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A Descriptive Study of the Obstetric and Neonatal Outcomes of Adolescent Pregnancies at a Tertiary Academic Hospital

Elena Cremona
0601751H

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Medicine in Paediatrics.

Johannesburg, 2022

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Declaration

I, Elena Cremona, declare that this research report is my original work. The submission is for the degree of MMed (Paediatrics) at the University of the Witwatersrand, Johannesburg. It has not previously been submitted for any degree or examination at this or any other University.

Elena Cremona

On this 16th day of September

Title Page and Author Qualifications

A Descriptive Study of the Obstetric and Neonatal Outcomes of Adolescent Pregnancies at a Tertiary Academic Hospital

Elena Cremona[1,3], Jayshree Jeebodh[2,4], Firdose L. Nakwa[1,5]

[1]Department of Paediatrics, Chris Hani Baragwanath Academic Hospital, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[2]Department of Obstetrics and Gynaecology, Chris Hani Baragwanath Academic Hospital. School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[3]MBBCH (WITS), FC Paed (SA)
[4]MBBCH (WITS), FCOG (SA), MMED (O&G) WITS, Maternal-fetal subspecialist
[5]MBBCH (WITS), FC Paed (SA), MMED (Paeds) Certificate of Neonatology (SA), Certificate of Paediatric Neurology (SA)

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I would also like to extend my gratitude to Ms Petra Gaylard for her assistance with the statistical analysis.

Author Contribution

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL MOTHER AND CHILD UNIT
DEPARTMENT OF PAEDIATRICS, DIVISION OF NEONATOLOGY

Postgrduate Committee

PV Tobias Building

Parktown

University of the Witwatersrand

03 July 2022

Re: Dr E. Cremona – submission in completion of MMed Paeds

Dr Cremona, as the primary investigator has performed the following contributions:

1. Protocol development and study design
2. Data collection
3. Data review and statistical analysis
4. Manuscript authorship
5. Collaboration between authors
6. Manuscript submission and review process

We affirm her contribution to this project

Yours faithfully

Dr F L. Nakwa

Dr J Jeebodh

Submission Format

This research report has been drafted in the Submissible Format as per guidelines issued by the University of the Witwatersrand.

This article is written in the manuscript style required by the journal entitled *Frontiers in Pediatrics* with the intention to publish this original manuscript.

Full, comprehensive author guidelines are available at https://www.frontiersin.org/about/author-guidelines

Guidelines for publication include:

- Word count: 12 000 words (excludes abstract, section titles, figure and table captions, funding statement and references in the bibliography.
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    - Introduction, with no subheadings
    - Materials and Methods
    - Results and
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- Figures and tables are submitted separately
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- A summary stating the research's contribution to the field should be included
- Table captions should precede the table
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- Font: Times New Roman was used, though no preference was stated in author guidelines
- Conflicts of interest are to be declared
- Funding of the project is to be declared

Draft Article

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Elena Cremona[1], Jayshree Jeebodh[2], Firdose L. Nakwa[1]

[1]Department of Paediatrics, Chris Hani Baragwanath Academic Hospital, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

[2]Department of Obstetrics and Gynaecology, Chris Hani Baragwanath Academic Hospital. School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

Correspondence:

Elena Cremona,

Chris Hani Baragwanath Academic Hospital

26 Chris Hani Road

PO Box Bertsham 2013

Diepkloof

Soweto

Johannesburg,

South Africa

lorentz.elena@gmail.com

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Abstract

Introduction: Adolescent mothers are at high risk of maternal morbidity and mortality and have poorer perinatal outcomes. Low and middle-income countries and especially Sub-Saharan Africa have a higher adolescent birth rate. Adolescent pregnancy and childbearing have significant health, social and economic consequences.

Objectives: To describe the demographics and obstetric outcomes of adolescent females as well as the demographics and neonatal outcomes of their neonates.

Methods: This was a retrospective record review of the obstetric, perinatal and neonatal demographics and outcomes of pregnant adolescents who delivered at, or who were referred to a tertiary academic hospital or in the perinatal period between January to December 2015. The group was divided into early (10– 14 years), middle (15– 17 years) and late adolescent (18– 19 years) mothers. Comparison of study variables between age groups was conducted using the chi-squared test for categorical variables, and one-way ANOVA.

Results: Two thousand and twenty-two adolescent mothers and 2039 babies' records were reviewed. Mean maternal age was 17.5 (12 -19) years. 11.3% had previous pregnancies. Of the 94.4% who accessed antenatal care, 52.9% did so after 20 week's gestation. Two thirds of the 8.6% Human Immunodeficiency Virus (HIV) infections were diagnosed during pregnancy. Hypertensive disorders occurred in 249 mothers (12.3%) with 142 (57.0%) having hypertensive complications. A third of deliveries were by cesarean section, with fetal distress (60.2%) and cephalopelvic disproportion (9.6%), as the most common indications.

Complications of normal vaginal deliveries (NVD) include third- and fourth degree tears or cervical injury (2.9%); 94 (4.7%) mothers required postpartum surgical intervention. There were no differences in pregnancy outcomes between the adolescent groups. There was one maternal death (49 per 100 000 live births). 54 were stillbirths and a quarter (26.4%) of the neonates were born premature. 17.0% of the babies required admission for respiratory complaints (8.1%). There were 23 (6.8%) neonatal deaths.

Conclusion: Adolescent mothers had complications including premature births, high cesarean section rate and perineal injuries. Numerous school-going pregnancies and adolescents in their second or third pregnancy suggest the need for public health and social interventions addressing reproductive education and family planning.

Introduction

The World Health Organisation (WHO) defines an adolescent pregnancy as pregnancy in a female between the ages of 10 and 19 years (1, 2) . Adolescence is a period of development associated with significant physical, psychological, and social change (1, 3). For these reasons, adolescent fertility and sexual health has recently become a priority on the global health agenda by coming into prominence in two major global strategies: the 2030 Sustainable Development Goals (SDGs) and the United Nations Global Strategy for Women's, Children's and Adolescents' Health. These strategies advocate for a reduction in adolescent childbearing though universal access to sexual and reproductive health care, education, and gender equality, with the adolescent birth rate and fertility being key identifiers linked to numerous targets related to the achievement of these goals (3-6).

