that showed that C-Sections accounted for 61% of the NHIF's maternity costs, and that more than one third of women covered by the fund were delivered via C-Section. Therefore there is the need to interrogate the C-Section rates further.

Currently the heterogeneity of C-Section classification does not allow for valid comparisons. The key issue to addressing the challenge in defining optimal C-Section rates has been the lack of a reliable and internationally acceptable classification system. A classification system that can produce standardized data enabling comparisons across populations and providing a tool to investigate the drivers of the upward trend of C-Section rates would be the cornerstone in addressing this growing challenge.

In Kenya, there are no studies addressing the classification of C-section rates as per the Robson classification hence making it difficult to gauge and compare with other countries in the region. Assessment of the C-Section rates using internationally accredited Robson's criteria will therefore demonstrate which category of mothers is the key driver or drivers to the growing trend in C-Section rates in the country. It will also provide an important tool that will be used to efficiently monitor the C-Section rates and associated maternal and peri-natal outcomes, across various facilities in the country, in a meaningful, targeted and transparent manner.

Such a simple, reproducible and robust classification, would allow for comparison within health-care facilities over time; across various facilities within the country as well as a region in East Africa and on larger scale, globally. This classification would help in generating policies, interventions, as well as being a tool for monitoring and evaluating, on programs seeking to reduce C-Sections among the various ten groups of the Robson classification.

4.0 CONCEPTUAL FRAMEWORK

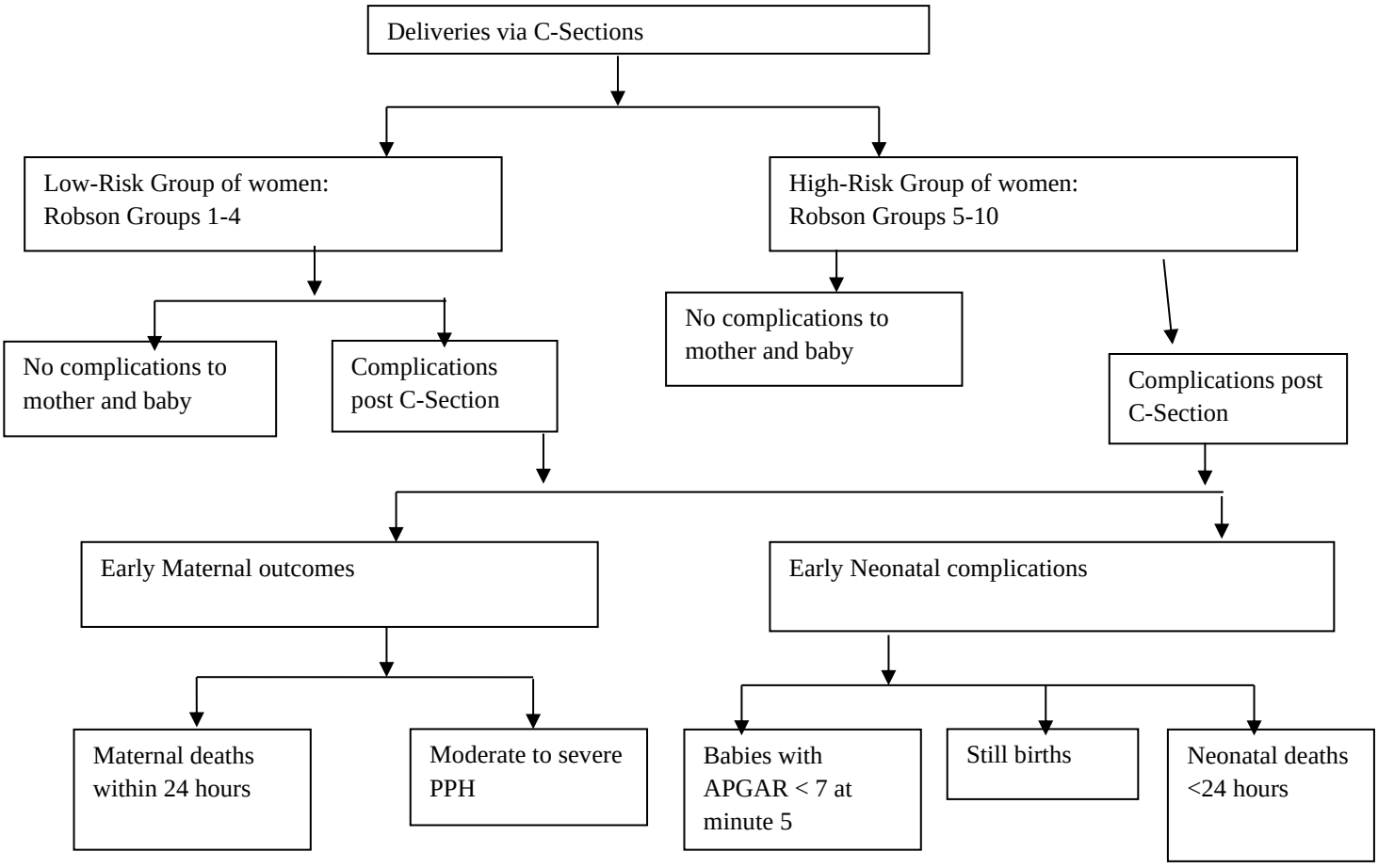


Figure 2: Conceptual framework

Conceptual framework narrative

Facility based deliveries are routinely classified as either C-section or vaginal deliveries (which has spontaneous vertex deliveries, breech deliveries and assisted vaginal deliveries). The rising C-Section rates are associated with increased maternal and neonatal complications which include but not limited to maternal mortalities, severe post-partum hemorrhage necessitating blood transfusions, peri-natal mortalities, severe birth asphyxia.

The Robson classification broadly groups women into either low risk or high risk. The low risk women are most often projected to have vaginal deliveries, while the high risk group most often are delivered via C-Section .The classification therefore identifies the groups of women maintaining the high C-Section rates across any obstetric unit. Interventions implemented to curb the rise in these rates can also be implemented across the groups, and their effectiveness assessed.

The classification system has been used in various countries to provide information on the key contributors on the reported C-Section rates. Additionally the Robson's classification can be modified to report on early pregnancy outcomes across the ten groups.

5.0 RESEARCH QUESTIONS

5.1: What was the caesarean section rate at the Pumwani Maternity Hospital for the year 2016?

5.2: What are the individual contributions and early maternal and neonatal outcomes of the ten groups as per the Robson classification to the overall C-Section rate for the year 2016?

6.0 BROAD OBJECTIVE

To analyze the C-Section rates and early pregnancy outcomes according to the Robson-Ten group classification, among women delivering at the Pumwani Maternity Hospital from 1st January 2016- 31st December 2016.

7.0 SPECIFIC OBJECTIVES

1. To determine the C-Section rate for the year 2016, at the Pumwani Maternity Hospital
2. To classify the C-Sections done at the Pumwani Maternity Hospital for the year 2016, as per the Robson ten groups and to establish the rate of C-Section in each group

3. To describe early pregnancy outcomes, (outcomes within 24 hours), among women who delivered via C-Section a as per the Robson ten groups, at the Pumwani Maternity Hospital

4. To establish the socio-demographic characteristics of women who delivered via C-Section at the Pumwani Maternity Hospital, between January 2016 and December 2016

8.0: STUDY METHODOLOGY

8.1: Study Design

This was a retrospective descriptive-cohort study conducted over a period of 12 months from January 2016-December 2016. Data was collected from the Pumwani Maternity Hospital (PMH) records.

8.2 Study Area

The study was conducted at the PMH, which is located in Nairobi County, the capital city of Kenya. PMH serves as a referral maternity hospital serving the Eastern side of Nairobi County. The hospital was established in 1926 and in 1944, it's management was taken over by the municipal council of Nairobi. PMH serves as the pioneer hospital in the provision of maternity care in SSA and is currently the largest maternity hospital in East and Central Africa. By its location it caters mostly to the needs of women of low socio-economic levels. PMH has 354 obstetric beds and 2 dedicated maternity theaters.

The government of Kenya has since June 2013, been providing free maternity health care across all government hospitals. The unit serves between 40-60 mothers per day, and conducts about 16,000 deliveries annually (both vaginal and C-Section deliveries). On average three hundred (300) of these deliveries are via C-Sections per month.

For every 12 hour shift, the unit is ran by 7-10 nurses-trained in midwifery and emergency obstetric care, 1 medical officer covering the labor ward, 1 medical officer running the triage in the obstetric unit, 1 medical officer running the maternity theatre (when the unit is busy, 2 medical officer are engaged to run both maternity theatres) and 1 consultant. The antenatal and postnatal wards are covered by 2 medical officers, with the back-up of the one consultant. It's the medical doctors who prescribe the caesarean sections when one is indicated.

PMH was ideal for this study to be carried out because of the large number of mothers served in this institution. This study area provided data which mirror the situation in the rest of the county hospitals in the country, offering an ideal study site to assess how applicable the Robson Classification was in analyzing contributors to the C-Section rate across the county hospitals in the country.

8.3 Study population

Records for all mothers who delivered at the PMH between 1st January 2016-31st December 2016 were identified and the sample of 403 as calculated below extracted for data abstraction using the data abstraction tool in annex 2.

Inclusion criteria

1. All women who delivered via C-Section at Pumwani Maternity Hospital, during the study period, were included in the study.
2. Women aged 14 years and above

Exclusion criteria

1. All mothers who delivered via C-Sections outside Pumwani Maternity Hospital

2. Unknown gestation, gestational age <28 weeks (including miscarriages and ectopic pregnancies.)

8.6 Sample size

The sample size of women undergoing caesarean section during the study period will be calculated using the formula for finite population (less than 10,000).

$$n = \frac{Nz^2pq}{E^2(N-1) + z^2pq}$$

n = Desired sample size

N = population size (number of women undergoing caesarean section per month at the PMH is approximately 550, and a retrospective scan of the files for 12 months from January 2016 to December 2016 will be approximately 6,600).

Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

p = expected true proportion (estimated at 20.5%, from the study conducted by Mbaye M. et al (2013) analysis of cesarean section rate according to Robson's classification in an urban health centre in Senegal, 20.5% of the caesarean section were from the Robson group 5.)

$$q = 1 - p$$

E = desired precision (0.05)

$$n = \frac{6{,}600\ x\ 1.96^2 x\ 0.205\ x\ 0.795}{0.05^2(6{,}600-1) + (1.96^2 x\ 0.205\ x\ 0.795)} = 242$$

To factor in for missing data, the formula of 1/1-f*the calculated sample size of 242 will be used. Prof. E. Cheserem in her study on establishing the characteristics and management of ovarian cancer at the Kenyatta National Hospital in 2013, established that missing data accounted for 36%, rounded of to 40%.

Hence, the sample size: = (1/1-f)*242

Where f=40%

(1/1-0.4)*242 = (1/0.6)*242

242*1.25= 403

403 were the minimum sampled files sampled in this study. To improve on the precision of the study, 500 files were sampled.

8.7 Sampling Procedure

This was done in two stages:

Stage 1: Identification of all records for the 12 month period (from January to December 2016). These records were serialized from 0001 to the last one. In view of the seasonal fluctuations of the deliveries, the records were batched in quarters as follows:

Table 4: Number of deliveries per quarter, for the period between January 2016 to December 2016

Quarter	Total number of hospital deliveries	Total number of Caesarean Sections
Quarter one	4882	1214
Quarter two	5174	1266

Quarter three	4112	990
Quarter four	2636	561
Total for 2016	16804	4031

Stage 2: Proportionate sampling was used to identify the number of files to be picked from each quarter using the formula as follows:

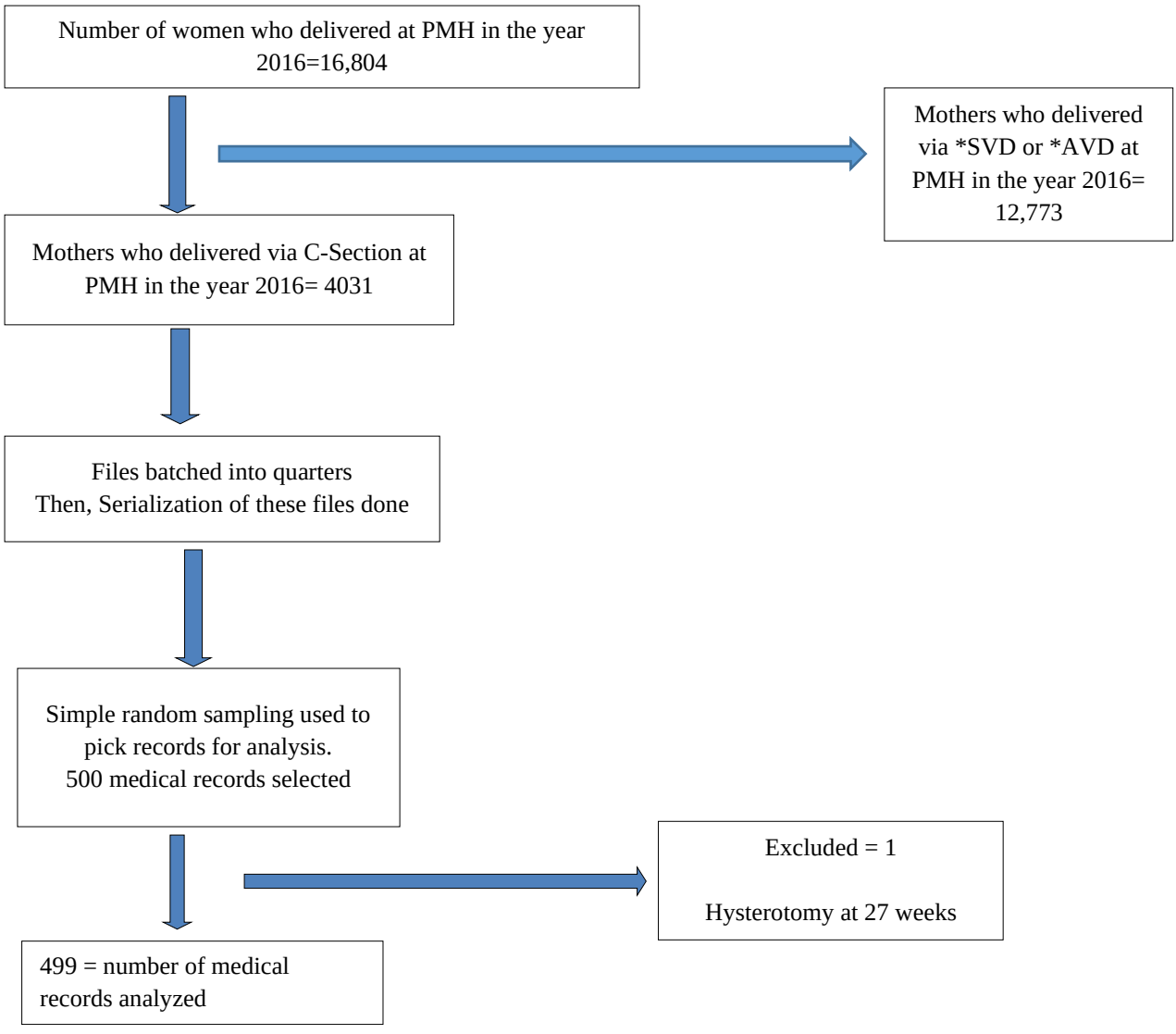
$$\frac{\text{Total C-Sections for the quarter}}{\text{Total C-Sections for 2016}} \times \text{Sample size (499)}$$