It is estimated that 21 million females aged 15 – 19 years in developing regions become pregnant annually, accounting for 11 percent of all births globally (2, 3, 7-9). Approximately half of these pregnancies are unplanned (7, 10). The WHO anticipates an increase in adolescent pregnancy by 2030, especially in Sub-Saharan Africa (8, 11). This is as a result of an increased number or projected total adolescents in this region (12). In 2015, 15.5% of all live births registered in South Africa were to females 10 – 19 years old, with a decline to 11% in 2018 (13). The South African adolescent birth rate (births per 1000 females, ages 15 -19 years) is currently estimated at 68; well below the regional and Sub-Saharan Africa averages, but higher than the global adolescent birth rate (ABR) of 42 per 1000, and significantly higher than that of high income countries, where it is typically less than 10 per thousand (14).

Adolescent pregnancy and childbearing have important health, social and economic implications for the adolescent, their children, communities and society as a whole (1, 8, 11, 15). The adolescent mother's schooling is often interrupted; she is less likely to complete formal high school education, affecting future employability, skill acquisition and income earning potential (7, 15, 16). Furthermore, giving birth in this period leads to greater pregnancy and maternal complications and an increased risk of poor perinatal outcomes (2, 7, 9, 11, 16).

In low- and middle-income countries, maternal complications are the leading cause of mortality in females 15 – 19 years old and contributes significantly to this age group's morbidity and disability-adjusted life years (DALYs) lost (1, 3, 7-9, 17). The adolescent maternal mortality rate remains the highest in Africa at 570 per 100 000 live births with 20% of all maternal deaths occurring in adolescents (1, 2). It is however, difficult to estimate age as an independent risk factor as adolescent mothers are more likely to come from adverse social backgrounds, be less educated, single and have inadequate access to antenatal care (8, 10, 17). Furthermore, of concern in this population is the exposure to sexually transmitted infections (STIs),

especially Human Immunodeficiency Virus (HIV) (1, 9, 11, 18). South Africa has an estimated HIV positive prevalence rate of 12.8%. Adolescent girls in South Africa are more susceptible to HIV infection (19). The vulnerability to HIV infection of this population group is multifactorial and includes anatomical factors, gender power disparities, socio-economic dependence and violence against women (20). This study aims to describe the obstetric and neonatal complication of babies born to this vulnerable and at-risk adolescent population.

Methods

Main outcomes and definitions

This study aimed to describe the demographic parameters and obstetric outcomes of adolescent females who delivered at CHBAH and associated MOUs, as well as the demographic parameters and neonatal outcomes of their infants and to determine predictors of maternal, perinatal and neonatal death within the population. This study also aimed to identify risk factors and predictors for still birth. Table one discusses pertinent definitions. As this was a retrospective study utilizing clinical records certain assessments and diagnosis of maternal conditions were deemed correct as made by relevant clinicians.

Study design and data collection

This was a retrospective descriptive study of the obstetric, perinatal and neonatal outcomes of pregnant women, <20 years of age who delivered at the Chris Hani Baragwanath Academic Hospital (CHBAH), or who were referred to this facility from community-based Midwife-managed Obstetric Units (MOU) between 1st January 2015 and 31st December 2015.

CHBAH is an academic tertiary-level hospital and is the referral facility for seven MOUs and a district hospital in Soweto and surrounding areas. The MOUs are managed by midwives and the standard practice, at the time of the study, mandated that pregnant women <20 years of age be referred to CHBAH for delivery. Soweto is a large peri-urban community on the outskirts of Johannesburg, South Africa. In 2015, 28 739 number of babies were delivered in this cluster, 20 324 of which occurred at CHBAH. Successful deliveries at clinic MOUs which complicate after delivery or any sick baby is also referred postnatally for review and further management.

Eligible participants for the study were identified from admission registers, cesarean section theater registers and birth registers within the maternity unit. The maternal record, which includes the antenatal, delivery and

postnatal records were reviewed and relevant data parameters recorded. Where there was an indication that the neonate was admitted to the neonatal unit following delivery, these records were also reviewed, and the relevant data recorded.

Study population

The study population was restricted to mothers younger than 20 years on the day of delivery who gave birth to a baby of at least 22 weeks' gestation or with a birthweight of at least 500g.

Statistical analysis

Categorical variables were summarised by frequency and percentage tabulation and illustrated using bar charts. Continuous variables were summarised by the mean, standard deviation, and median. The relative risk of each study variable for stillbirth was determined, together with its 95% confidence interval, using binomial regression. Study variables significant at $p<0.20$ were combined into a multivariable model, after examining each pair of variables for possible confounding using the chi-squared test (or Fisher's exact test for 2x2 tables). A value of Cramer's V (or the phi coefficient for Fisher's exact test) > 0.60 was regarded as too strong an association to include both variables in the multivariable model.

Comparison of study variables between age groups was conducted using the chi-squared test for categorical variables, and one-way Analysis of Variance for continuous variables (the Kruskal-Wallis test was used where the assumptions of one-way ANOVA were not satisfied). Categories with $n<30$ overall were not included in analyses. Data analysis was carried out using SAS version 9.4 for Windows. A p value <0.05 was regarded as significant.

Ethics

Ethics approval was granted by the University of the Witwatersrand Human Research and Ethics Committee (M160763). Permission to access patient records was granted by the clinical head of CHBAH as well as the heads of the department from both the Department of Obstetrics and Gynecology and the Department of Pediatrics.

Results

The records of 2022 adolescents who gave birth to 2039 infants were retrieved and analyzed. The average maternal age was 17.5 years (range 12 – 19 years) (Figure. 1). Older adolescents, 18 and 19-year-olds,

accounted for the majority of the mothers (1148/2022, 56.8%). 1924 (95.2%) of the adolescents delivered at CHBAH while the remainder (3.2%) were referred in from other facilities (3.2%) within CHBAH's referral area for either maternal or infant review, or were born before arrival (BBA) (1.7%).

The socio-demographic characteristics of the adolescent mothers are described in table 2. Most of adolescents were unmarried and still undertaking formal schooling. Eleven percent of adolescents had previous pregnancies. Antenatal care (ANC) was accessed by 1908 (94.4%) of mothers however, more than half (991/1872, 53.0%) did so after 20 weeks gestation. Only 41.3% of those who accessed care had more than four antenatal visits. Pre-term deliveries accounted for just over a quarter (533/2016, 26.4%) of deliveries. Twin and triplet pregnancies accounted for less than one per cent of all deliveries. There were 174 (8.6%) adolescents who were HIV positive at delivery with two-thirds (116/174, 66.7%) being diagnosed during pregnancy or at delivery as . All but two mothers had a documented HIV test result in their hospital records. The HIV viral load at delivery was not known for 114 (65.5%) of mothers.

Less than half (846/1889, 44.8%) of adolescents had anemia at the time of accessing ANC and a similar proportion (564/1223, 46.1%) had anemia at delivery (table 3). Hypertensive disorders were the most commonly diagnosed co-morbid disease (249/2022, 12.3%) with 142/2022 (7.0%) complicating to pre-eclampsia (112/2022, 5.5%), eclampsia (23/2022, 1.2%) or haemolysis, elevated liver enzymes, low platelet count (HELLP) syndrome (7/2022, 0.4%). See table 4.

More than two-thirds (1430/2020, 70.8%) of deliveries were by normal vaginal delivery (NVD) with 75 (5.2%) of these deliveries requiring assistive devices (forceps 0.6% and vacuum 4.7%). Cesarean sections were required in 590 (29.2%) of deliveries where fetal distress was the most common indication for cesarean section (353/586, 60.2%) followed by cephalopelvic disproportion (CPD) (56/586, 9.6%). Perineal injuries were a frequent complication of NVDs; half of the vaginal deliveries required episiotomies and 2.1% (28/1430) had third or fourth degree perineal tears, as shown in table 4. Cervical injuries complicated 0.8% of NVDs (11/1430). Post-partum hemorrhage complicated 139 (6.9%) of deliveries. Ninety-four (4.6%) had complications required surgical intervention, including uterine evacuation for the removal of retained products of conception (33/94, 35.1%), repair of perineal injuries (47/94, 50.0%) and the management of puerperal sepsis (5/94, 5.3%). There was one maternal death recorded equating to a maternal mortality rate of 49 per 100 000 births.

Maternal demographic and clinical characteristics were categorized by maternal age, as tabulated in table 5. There was no significant association between age group and race, access to antenatal care, gestational age at delivery, maternal anemia or maternal co-morbid illness. Delivery characteristics and neonatal profiles were also similar. There was a significant, though weak association between maternal age group and the timing of antenatal care access ($p<0.0001$; Cramer's $V=0.09$) with the proportion of mothers seeking earlier care,

increasing with age. There was a significant, weak, association between age group and HIV status ($p<0.0001$; Cramer's V=0.11). HIV prevalence and anti-retroviral usage increased with increasing age. The prevalence of anemia at delivery was higher in the in the younger two age groups when compared to the oldest group ($p = 0.027$; Cramer's V=0.08).

On review of neonatal characteristics, 97.4% were live births and 17% (337/1981) of babies required admission to the neonatal unit; half of the babies born were male, as shown in tables 6 and 7. One thousand six hundred and forty-five neonates (81.8%) weighed more than 2500g. There were no significant differences between maternal age groups and neonatal outcomes, other than data related to HIV-exposure. Neonatal HIV-exposure was more likely in the older adolescent age group. Three babies were confirmed HIV positive, but birth test results were not known for more than half of the HIV-exposed babies. Respiratory conditions were the most frequent reason for admission, followed by neonatal encephalopathy and early onset neonatal sepsis. Of the admitted babies with known outcomes (n=337), 6.8% died. Eighty-two babies (including stillbirths) died; 72 (88.0%) were perinatal deaths and 6.0% were late neonatal deaths and infant deaths.

There were 54 stillbirths (2650 per 100, 000 births) and analysis attempted to determine risk factors for such (see table 7). The final multivariable model and considering the size of the outcome group (n = 54), only two significant variables remained (21). This indicates that those mothers who did not access antenatal care (RR 2.5; 95% CI 1.5 - 4.1) and low birth weight babies (RR 7.68; 95% CI 3.1 – 18.9) were at higher risk of stillbirth as noted in table 8.

Discussion

This study aimed to describe the demographic characteristics and outcomes of adolescent pregnancies at a tertiary academic hospital and to describe their infants in the neonatal period.

Antenatal care is recommended to prevent adverse pregnancy outcomes (10). South African guidelines for maternity care suggest that antenatal care should be accessed before 12 weeks gestational age (22). Adolescent ANC attendance is often poor, accessed later in pregnancy than recommended and the adolescent may have fewer visits and consequently may not receive all the benefits of ANC (1, 8, 10, 17, 23, 24). Reasons suggested for the delay in seeking care include financial constraints, limited regard for the risks of pregnancy and benefits of ANC, stigma, fear of reprisal and poor treatment by health care workers and poor education (3, 8). In this study ANC attendance was high, but the first visit predominantly occurred following 12 weeks of gestation and most mothers had fewer than four visits. Similar findings have been

described from literature based on African as well as Pakistani studies (8, 10, 23, 25). Lack of access to ANC was a significant risk factor for stillbirth in this study (p-value <0.0001 with RR 9.93 (95% CI 5.91 – 16.8).

HIV transmission in this population remains a public health interest, with Southern Africa bearing the greatest burden of disease and females in this region accounting for the majority of new infections (26). Multiple targeted programs have been initiated to ensure the inclusion of this population in the global response to HIV and Acquired Immunodeficiency Syndrome (AIDS) to reach goals required to control the HIV epidemic (26). In addition to utilizing the opportunity to diagnose HIV and facilitate uptake into Prevention of Mother to Child Transmission (PMTCT) programs and eventual chronic care, the opportunity to engage the HIV negative mother regarding safe sexual practices is a necessity. HIV positive adolescent mothers have poorer PMTCT outcomes and this population thus remains a priority (11, 26). Of the 174 (8.6%) mothers diagnosed with HIV, two-thirds were diagnosed in this pregnancy or at delivery. More than half of the adolescents had no viral loads recorded. These data, however precede a change in national HIV PMTCT guidelines mandating a maternal viral load at delivery (27, 28).

Adverse maternal and perinatal outcomes are linked to adolescent pregnancies, with younger age groups being more at risk (2, 10). Over 40% of the adolescents were anemic at access of antenatal care and at delivery; a number significantly higher than described in other studies (1, 2, 23, 25). This study however, had fewer anemic mothers than a study conducted in Sub-Saharan Africa, where 63% of adolescents were anemic at baseline. This may reflect the nutritional status of the population and may be due to menarche and the adolescent growth spurt (23). Multiple authors agree that adolescent pregnancies tend to result in a high number of preterm deliveries. A quarter of pregnancies resulted in premature births, a finding which concurred with Fouelifack (29.3%) and Agbor (27.7%) in Africa. This is significantly higher than other studies from similar settings (Ganchimeg – multiple low- and middle income countries in South America, Africa and Asia, 7.8%, Kassa in Ethiopia, 14.0%) as well as studies from more affluent regions (Kawakita in the USA, 16.9%) (2, 8, 23-25). African ethnicity, age-related pelvic and anatomical factors, inadequate antenatal care, poverty, and poor social support are postulated risk factors for prematurity, many of which are applicable to this population (29-31). The reporting of hypertension in pregnancy also varied greatly with some studies reporting that 13.2% of adolescents were hypertensive and others much lower at 5.8%. These studies reflect a racially diverse population. Hypertension related complications (PET and eclampsia) complicated more pregnancies than described in studies from similar economic settings, while there were similar findings across adolescent age groups to this study in the USA (17, 23-25).