Table 5: Proportionate Sampling

Quarter	**Total Number of C-Sections**	**Total number of files sampled per quarter**
Quarter one	1214	150
Quarter two	1266	158
Quarter three	990	122
Quarter four	561	70
Total for 2016	4031	500

Stage 3: Random sampling using random sample tables was used to pick the records for review from each quarter. Once randomly identified, the records were color coded and data collected using the data abstraction tool attached in annex 2.This is summarized as below in Figure: 3.0

Figure 3.0: Study Flow Chart



8.8 Data variables

The following variables were used and data collected from patient records

Table 6: Study Variables

Variable	Type of variable
Number of caesarean section	Outcome
Indications for caesarean section	Exposure
Outcomes of the caesarean section: Maternal: Postpartum hemorrhage: early maternal death Neonatal: Birth Asphyxia, Sepsis	Outcome
Nulliparous,single,cephalic,>37weeks,sponatenoues labor	Outcome
Nulliparous,single,cephalic,>37 weeks, induced labor or Delivered by caesarean section before labor.	Outcome
Multi-parous women, no previous uterine scar, single, cephalic >37 weeks, spontaneous labor.	Outcome
Multi-parous women, no previous uterine scar,>37 weeks, either had induced labor or were delivered by elective caesarean section.	Outcome
Multi-parous women, at least one previous uterine scar, single, cephalic,>37 weeks gestation	Outcome
Nulliparous women, single, breech pregnancy (all nulliparous women with breech presentation)	Outcome
Multi-parous women, single, breech, Including women with previous uterine scars (all multi-parous women with breech presentation)	Outcome
Women with multiple pregnancies ,including women with previous uterine scars (all multiple pregnancies)	Outcome
Women with a single pregnancy, transverse, oblique, including women with previous uterine scars (all abnormal lies)	Outcome
All women with single, cephalic, <37 weeks, including women with previous scars.	Outcome

8.9 Data collection

Once permission to collect data was granted, the identified charts were extracted from the records department. Two research assistants, with data collection and clinical background training were hired and trained to help in the data collection. Data was collected using the data abstraction tools as attached in annex 2.

8.10 Data Management and Analysis

Data was collected by filling in the pre-coded data abstraction form. This was verified by the principal investigator on a daily basis to ensure completeness. The data were then entered in an MS access database for data cleaning. The extracted data was entered and analyzed by use of SPSS (Version 21.0, Chicago-Illinois). Section A of the data extraction tool which captures demographic and obstetric detail data was analyzed and presented as frequencies and proportions and where applicable the mean plus the associated standard deviation, median and 95% confidence interval was calculated.

Section B and C of the tool which captured the maternal and neonatal outcomes was analyzed and presented as frequencies and proportions. Chi square test was used to test associations between maternal and neonatal outcomes and the different classifications based on Robson's criteria. Multivariate analysis was done to assess the inter and intra class variations for the associations between Robson's classification and C-Sections.

8.11 Data Quality

A pre-testing exercise was conducted to help ascertain and assess the reliability of the data abstraction form in collecting the intended information. 10% of the sample size, randomly selected-24 files- was used in the pilot study to help in determining the adequacy of the data

abstraction form. The principal researcher sought the assistance of two research assistants. They were recruited based on their experience on medical data collection. They were trained on confidentiality, information retrieval and filling in of the data abstraction form.

The principal investigator ensured regular monitoring and supervision of the research assistants during the data collection period. This included checking each of the data abstraction forms for completeness. Periodically, once 20 data abstraction forms had been filled in, 10 of them were randomly picked and manually checked against the primary data source-patient's files-to ensure accuracy of the data collected.

8.12 Study Procedures

Once the approval was granted from the Kenyatta National Hospital/University of Nairobi Ethical Review Committee (KNH/UoN/ERC), an approval from the Pumwani Maternity Hospital Research and Ethics committee was applied for. The patients' files were retrieved from the Health Information Department at the PMH.

Patient records files that met the exclusion criteria were excluded. Using the structured pre-coded data form, the relevant information was retrieved; then each sampled patient was classified into the appropriate Robson group. Two outcomes of interest for the maternal arm were analyzed. These included the rate and percentage of mothers with moderate to severe PPH within 24 hours of delivery and maternal death rate within 24hours, in each of the ten groups in the Robson classification. Similarly the APGAR scores of <7 at minute 5, and the peri-natal deaths (occurring within 24 hours) were analyzed as outcomes of interest for the neonatal arm, in each of the ten groups in Robson classification. This was expressed as rates and percentages.

8.13 Ethical Considerations

Ethical approval was obtained from both the Kenyatta National Hospital -University of Nairobi Ethics and Research committee (KNH - UoN ERC) **(P712/11/2017)** and the Pumwani Maternity Hospital Ethics Committee (**PMH/DMOH/75/0248/2018**), attached as annex 3 and 4 respectively. No harm befall the study subjects, since this study retrieved its information and data not from the patients' themselves, but from their hospital files. To maintain patients' confidentiality, patients' names and their hospital numbers were not used. Instead, unique study number on each data extraction form was allocated for purposes of identification during data collection, analysis and presentation. The findings of this study will be shared with PMH and the National Reproductive Health unit for possible in-corporation into standard operating procedures in the management of expectant mothers during delivery.

9.0: STUDY STRENGTHS

This study was conducted at Pumwani Maternity Hospital, which serves a large catchment area in Nairobi County. By virtue of its location, it caters for women of low social economic status. The study was conducted 3 years after the implementation of free maternity services in all public health hospitals, hence the performance of C-Sections was not dependent on affordability. Majority of the mothers sampled had primarily sought maternity services from this institution with only 3% being referral- ins. Therefore the results of this study could be generalized to most county hospitals in Kenya. This was the first time the Robson classification was being used to assess C-Sections and early pregnancy outcomes in this institution.