One in ten adolescents had previously been pregnant. There is variation in the literature, with a study from Ethiopia reporting that 8.3% of adolescents had previously been pregnant while two studies conducted in

Cameroon describe that more than 20% of the adolescents in their study had previously been pregnant (8, 32, 33). Adolescents have high rates of repeat pregnancy in their adolescence, with their second pregnancy being associated with an even greater risk of adverse outcomes or complications (2, 10). Most adolescents were never married compared to adolescent mothers from other African countries, where more than 90 percent of adolescents were married (2, 7, 8, 33). This may reflect local cultural norms.

The WHO suggests that a cesarean section rate more than 10% offers limited improvement to maternal morbidity and mortality (33, 34). This study found a high number of cesarean sections, with just less than 30% of births occurring by cesarean section. This cesarean section rate is higher than that described by other authors in low- and middle-income countries where 22.4% of adolescents required cesarean sections for delivery. Studies conducted in Cameroon also report varying cesarean rates that range from 1.0% to 16%. Reports from studies published from the United States of America (USA) also report a lower adolescent cesarean section rate (14.9% and 20.3%) (2, 24, 25, 32, 33). Agbor showed a very low cesarean section rate amongst adolescents at 0.5% but postulated that geographical challenges accessing hospitals with facilities to perform cesarean sections and recording errors may have underestimated the number of or need for cesarean sections (33). A study with a smaller sample of adolescent pregnancies conducted in Pakistan had a similar cesarean section rate (23). A higher cesarean section rate is reported in this study, as CHBAH is a large obstetric referral center where mothers may present more frequently with indications for cesarean sections; foetal distress was by far the most common indication followed by cephalopelvic disproportion. This differs from two American studies where CPD is described as the most frequent indication for cesarean section delivery (24, 25).

Second- to fourth degree perineal tears have been found to complicate vaginal deliveries in adolescents and more so in LMIC countries. In some studies, where this may not have been the case, a high number of episiotomies were performed (32). This is attributed to the physical immaturity of the pelvic anatomy (33). The concern regarding a high rate of perineal injuries is related to the short – and long-term physical and psychological complications of these injuries and cost to the health care system (35). This study found a comparative rate of significant perineal injuries (second to fourth degree tears) to other studies (32). When reviewing only third- and fourth-degree tears, a similar result was found (2.1%) (32, 33). When including first degree tears, injuries were more than 20% of vaginal deliveries. This study also shows a high rate of episiotomies with the procedure being performed in half the parturients, which is contrary to Fouelifack's report with a higher number of NVDs (32). In studies where a higher number of significant perineal injuries (third- and fourth degree tears) were reported, there was a lower cesarean section rate (24). The prevalence of these complications occurred in similar proportions across the adolescent age groups with no significant age-related variability.

The number of low birth weight babies (13.6%) was comparable to previously described studies, but higher than described in a multi-center study from low- and middle-income countries and a study by Agbor in Cameroon (9.8%) (2, 8, 17, 24, 25, 32, 33). It is worth noting that this study found less intrauterine growth restriction with fewer small for gestational age babies (4.8% compared to 13.9% and 17.4%) than in studies conducted in the Washington State in the USA and Pakistan. This finding is noteworthy considering that more than half of this study's adolescents accessed antenatal care after 20 weeks gestation, a high burden of prematurity and a higher incidence of hypertension in pregnancy (23, 24). The ongoing adolescent growth-spurt is a contributing factor to low birth weight babies in this population. (31)
There were 54 (2.6%) stillbirths which was comparable to other studies (2, 23, 33). An analysis to determine risk factors identified inadequate access to antenatal care, prematurity, being born outside of a health care facility and birth weight of < 2500g as risk factors for stillbirth.

An Ethiopian study noted that 5.7% of the babies born to adolescents required admission, which is similar to a study from Pakistan, compared to 17.0% from this study, with prematurity related problems. An American study reported 11.8% of babies were admitted, also mostly with prematurity or sepsis related problems (8, 23, 25). This is in contrast to this study where the majority of babies had respiratory system related conditions. As the data set is incomplete, these data might not be completely reflective of the reasons for neonatal admission. While only 23 (6.8%) of the admitted babies are known to have died, the outcomes of 35.9 % of the babies are not know. This limits the possibility of meaningful analysis to identify risk factors related to death.

Limitations

There are notable limitations to this study. Incomplete data sets with regards to neonatal outcomes limits the possibility of identifying risk factors for adverse neonatal outcomes. Similarly, not having information around maternal body weight, lifestyle habits (such as smoking or alcohol use) and social circumstances limits the possibility to identify factors that may influence maternal or neonatal outcomes. This study only included viable deliveries, as such the true number of adolescent pregnancies may in fact be far greater as miscarriages and termination of early pregnancies was not included. Furthermore, the absence of a control group of adult mothers does not allow for comparison for both obstetric and neonatal outcomes. The study was retrospective descriptive study of adolescent patients in a tertiary academic unit. The absence of pre-exiting databases for both obstetric and neonatal patients precluded the addition of an older group. Manual extraction of all the adolescent files was undertaken by the researcher with limited resources and time constraints in a unit with 20 000 deliveries per year. Future studies comparing the adolescent age group with an older maternal age group is warranted.

However, despite these limitations, this study described the obstetric outcomes of adolescent pregnancy at a tertiary academic hospital.

Conclusion

In 2015, 2022 adolescents gave birth at CHBAH. Late accessing of antenatal care, high incidence of hypertensive disorders, anemia, premature birth, perineal injuries and cesarean section were noteworthy findings. Further research into outcomes of adolescent pregnancy is required. Efforts focused on educational and public health interventions in preventing adolescent pregnancy and its social consequences are to be intensified. Repeating this study in a similar setting with a control group of older females for the comparison of variables and outcomes may be of value.