10.0: STUDY LIMITATIONS

Incompleteness of information and incorrect recording of the medical records were reasons for exclusion of some data (1 record).The core variables for the Robson classification (parity, gestational age, fetal presentation, number of fetuses, history of prior C-Section scar and onset

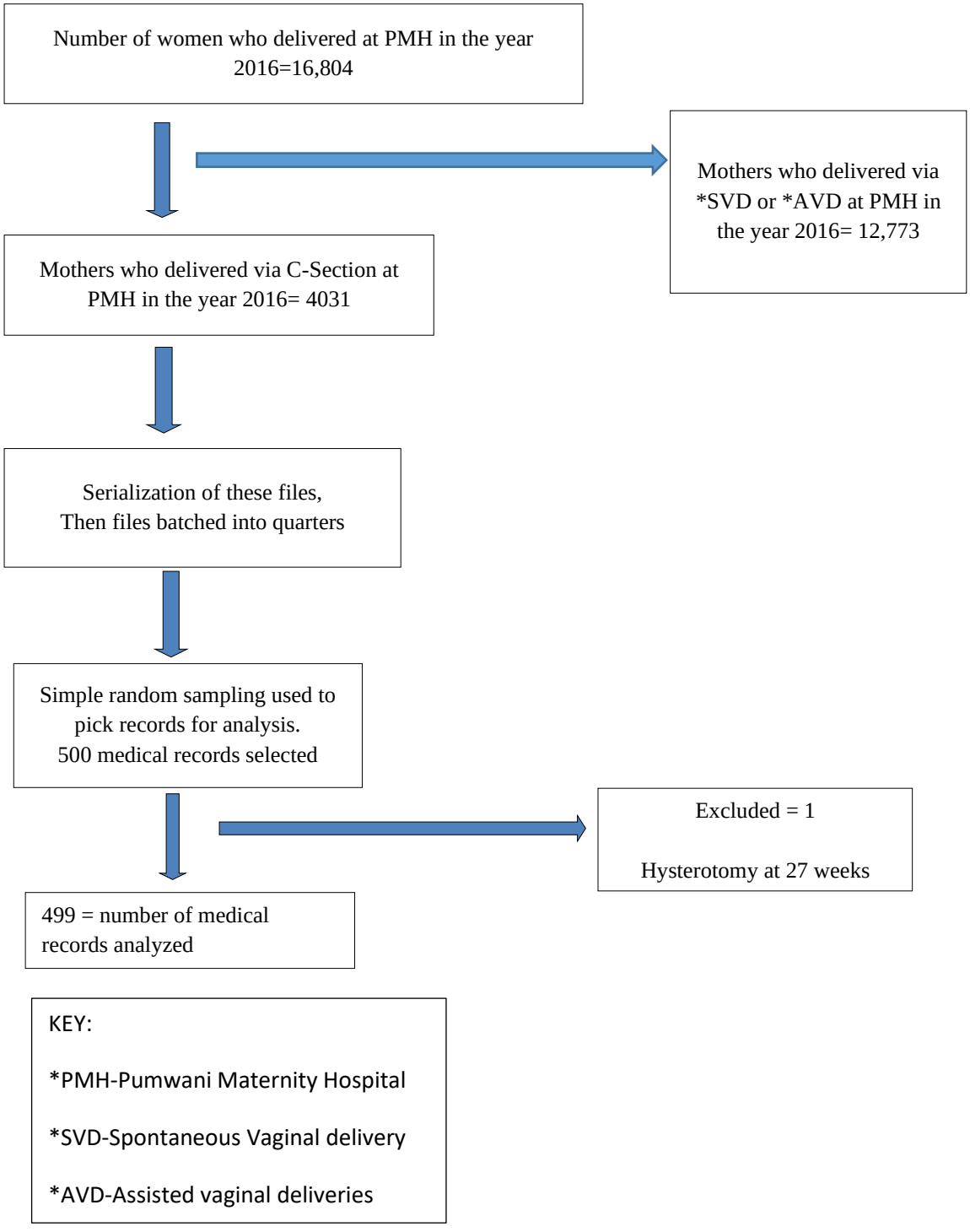
of labor) are part of routine obstetric assessment. The retrospective nature of the study might have affected the results due to incompleteness of the medical records. To mitigate this, the WHO, on November 2017, provided Robson implementation manual. This manual, provides for missing variables, and advises that where there are missing variables the women affected shall be reported at the footnote of the table. This category informs on the quality of data that a hospital has, and helps an institution to improve on the future data collection. In our study, we documented them as Robson group -0 and they accounted for 3% of the mothers sampled.

We were unable to compute the relative size of each Robson group, and we therefore cannot compare the women who delivered via vaginal or assisted vaginal delivery with women who delivered via C-Sections. This is because it would have required the analysis of all the 16,804 deliveries for the year 2016, as per the Robson classification, a task beyond the study timelines and budget of this study. Perhaps future studies will be able to provide this information.

11.0: RESULTS

Between February 2018 and April 2018, a total of 4031 patient records were retrieved from the Pumwani Maternity Hospital records department. After the two-stage sampling criteria, earlier described, 499 files were included in the study as shown in figure 4.0 below:

Figure 4.0: Study Flow Chart



11.1: Social Demographic Characteristics of the Mothers Who had C-Sections during The Study Period

During the study period, there were 16,804 deliveries out of which 4,031 were C-sections translating to a C-Section rate of 24%. The mean age of the mothers was 25 years (SD, 22-28), majority were married at 92%, those with secondary level education at 61% (for those with records), while 14% of study participants with records had formal employment. Of the mothers who underwent C-Sections 6 % were referrals, as outlined in Table 7.

Table 7: Social-demographic characteristics of women who had C-sections at the Pumwani Maternity Hospital between January-December 2016.

Characteristic	Frequency N=499	Percentage (%)
Age in years		
Up to 19	47	9.4
20 – 29	352	70.5
30 – 39	97	19.4
40 and above	3	0.6
Marital Status		
Married	457	92
Single	42	08
Level of Education		
Primary	73	15
Secondary	152	30
Tertiary	24	05
Missing Data	250	50
Employment status		
Employed	28	14
Un employed	178	86
Missing data	293	59
Admission		
Primary	469	94
Referral	30	06

11.2: Obstetric characteristics of women who underwent C-section at the Pumwani Maternity Hospital for the year 2016.

As shown in Table-8, 40% of the women who underwent C-Sections at this facility were first time mothers, (primigravidae). The table below presents a summary of the parity of the women who underwent C-Section at this facility.

Table 8: Parity of women who had C-sections at the Pumwani Maternity Hospital between January-December 2016.

Parity	Frequency (n=499)	Percentage
Para 0	225	45.1%
Para 1	148	29.7%
Para 2	83	16.6%
Para 3	28	05.6%
Para 4	09	01.8%
Para 5	05	01.0%
Para 7	01	00.2%

11.3 Analysis of C-section rates and early pregnancy outcomes as per the Robson classification

The largest contributor to the overall C-section rate was **Group-1**. This group had a C-Section rate of 36%, of the overall 24%. The second highest contributors were Robson groups 3 and 5, whose individual contribution to the overall C-section rate was 24% each. Descriptions of the 10 groups in the Robson classification and percentage contribution by each group to the overall C-Section rate, at the Pumwani Maternity Hospital, for 2016 are as shown in Figure 4 and Table 9:

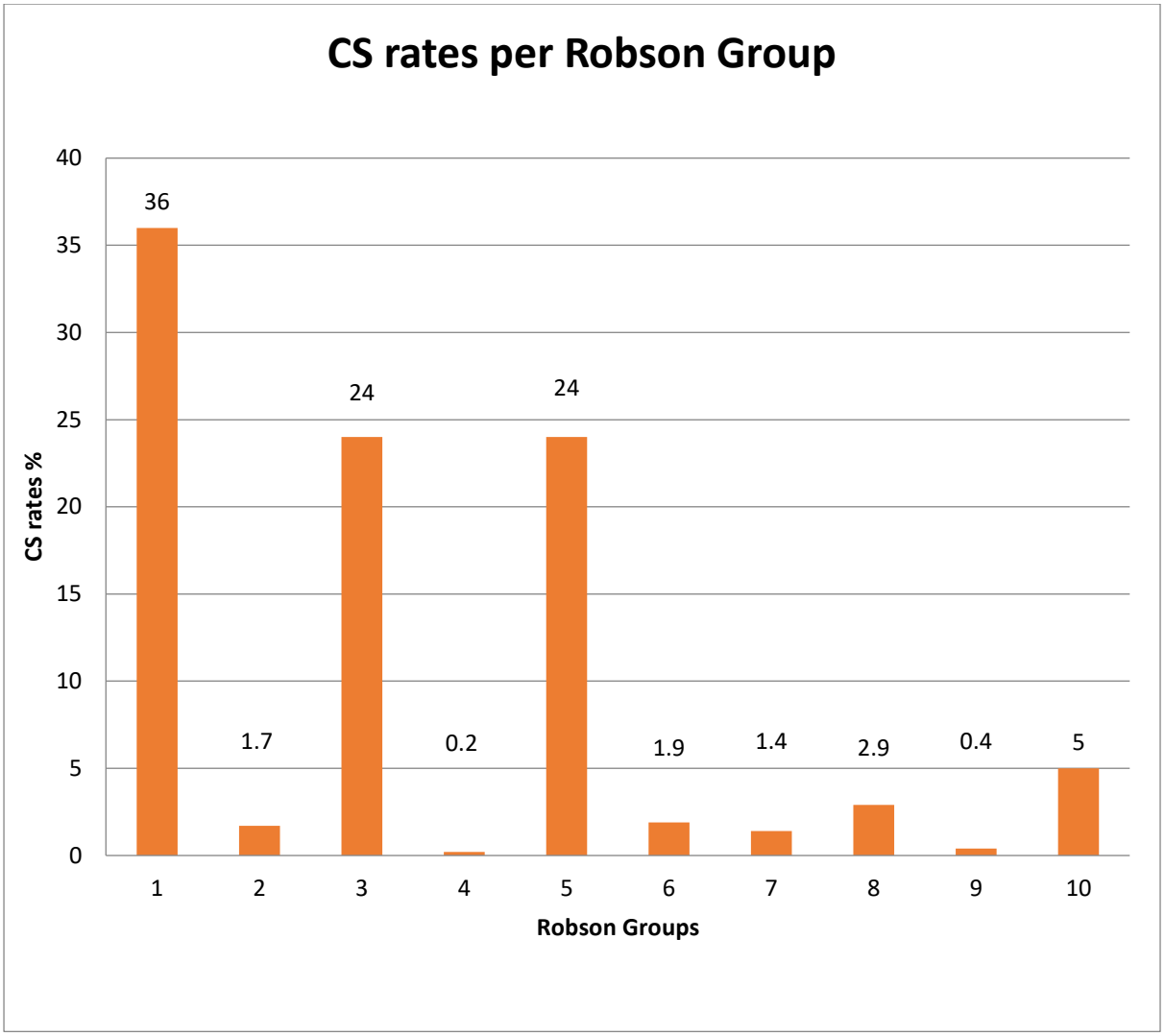


Figure 4: Distribution of CS Rates as Per the Robson Classification at the Pumwani Maternity Hospital between January-December 2016.

Table 9: Robson's classification and percentage contribution by each group to the overall C-Section rate at the Pumwani Maternity Hospital, for the year 2016.

Group	Description	N	Contribution to the overall CS rate
1	Nullipara: single cephalic term pregnancy*; spontaneous labour	180	36.1
2	Nullipara: single cephalic at term; planned CS or induced labour	08	1.6
3	Multipara without uterine scar: single cephalic at term*; spontaneous labour	118	24
4	Multipara without uterine scar: single cephalic term pregnancy*; planned CS or induced labour	01	0.2
5	Multipara with a scarred uterus: single cephalic term pregnancy*	120	24
6	All nulliparous: singleton breech presentation	09	1.8
7	All multipara: singleton breech presentation (including women with a scarred uterus)	07	1.4
8	All multiple pregnancies (including women with a scarred uterus)	14	2.8
9	All women with single oblique or transverse pregnancy (including women with a scarred uterus)	02	1.4
10	All women with a singleton cephalic preterm pregnancy <37 weeks' gestational age at delivery	25	5

*At least 37 completed weeks of pregnancy

11.4: Analysis of early post-natal outcomes, per Robson classification

11.4.1 Maternal Outcomes

All the sampled women across all the ten Robson groups were alive within the first 24 hours after delivery. The mean amount of blood lost during C-section was 516.05mls (SD= 85.93). The lowest amount of blood lost was 400mls while the highest was 1,500mls. A total of 8 women lost at least 1,000mls during the surgical operation as depicted in figure 5.