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Contribution to the field

Adolescent mothers are at high risk of pregnancy related morbidity and mortality and are at risk of poorer neonatal outcomes. Sub-Saharan Africa experiences a high burden of adolescent pregnancy. This study details the obstetric and neonatal outcomes of a vulnerable female population in a low to middle-income country in 2015. This population, in a peri-urban area in South Africa has not previously been described. 2022 adolescent pregnancies were evaluated during this period. We described the antenatal care habits of adolescents and identified a high number of repeat pregnancies. This study described the obstetric and neonatal outcomes as well as identified risk factors for still birth in adolescent pregnancies. Age-group comparisons of outcomes were discussed. Co-morbid illnesses including hypertension, anemia and HIV were detailed. Mode of deliveries with high burden of cesarean section and perineal injuries was outlined. A quarter of births were premature. Adolescent pregnancies remain high in South Africa. This study suggests emphasis be placed on public health and educational interventions aimed at family planning in adolescents to alleviate stressors faced by the youth in this country. A contribution to the fields of both obstetrics and neonatology was made.

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Conflicts of interest

None to declare

Tables and figures

Table 1: Definitions of Variables

Adolescent	<20 years of age
Gravidity	Number of pregnancies
Parity	Number of previous births at foetal viability
Term *	≥ 37 weeks gestational age (37 0/7 weeks)
Preterm/premature	< 37 weeks gestational age
Prelabor rupture of membranes (PROM)**	Rupture of membranes before the onset of labour
Preterm prelabor rupture of membrane (PPROM)***	Rupture of membranes prior to 37 weeks of completed gestation
Anemia****	Haemoglobin concentration <11.0g/dl
Mild anemia	Haemoglobin concentration 10-10.9g/dl
Moderate anemia	Haemoglobin concentration 7-9.9g/dl
Severe anemia	Haemoglobin concentration <7.0g/dl
Small for gestational age	Birth weight < 10th centile for gestational age
Large for gestational age	Birth weight > 90th centile for gestational age
Normal birth weight	Birth weight ≥ 2500g but < 4000g
Low birth weight	Birth weight <2500g
Very low birth weight	Birth weight <1500g
Extremely low birth weight	Birth weight <1000g
Perinatal death	Death < 7 days of life including still births
Late neonatal death	Death between 7 and 28 days of life
Infant death	Death after day 28 of life

* Term as defined by The American College of Obstetricians and Gynecologists (36)
** PROM as defined by Dayal (37)
*** PPROM as defined by Menon (38)
****Anemia in pregnancy as defined by Wermakor (39)

Table 2. Adolescent maternal demographics

Variable (n = 2022)	n (%)	
Race		
African	1921	(95.0)
Mixed ethnicity	84	(4.2)
Indian	16	(0.8)
Caucasian	1	(0.0)
Relationship status (n = 2002)		
Single	1929	(96.4)
Relationship	53	(2.6)
Married	20	(1.0)
Occupation (n = 1996)		
Ongoing education	1235	(61.9)
Unemployed	731	(36.6)
Employed	30	(1.5)
Gravidity (n = 2021)		
One	1792	(88.7)
Two	220	(10.9)
Three	9	(0.4)
Parity (n = 2021)		
Zero	1848	(91.4)
One	169	(8.4)
Two	4	(0.2)
Three	0	(0.0)
Access to ANC		
Yes	1908	(94.4)
No	114	(5.6)
Time of access to ANC (n=1872/1908)		
≤ 12 weeks	251	(13.4)
12 - ≤ 20 weeks	630	(33.7)
> 20 weeks	991	(52.9)
Number of ANC visits (n=1939)		
None	114	(5.9)
One	187	(9.6)
Two	334	(17.2)
Three	504	(26.0)
Four	513	(26.5)
More than four	287	(14.8)
HIV status at delivery		
Negative	1846	(91.3)
Positive	174	(8.6)
Unknown	2	(0.1)
Timing of HIV diagnosis (n=174)		
Prior to pregnancy	48	(27.6)
During pregnancy	110	(63.2)
At delivery	6	(3.4)
Unknown	10	(5.7)
HIV positive mothers on (HAART) (n=174)		
On HAART	166	(95.4)

Not on HAART	8	(4.6)
HIV viral load at delivery (n=174)		
<50	36	(20.7)
50 – 999	10	(5.7)
>1000	14	(8.0)
Unknown	114	(65.5)
Facility where delivered		
CHBAH	1924	(95.2)
MOU	62	(3.1)
BMH	2	(0.1)
Born before arrival	34	(1.7)
If not inborn, reason for referral (n=64/64)		
Maternal review	47	(73.4)
Infant review	17	(26.6)
Gestational age at delivery (n=2016)		
Term	1483	(73.6)
Premature	553	(26.4)
Mode of delivery (n=2020)		
NVD	1355	(67.1)
Assisted NVD	75	(3.7)
Caesarean section	590	(29.2)
Type of assisted delivery (n=75/75)		
Forceps	8	(10.7)
Vacuum	67	(89.3)
Indication for caesarean section (n=586/590)		
Foetal distress	353	(60.2)
CPD	56	(9.6)
Breech	28	(4.8)
Previous caesarean section	26	(4.4)
Hypertension related	33	(5.6)
Other*	90	(15.4)
Multiplicity		
Singleton	2006	(99.2)
Twins	15	(0.7)
Triplets	1	(0.0)

N frequency, *ANC* antenatal care, *HIV* human immunodeficiency virus, *HAART* highly active antiretroviral therapy, *CHBAH* Chris Hani Baragwanath Academic Hospital, *MOU* Midwife operated obstetric unit, *BMH* Bheki Mlangeni Hospital, *NVD* normal vaginal delivery, *CPD* cephalo-pelvic disproportion

* including antepartum haemorrhage, multiples, failed induction of labour, other abnormal lies

Table 3. Anemia in adolescent pregnancy

Variable	Category	n%	
n		2022	(%)
Anemia^ at ANC access (n=1889)	Yes	846	(44.8)
	No	1043	(55.2)
Severity of anemia at booking (n=846/846)	Mild	458	(54.1)
	Moderate	376	(44.4)
	Severe	12	(1.4)
Anemia at delivery (n=1223/1223)	Yes	564	(46.1)
	No	659	(53.9)
Severity of anemia at delivery (n=564/564)	Mild	282	(50.0)
	Moderate	265	(47.0)
	Severe	17	(3.0)

Table 4. Maternal complications

Variable	N =2022 (%)	
Perineal Injury (n=1326/1430)		
None	217	(16.4)
Laceration	117	(8.8)
First Degree	192	(14.5)
Second Degree	86	(6.5)
Third Degree	25	(1.9)
Fourth Degree	3	(0.2)
Episiotomy	675	(50.9)
Cervical tear	11	(0.8)
Indication for caesarean section (n=586/590)		
Fetal distress	353	(60.2)
CPD	56	(9.6)
Breech	28	(4.8)
Previous caesarean section	26	(4.4)
Hypertension related	33	(5.6)
Prolonged second stage of labour	40	(6.8)
Other	50	(8.5)
Post-natal theatre-requiring complications (n=94)		
Removal of RPOC	33	(35.1)
Repair of third degree tear	26	(27.7)
Repair of cervical injury	12	(12.8)
Repair of perineal injury	9	(9.6)
Puerperal sepsis	5	(5.3)
Postpartum haemorrhage	1	(1.1)
Other	8	(8.5)