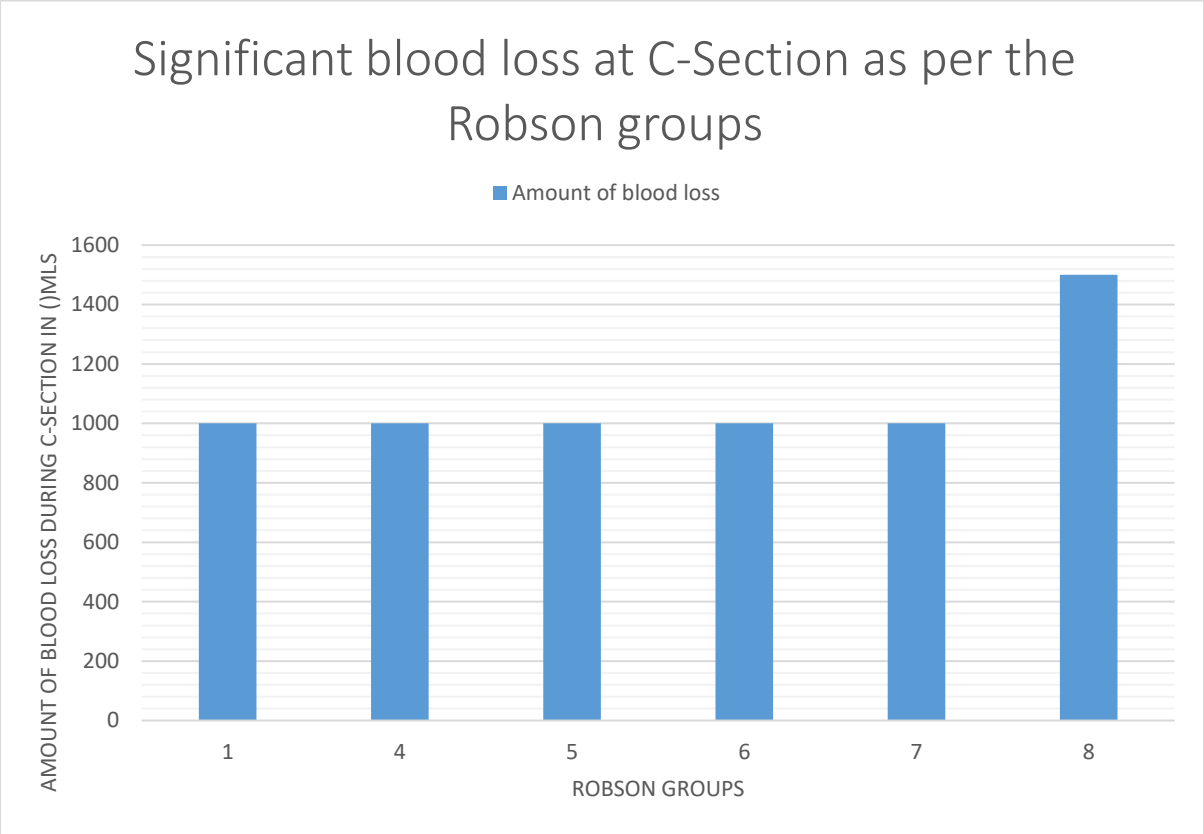


Figure 5: Significant blood loss at C-Section as per the Robson classification-for women who underwent C-Section at the Pumwani Maternity Hospital for the year 2016

11.4.2 Foetal Outcomes

11.4.2.1 APGAR Score

The APGAR score for 95.79% of the babies was above five at minute one while 4.21% scored five and below as demonstrated in table-10 and figure 6 below:

Table 10: APGAR scores as per the Robson Classification-for babies born to women who underwent C-Section at the Pumwani Maternity Hospital for the year 2016

Robson Group	n	APGAR Score 0-5 (%)	APGAR Score 6-10 (%)
0	15	04 (26.7)	11 (73.3)
1	180	06 (3.3)	174 (96.7)
2	8	00 (0.0)	08 (100.0)
3	118	03 (2.5)	115 (97.5)
4	1	01 (100.0)	0 (0.0)
5	120	02 (1.7)	118 (98.3)
6	9	01 (11.1)	08 (88.9)
7	7	01 (14.3)	06 (85.7)
8	14	00 (0.0)	14 (100.0)
9	2	00 (0.0)	02 (100.0)
10	25	03 (12.0)	22 (88.0)
Total	499	21 (4.2)	478 (95.8)

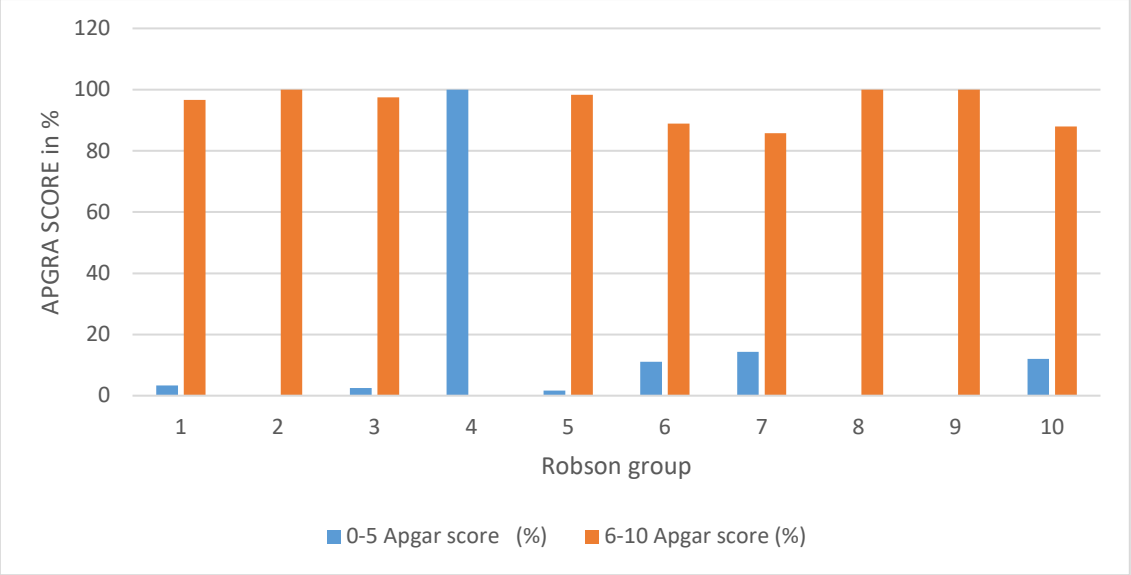


Figure 6: APGAR scores as per the Robson classification-for babies born to women who underwent C-Section at the Pumwani Maternity Hospital for the year 2016

Table 11: Status of the babies born via C-Section as per the Robson groups for the year 2016, at the Pumwani Maternity Hospital

Robson Group	n	**Alive (%)**	**Dead (%)**
0	15	12 (80)	3 (20)
1	180	179 (99.4)	1 (0.6)
2	8	08 (100.0)	0 (0.0)
3	118	117 (99.2)	1 (0.8)
4	1	00 (0.0)	1 (100)
5	120	118 (98.3)	2 (1.7)
6	9	09 (100.0)	0 (0.0)
7	7	06 (85.7)	1 (14.3)
8	14	14 (100.0)	0 (0.0)
9	2	02 (100.0)	0 (0.0)
10	25	25 (100.0)	0 (0.0)
TOTAL	**499**	**490 (98.2)**	**9 (1.8)**