NVD normal vaginal delivery, *CPD* cephalopelvic disproportion, *RPOC* retained products of conception

Table 5. Maternal characteristics by age

Variable	12-15 year n	12-15 year %	16-17 year n	16-17 year %	18-19 year n	18-19 year %	p-value for between-group test
Adolescent Mother	**179**		**695**		**1148**		
Race (n = 2022)							
African	175	(97.8)	655	(94.2)	1091	(95.0)	0.15
Other	4	2.2	40	5.8	57	5.0	
Relationship status (n = 2002)							
Single	175	(98.9)	674	(97.5)	1080	(95.2)	0.0068 (V=0.07)
Relationship / Married	2	(1.1)	17	(2.5)	54	(4.8)	
Occupation (n = 1996)							
Ongoing education	168	(94.9)	574	(83.2)	493	(43.7)	<0.0001 (V=0.31)
Unemployed	9	(5.1)	112	(16.2)	610	(54.0)	
Employed	0	(0.0)	4	(0.6)	26	(2.3)	
Gravidity (n = 2021)							
One	176	(98.3)	653	(94.0)	963	(84.0)	<0.0001 (V=0.17)
Two / Three	3	(1.7)	42	(6.0)	184	(16.0)	
Parity (n = 2021)							
Zero	179	(100.0)	666	(95.8)	1003	(95.8)	<0.0001 (V=0.17)
One or more	0	(0.0)	29	(4.2)	44	(4.2)	
Access to antenatal care (n = 2022)							
Yes	166	(92.7)	658	(94.7)	1084	(94.4)	0.60
No	13	(7.3)	37	(5.3)	64	(5.6)	
Time of access to antenatal care (n = 1872/1908)							
≤ 12 weeks	12	(7.5)	66	(10.1)	173	(16.3)	<0.0001 (V=0.09)
12 - ≤ 20 weeks	46	(28.6)	208	(32.0)	376	(35.5)	
> 20 weeks	103	(64.0)	377	(57.9)	511	(48.2)	
Number of visits to antenatal care (n = 1939)							
None	13	(7.7)	37	(5.5)	64	(5.9)	0.0070 (V=0.08)
One	26	(15.4)	68	(10.1)	93	(8.5)	
Two	31	(18.3)	133	(19.7)	170	(15.5)	
Three	41	(24.3)	177	(26.2)	286	(26.1)	
Four	39	(23.1)	182	(26.9)	292	(26.7)	
More than four	19	(11.2)	79	(11.7)	189	(17.3)	
Gestational age at delivery (n = 2016)							
Term	139	(78.1)	496	(71.6)	848	(74.1)	0.18
Premature	39	(21.9)	197	(28.4)	297	(25.9)	
Facility where deliveries (n = 2022)							
CHBAH	175	(97.8)	668	(96.3)	1081	(94.2)	0.15
MOU facility	3	(1.7)	17	(2.4)	42	(3.7)	
Born before arrival	1	(0.6)	9	(1.3)	24	(2.1)	
HIV status at delivery (n = 2022)							
Negative	172	(96.1)	656	(94.5)	1018	(88.8)	<0.0001 (V=0.11)
Positive	7	(3.9)	38	(5.5)	129	(11.2)	
Timing of HIV diagnosis (n = 174)							
During pregnancy	7	(100.0)	25	(75.8)	78	(66.1)	0.11
Before pregnancy	0	(0.0)	8	(24.2)	40	(33.9)	

Anemia at first antenatal visit (n = 1889)							
Yes	73	(44.8)	291	(44.7)	482	(44.8)	>0.99
No	90	(55.2)	360	(55.3)	593	(55.2)	
Severity of anemia at booking (n = 846/846)							
Mild	41	(56.2)	160	(55.0)	257	(53.3)	0.85
Moderate / Severe	32	(43.8)	131	(45.0)	225	(46.7)	
Anemia at delivery (n = 1223/1223)							
Yes	50	(49.5)	211	(50.8)	303	(42.9)	0.027 (V=0.08)
No	51	(50.5)	204	(49.2)	404	(57.1)	
Severity of anemia at delivery (n = 564/564)							
Mild	25	(50.0)	116	(55.0)	141	(46.5)	0.17
Moderate / Severe	25	(50.0)	95	(45.0)	162	(53.5)	
Maternal co-morbid illnesses diagnosed before pregnancy							
Any	8	(4.5)	21	(3.0)	25	(2.2)	0.16
None	171	(95.5)	674	(97.0)	1123	(97.8)	
Maternal medication							
Antibiotics	29	(16.2)	135	(19.4)	202	(17.6)	0.48
Augmentation of labour	22	(12.3)	101	(14.5)	180	(15.7)	0.45
Antenatal steroids	20	(11.2)	92	(13.2)	132	(11.5)	0.50
Methyldopa	11	(6.1)	56	(8.1)	133	(11.6)	0.17
HAART	7	(3.9)	37	(5.3)	122	(10.6)	<0.0001 (V=0.10)
Induction of labour	12	(6.7)	55	(7.9)	83	(7.2)	0.80
Tocolytics	10	(5.6)	46	(6.6)	50	(4.4)	0.10
Nifedipine	7	(3.9)	24	(3.5)	64	(5.6)	0.10
Magnesium Sulphate	5	(2.8)	25	(3.6)	44	(3.8)	0.78
Any	107	(59.8)	370	(53.2)	572	(49.8)	0.031 (V=0.06)
Mode of delivery (n = 2020)							
NVD	130	(72.6)	470	(67.7)	755	(65.8)	0.33
Caesarean Section	46	(25.7)	198	(28.5)	346	(30.2)	
Assisted NVD	3	(1.7)	26	(3.7)	46	(4.0)	
Perineal Injury (n = 1326/1430)							
None	16	(13.4)	71	(15.7)	130	(17.4)	0.71
Laceration	11	(9.2)	47	(10.4)	59	(7.9)	
First Degree	14	(11.8)	62	(13.7)	116	(15.6)	
Second - Fourth Degree	12	(10.1)	40	(8.9)	62	(8.3)	
Episiotomy	66	(55.5)	231	(51.2)	378	(50.7)	
Cervical tear							
Indication for caesarean section (n = 586/590)							
Fetal distress	28	(60.9)	116	(58.6)	193	(51.9)	0.0068 (V=0.11)
CPD	8	(17.4)	26	(13.1)	22	(5.9)	
Other	10	(21.7)	56	(28.3)	157	(42.2)	
Peri- and postpartum complications (n = 2020)							
Preterm labour	30	(16.8)	149	(21.5)	230	20.1	0.36
Postpartum haemorrhage	16	(8.9)	50	(7.2)	73	6.4	0.41
Pre-eclampsia	5	(2.8)	37	(5.3)	50	4.4	0.31
Pre-labour rupture of membranes	3	(1.7)	16	(2.3)	25	2.2	0.88