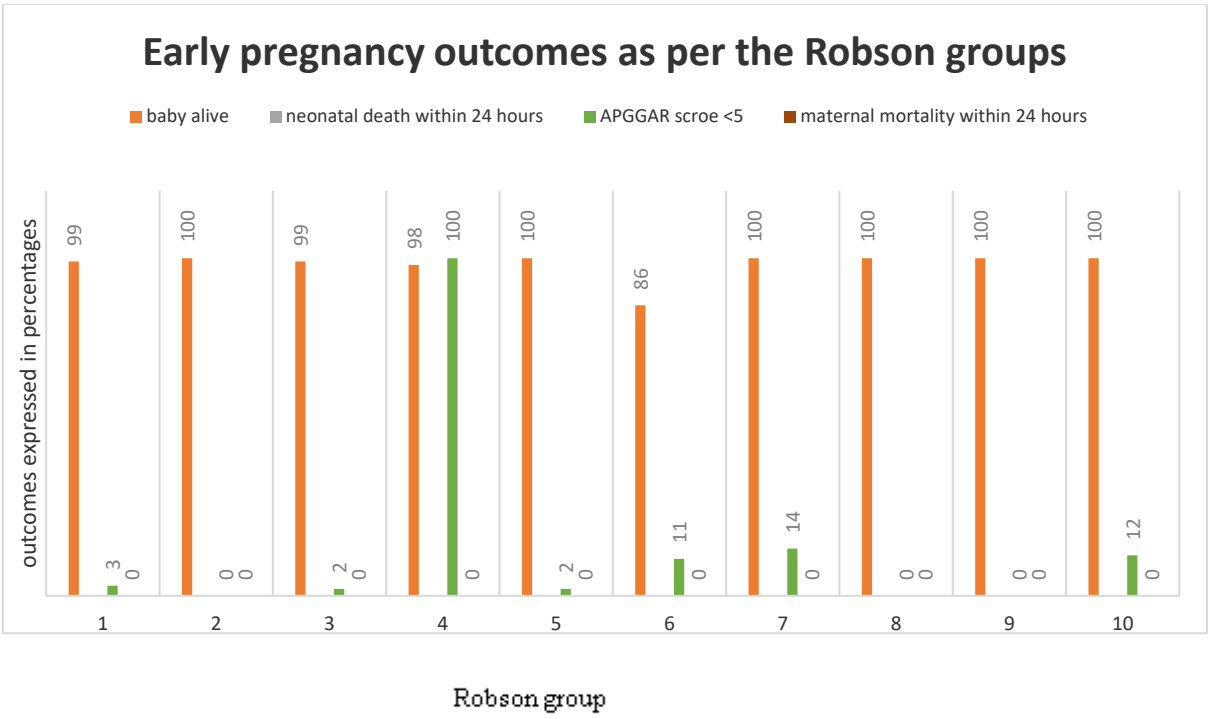


Figure 7: Early Pregnancy Outcomes as per the Robson classification for women who had C-Sections at the Pumwani Maternity Hospital for the year 2016

12.0 DISCUSSION

In this study the Robson classification was applied easily to assess the C-Section rates for the year 2016 at the Pumwani Maternity Hospital. PMH covers more than half of the institutional deliveries within Nairobi county serving women of low social-economic levels. In this year the C-Section rate was at 24% compared to 23% in 2015, 19% in 2017(this calendar year was marked by various industrial disputes in the health sector) and 23% in 2018. This C-Section rate was higher than the rate of 5-15% set by the WHO (6). The rate at the Kenyatta National Hospital - one of the National referral hospitals in Kenya located in Nairobi County was 40% for the year 2015, while a hospital report at the Agha Khan University, a private hospital within Nairobi County for the year 2017 was at 42%. Perhaps these rates demonstrate the disparities of C-Section rates depending on the status of the clientele and place of the hospital in the healthcare system.

The findings in this study indicated that second time mothers constituted 27% of the mothers who underwent C-Section at this facility. The mean age of the mothers was at 22 years, with 92% of them being married and 35% of them had attained secondary level of education. PMH much as it's mandated to run as a referral hospital, had 94% of the clients sampled in this survey, primarily seeking healthcare from it, with 4% being referrals in.

The young age of the mothers who are pregnant from the sampled population could indicate a high rate of unplanned pregnancies. Improving on the access to and provision of family planning services would result in planned future pregnancies and decrease the primary C-Section rate and hence subsequent repeat C-Sections. Furthermore, the mothers in Robson Groups 1 and 2, in future deliveries feed into the Robson Group-5, with the attendant increased risks associated with repeat C-Sections which include, but not limited to, wound sepsis,

adhesions, visceral injury to urinary bladder and bowel, deep venous thrombosis, moderate to severe post-partum hemorrhage with increased blood transfusions rates and at times hysterectomies. This in turn increase the cost of health care.

In a similar study conducted at a University hospital in Ethiopia, the mean age for the C-Sections was 26 years, with first time mothers constituting 31% of the population sampled. In South Africa, a similar study demonstrated the mean age of mothers undergoing C-Sections as 24 years (26).

Our study demonstrated Robson groups 1, 3 and 5 to be the key drivers to the overall reported C-Section rate at the PMH. Robson Group-1 represents-nulliparous women with singleton gestation, cephalic presentation at term, who spontaneously go into labor. This low risk obstetric group had a C-Section rate of 36.1%. Robson group -3-includes multiparous mothers, at term, with a singleton term gestation who spontaneously go into labor. This low risk obstetric group posted a C-Section rate of 24%. The performance of primary C-Sections in low risk obstetric groups, which includes Robson groups 1-4,is a key indicator of the increasing C-Section rates posted in Robson group 5 in future pregnancies. This group of women cumulatively contributed 61% to the overall C-Section rate at the PMH, a rate which is significantly high. Targeted interventions should be implemented to monitor the performance of C-Section rates in these low risk group of women, because if unchecked they end up subsequently as the Group 5, thereby maintaining the high rate of C-Sections. Some of these interventions include increasing the number of midwives, medical officers and obstetricians in the unit. Implementation of non -clinical interventions, proposed by WHO that embrace provision of health education for expectant mothers have been designed to reduce C-Section births and encourage vaginal births. This includes counseling on areas such as

respectful and dignified care, effective communication addressing the risks, benefits, pain management, positions assumed and delivery mode. Expectant mothers should be encouraged to seek second opinion on birth plans. Maternity units should routinely conduct audits to provide feedback to the clinicians and support symbiosis between midwives and the obstetrician.

The early pregnancy outcomes for Robson groups 1-4 were good, perhaps indicating that they were medically justified and that PMH is well equipped to offer comprehensive obstetric services. The indications for the performance of C-Sections were not indicated, an inherent weakness in the Robson classification.

Robson group 5 which contributed 24% to the overall C-Section rate, includes multiparous mothers, with a scarred uterus, with singleton gestations at term. This groups represents women who undergo repeat C-Sections. PMH has a policy in place that refers out elective repeat C-Sections, and perhaps what is represented in our results are emergency repeat C-Sections. For PMH, the selected early pregnancy outcomes were good, with all no maternal mortality, 98% of the newborns born scored APGAR scores> 7 at minute 5 and with acceptable blood loss at C-Section (blood loss between 500mls-1000mls). Trial of labor after a C-Section (TOLAC) for non-recurring indications has a success rate of between 70-75% for safe vaginal delivery (VBAC). This is the only measure that can be applied to reduce the C-Section rate for Robson Group 5. However, globally, the number of women who opt for this and the number of obstetric units that offer TOLAC has reduced dramatically over the years mostly due to safety concerns (VBAC). Most obstetric units that could offer TOLAC therefore shy away from it due to the castigation that follows an untoward outcome. However, the decline in TOLAC, not only drives up the C-Section rate, but also increases the complications

associated with repeat C-Sections such as dense adhesions-increasing risk of visceral injury, abnormal placentation – placenta accrete, increta and percretta-which increase maternal morbidity and mortality.

Traditionally, most critics have alleged that breech presentations, abnormal lie and multiple gestations are the key drivers of increasing C-Section rates .The Robson classification, challenges this myth: At the PMH, Robson groups 6-10 cumulatively contributed 11% to the overall reported C-Section rate. Robson groups 6 and 7 are comprised of nulliparous and multiparous groups of women with breech presentation, respectively. The relative size of these groups at PMH was small, contributing to 3.2%, but there is also no policy for external cephalic version at this institution nor, trials of breech deliveries, with most being delivered via C-Sections. Mothers with pre-term gestations (Robson group 10) of less than 37% contributed to 5% of the overall reported C-Section rate. The selected early maternal and perinatal outcomes were favorable for this group, with no reported maternal and perinatal mortality for the first 24 hours .APGAR scores for 88% of these newborns were more that 7 at minute 5,indicating that PMH is well suited to cater to the needs of premature babies.