Preterm. pre-labour rupture of membranes	4	(2.2)	9	(1.3)	26	(2.3)	0.33
Antepartum haemorrhage	3	(1.7)	14	(2.0)	22	(1.9)	0.99
Any	68	(38.0)	292	(42.1)	446	(38.9)	0.34

N frequency, *CHBAH* Chris Hani Baragwanath Academic Hospital, *MOU* Midwife operated obstetric unit, *BMH* Bheki Mlangeni Hospital, *HIV* human immunodeficiency virus, *NVD* normal vaginal delivery, *HAAART* highly active antiretroviral therapy

Table 6. Neonatal characteristics

Variable	N = 2039 (%)	
Gender (n=1980)		
Male	1006	(50.8)
Female	972	(49.1)
Ambiguous genitalia	2	(0.1
Gestational age at delivery (n=2016)		
Term	1483	(73.6)
Premature	533	(26.4)
Size relative to gestational age (n=2006)		
SGA	97	(4.8)
AGA	1846	(92.0)
LGA	63	(3.1)
Weight category (n=2012)		
Normal	1611	(80.1)
LBW	274	(13.6)
VLBW	49	(2.4)
ELBW	44	(2.2)
Fetal Macrosomia	34	(1.7)
Vitality at birth (n=2038)		
Alive	1984	(97.4)
Still birth	54	(2.6)
Type of stillbirth (n=54/54)		
Fresh stillbirth	27	(50.0)
Macerated stillbirth	27	(50.0)
Neonatal Admission (n=1981)		
Admitted to neonatal unit	347	(17.5)
Not admitted to neonatal unit	1634	(82.5)
HIV exposure		
HIV exposed	174	(8.5)
HIV not-exposed	1863	(91.4)
Unknown	2	(0.1)
HIV status if exposed (n=174/174)		
Negative	77	(44.3)
Positive	3	(0.7)
Unknown	94	(54.0)
Neonatal diagnosis (n=1863)		
Respiratory conditions	150	(8.1)
Congenital heart disease	5	(0.3)
Early onset neonatal sepsis	17	(0.9)
Nosocomial sepsis	33	(1.8)

Neonatal encephalopathy	21	(1.1)
NEC (> grade 2)	7	(0.4)
Neonatal jaundice	121	(6.5)
Congenital anomalies	14	(0.8)
Birth Trauma	3	(0.2)
Sub-aponeurotic haemorrhage	20	(1.1)
IDM	3	(0.2)
Bronchopulmonary dysplasia	7	(0.4)
Renal dysfunction	31	(1.7)
Other	80	(4.3)
Anemia	20	(1.1)
Meningitis	5	(0.3)
None/ well baby	1583	(85.0)
Outcome of admission (n=337/337)		
Discharged	196	(56.5)
Death	27	(7.8)
Unknown	124	(35.7)
Type of death (n=82)		
Perinatal death (< 7 days of life including still births)	72	(88.9)
LNND (>7 -28 days)	5	(6.2)
Infant death (>28 days)	5	(6.2)

N frequency, *SGA* small for gestational age, *AGA* weight appropriate for gestational age, *LGA* large for gestational age, *LBW* low birth weight, *VLBW* very low birth weight, *ELBW* extremely low birth weight, *NEC* necrotising enterocolitis, *IDM* Infant of a diabetic mother, *LNND* late neonatal death

Table 7. Neonatal Characteristics per adolescent age group

	12-15 year		16-17 year		18-19 year		p-value for between-group test
Variable	**n**	**%**	**n**	**%**	**n**	**%**	
Babies	**179**		**702**		**1158**		
Gender (n = 1980)							
Male	93	(53.4)	349	(51.5)	564	(50.1)	0.66
Female	81	(46.6)	329	(48.5)	562	(49.9)	
Size for gestational age (n = 2006)							
Small for gestational age	8	(4.6)	34	(4.9)	55	(4.8)	>0.99
Appropriate for gestational age	161	(92.5)	634	(91.8)	1051	(92.1)	
Large for gestational age	5	(2.9)	23	(3.3)	35	(3.1)	
Weight category (n = 2012)							
Normal	149	(85.1)	549	(79.3)	913	(79.7)	0.51
Low birth weight	18	(10.3)	96	(13.9)	160	(14.0)	
Very low birth weight	4	(2.3)	22	(3.2)	23	(2.0)	
Extremely low birth weight	2	(1.1)	16	(2.3)	26	(2.3)	
Fetal Macrosomia	2	(1.1)	9	(1.3)	23	(2.0)	
Vitality at birth (n = 2038)							
Alive	177	(98.9)	679	(96.9)	1128	(97.4)	0.32
Still birth	2	(1.1)	22	(3.1)	30	(2.6)	
Neonatal Admission (n = 1981)							
Yes	31	(17.5)	124	(18.3)	192	(17.1)	0.81
No	146	(82.5)	555	(81.7)	933	(82.9)	
HIV exposure							
Yes	7	(3.9)	38	(5.4)	129	(11.1)	<0.0001 (V=0.10)
No	172	(96.1)	663	(94.6)	1028	(88.9)	
Unknown							
Neonatal diagnosis (n = 1863)							
Respiratory distress syndrome	5	(2.9)	19	(3.0)	30	(2.8)	0.97
TTN	7	(4.1)	20	(3.2)	49	(4.6)	0.35
Any	28	(16.5)	95	(15.1)	157	(14.8)	0.85
Mortality (where it could be determined)	**25**		**97**		**155**		
Perinatal mortality	5	(20.0)	30	(30.9)	36	(23.2)	0.31

N frequency *CPD* cephalopelvic disproportion, *TTN* transient tachypnea of the newborn