Our study findings are similar to study findings in Tanzania and Senegal. Litorp et al in Tanzania reported a C-Section rate of 27% with Robson groups 1, 3 and 5 contributing 12%, 12% and 14% respectively (32). However in this study, it was explained that all the decisions for the performance of C-Sections had the involvement of obstetricians in contrast to our study, where majority of the decisions for C-Sections were made by non-specialized medical officers.

Magatte M et al in 2013, carried out a similar study in Senegal at the Philippe Senghor Health center in Dakar. This study reported a C-Section rate of 18.2%. The groups contributing to the

reported C-Section rate were: Group-5 at 20.5%, group-1 at 34.2% and group-3 at 17.6% (29). A similar study in South Africa (26) had an overall C-Section rate of 42.4%, with Robson groups 1, 10 and 5 being the key drivers to this C-Section rate contributing 27.4%, 23.4% and 17.2% respectively. The finding of a high C-Section rate for the Robson group 10 is in contrast to the earlier referenced studies. These differences are related to variations in the obstetric populations, their demographics and eventually the C-Section rates. The differences could also be attributed to the variations in monitoring labor in different obstetric units, which could have an influence on the drivers of C-Section rates. For instance, an obstetric unit which is well staffed with well trained midwives is likely to have a lower C-S rate for Robson groups 1, 2 and 3 and the converse also applies.

The maternity unit at the Pumwani Maternity Hospital is run by a team of non-specialized medical officers and midwives. Lack of robust fetal monitoring equipment in labor such as cardio-tocographs (CTG), and the lack of obstetrician review for each C-Section prescribed, may have led to increased performance of C-Sections in this low risk primary obstetric groups of women.

Group 1 and 3 are amenable to corrective measures and close monitoring in labor. Obstetricians' review for each C-Section prescribed, training on interpretation of the CTG by the midwives and proper use of partograph are measures that can be strengthened to reduce these primary C-Sections.

All the mothers sampled in this study were alive 24 hours after delivery. The mean blood lost at C-Section was 516 mls. The APGAR score at minute 5 of life was more than seven for 96% of the newborns and 98% of the babies were delivered alive. The neonatal outcomes are

similar to a South African study conducted by Makhanya (26) where 98% of the babies were born alive. This was in keeping with the high C-Section rate of the Robson Group 10-which comprises of pre-term deliveries which was reported as 23.4% (26).

Boatin AA et al in 2017, conducted a systematic review to assess the effectiveness of applying the Robson classification in auditing C-Section rates (10). This systematic review included among others literature published in Brazil (low middle income country), Italy, Chile and Sweden (the latter three are high income countries) (10). The four countries reported a reduction in the C-Section rates without compromising on maternal and fetal outcomes. Some of the interventions implemented by these 4 countries, included, regular audits and feedback using the Robson classification and increased training of the midwives to reduce un-necessary C-Sections.

This study demonstrates that it is easy to apply the Robson classification to assess contributors to the overall C-Section rate. The main limitation in this study was missing data which is an inherent limitation in retrospective studies. However, the implementation manual of the Robson classification provides for this missing data. For women who could not be classified into any of the ten Robson groups. This group of "unclassified women" are reported as a footnote at the bottom of the Robson table. This constitute an important parameter as it indicated the quality of data at the hospital.

13.0 CONCLUSION

The C-Section rate for the year 2016 was at 24% compared to the rate published in 2009 which was 17.7%. The Robson classification identified low-risk women (Robson Groups 1 &3) as the largest contributors to the CS rates at Pumwani Maternity Hospital. The selected early pregnancy outcomes across the ten groups were favorable. Additional studies should evaluate

indications for CS and identify strategies for reducing CS in this low-risk obstetric population, without compromising pregnancy outcomes.

14.0 RECOMMENDATIONS

The Robson classification should be implemented and used in similar obstetric units across the country. This classification, should then be used as an audit tool, to monitor C-Section trends ,maternal and fetal outcomes across all obstetric units. An understanding of the major drivers of caeserean deliveries would help develop interventions aimed at mitigating high caeserean section rates without compromising on pregnancy outcomes. Furthermore, in order to further assess the pregnancy outcomes using the Robson's classification, a larger multi-center study is recommended.

15.0 STUDY TIMELINES

	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	March 2018	April 2018	May 2018	June 2018
Concept development										
Proposal development										
Ethical approval										
Data collection										
Data analysis										
Results presentation										

16.0 BUDGET AND BUDGET JUSTIFICATION

Item	Units	Unit cost in Kshs.	Total cost in Kshs.
Statistician	1	1	60,000
Research Assistant	2	10,000	20,000
Printing and stationery	5	6	6,000
Travel costs	3	100*21	6,300
Internet	1	4700*6	28,200
Flash disk/storage files	2	2*3000	6,000
TOTAL			126,500

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Annex 1: Data abstraction tools

1. **Questionnaire**

1 Unique number…….

2 Robson's Group……...

a. Part 1: Demographic details

1. Age in years……..

2. Marital status

☐ Single ☐ Married ☐ Separated ☐ Divorced ☐ Widowed

3. Highest level of education

☐ Primary ☐ Secondary ☐ College/University

4. Employment Status

☐ Housewife ☐ Informal employment ☐ Formal employment

5. Referral Status

☐ Referred ☐ Not referred

Part 2: Obstetrics History

1. Parity (use the format, Para ___+___)……

2. Gestation at delivery (in completed weeks)……

3. Previous Caeserian Section

☐ Yes ☐ No

4. Onset of labour

☐ Spontaneous ☐ Induced ☐ No labour/Elective CS

5. Number of children born during the last delivery

☐ One ☐ Two ☐ More than two

6. Fetal presentation during the last pregnancy

☐ Cephalic ☐ Breech ☐ Transverse/Oblique ☐ Other

Part three: Maternal and Neonatal Outcomes

1. Amount of blood lost during the CS (in mls)…….

2. Maternal death

☐ Yes ☐ No

If Yes to 2 above, after how many hours?.....

3. Status of baby at birth

☐ Alive ☐ Dead

4. Baby's APGAR score at minute 5……/10

Annex 2.0 Robson's Tool

Group 1	**Nulliparous,single,cephalic,>37weeks,spo natenoues labor**	**Score**
Group 2	Nulliparous,single,cephalic,>37 weeks, induced labor or Delivered by caesarean section before labor.	
Group 3	Multi-parous women, no previous uterine scar, single, cephalic >37 weeks, spontaneous labor.	
Group 4	Multi-parous women, no previous uterine scar,>37 weeks, either had induced labor or were delivered by elective caesarean section.	
Group 5	All multi-parous women, at least one previous uterine scar, single, cephalic,>37 weeks gestation	
Group 6	All nulliparous women, single, breech pregnancy (all nulliparous women with breech presentation)	
Group 7	Multi-parous women, single, breech, Including women with previous uterine scars. (all multi-parous women with breech presentation)	
Group 8	All women with multiple pregnancies ,including women with previous uterine scars (all multiple pregnancies)	
Group 9	All women with a single pregnancy, transverse, oblique, including women with previous uterine scars. (all abnormal lies)	
Group 10	All women with single, cephalic, <37 weeks, including women with previous scars.	

Annex 3.0 UON/KNH ETHICAL APPROVAL

ANNEX 4.0 PMH ETHICAL APPROVAL