Table 8. Risk factors for stillbirths

Variable	Alive N (%)		Stillbirth N (%)		p-value	RR for stillbirth	95% CI for RR	
Mothers								
n	**1984**	(97.4)	**54**	(2.6)				
Age								
12-15	177	(98.9)	2	(1.1)	0.25	0.43	0.10	1.79
16-17	679	(96.9)	22	(3.1)	0.49	1.21	0.70	2.08
18-19y	1128	(97.4)	30	(2.6)		1.00	reference	
Race								
Black	1885	(97.3)	52	(2.7)		1.00	reference	
Other	99	(98.0)	2	(2.0)	0.67	0.74	0.18	2.99
Relationship status (n = 2018)								
Single	1894	(97.4)	50	(2.6)		1.00	reference	
Relationship / Married	70	(94.6)	4	(5.4)	0.14	2.10	0.78	5.67
Occupation (n = 2012)								
Ongoing education	1209	(97.1)	36	(2.9)		1.00	reference	
Unemployed	719	(97.6)	18	(2.4)	0.55	0.84	0.48	1.48
Employed	30	(100.0)	0	(0.0)		not estimable		
Gravidity (n = 2037)								
One	1761	(97.5)	45	(2.5)		1.00	reference	
Two / Three	222	(96.1)	9	(3.9)	0.21	1.56	0.77	3.16
Parity (n = 2037)								
Zero	1816	(97.5)	47	(2.5)		1.00	reference	
One or more	167	(96.0)	7	(4.0)	0.24	1.59	0.73	3.47
Accessed antenatal care								
Yes	1890	(98.2)	34	(1.8)		1.00	reference	
No	94	(82.5)	20	(17.5)	<.0001	9.93	5.91	16.68
Timing of access to ANC (n = 1888)								
≤ 12 weeks	252	(98.4)	4	(1.6)		1.00	reference	
12 - ≤ 20 weeks	631	(98.9)	7	(1.1)	0.57	0.70	0.21	2.38
> 20 weeks	972	(97.8)	22	(2.2)	0.52	1.42	0.49	4.07
Number of ANC visits (n = 1954)								
None	94	(82.5)	20	(17.5)	0.0001	50.70	6.88	373.38
One	177	(94.7)	10	(5.3)	0.0088	15.45	1.99	119.73
Two	327	(97.0)	10	(3.0)	0.040	8.58	1.10	66.59
Three	502	(98.4)	8	(1.6)	0.15	4.53	0.57	36.06
Four	515	(99.6)	2	(0.4)	0.93	1.12	0.10	12.28
More than four	288	(99.7)	1	(0.3)		1.00	reference	
Gestational age (n = 2016)								
Term	1476	(99.3)	10	(0.7)		1.00	reference	
Premature	503	(92.1)	43	(7.9)	<.0001	11.70	5.92	23.13
Facility delivered								
CHBAH	1892	(97.6)	47	(2.4)		1.00	reference	
MOU	61	(96.8)	2	(3.2)	0.70	1.31	0.33	5.27
Born before arrival	29	(85.3)	5	(14.7)	<.0001	6.07	2.57	14.30
BMH								
HIV status								

Negative	1812	(97.3)	50	(2.7)		1.00	reference	
Positive	172	(98.9)	2	(1.1)	0.18	0.52	0.20	1.36
Unknown								
Anemia at booking (n = 1905)								
Yes	830	(97.8)	19	(2.2)	0.25	1.48	0.76	2.85
No	1040	(98.5)	16	(1.5)		1.00	reference	
Severity of anemia at booking (n = 849/849)								
Mild	452	(97.8)	10	(2.2)		1.00	reference	
Moderate / Severe	378	(97.7)	9	(2.3)	0.87	1.07	0.44	2.62
Haemoglobin taken at delivery								
No	794	(98.8)	10	(1.2)		1.00	reference	
Yes	1190	(96.4)	44	(3.6)	0.0024	2.87	1.45	5.66
Anemia at delivery (n = 1234/1234)								
Yes	548	(96.1)	22	(3.9)	0.61	1.16	0.65	2.08
No	642	(96.7)	22	(3.3)		1.00	reference	
Severity of anemia at delivery (n = 570/570)								
Mild	276	(96.8)	9	(3.2)		1.00	reference	
Moderate / Severe	272	(95.4)	13	(4.6)	0.39	1.44	0.63	3.33
Maternal co-morbid illnesses diagnosed before pregnancy								
Any	53	(98.1)	1	(1.9)	0.71	0.69	0.10	4.92
None	1931	(97.3)	53	(2.7)		1.00	reference	
Maternal disease diagnosed in pregnancy								
Hypertensive disorder	240	(96.0)	10	(4.0)	0.16	1.63	0.83	3.19
Pregnancy induced hypertension	195	(96.1)	8	(3.9)	0.23	1.57	0.75	3.28
Unclassified hypertension	45	(95.7	2	(4.3)	0.49	1.63	0.41	6.49
Any	249	(96.1)	10	(3.9)	0.20	1.56	0.80	3.06
Maternal medication received during pregnancy								
Antibiotics	361	(98.4)	6	(1.6)	0.19	0.57	0.25	1.32
Augmentation of labour	296	(97.7)	7	(2.3)	0.69	0.85	0.39	1.87
Antenatal steroids	245	(98.0)	5	(2.0)	0.50	0.73	0.29	1.81
Methyldopa	176	(97.8)	4	(2.2)	0.71	0.83	0.30	2.26
HAART	164	(98.8)	2	(1.2)	0.24	0.43	0.11	1.76
Induction of labour	145	(96.0)	6	(4.0)	0.29	1.56	0.68	3.59
Tocolytics	108	(98.2)	2	(1.8)	0.58	0.67	0.17	2.73
Nifedipine	91	(95.8)	4	(4.2)	0.33	1.64	0.60	4.44
Magnesium Sulphate	68	(91.9)	6	(8.1)	0.0040	3.32	1.47	7.50
Any	958	(97.7)	23	(2.3)	0.41	0.80	0.47	1.36
Mode of delivery								
NVD	1317	(96.6)	46	(3.4)		1.00	reference	
Caesarean section	591	(98.7)	8	(1.3)	0.015	0.40	0.19	0.83
Assisted NVD	75	(100.0)	0	(0.0)		not estimable		
Babies	**1984**		**54**					
Gender (n = 1978)								
Male	981	(97.5)	25	(2.5)		1.00	reference	

Female	952	(97.9)	20	(2.1)	0.52	0.83	0.46	1.48
Weight vs GA (n = 2006)								
SGA	89	(91.8)	8	(8.2)	0.0003	3.90	1.88	8.12
AGA	1807	(97.9)	39	(2.1)		1.00	reference	
LGA	62	(98.4)	1	(1.6)	0.78	0.75	0.10	5.38
Weight category (n = 2012)								
Normal	1603	(99.5)	8	(0.5)		1.00	reference	
LBW	263	(96.0)	11	(4.0)	<.0001	8.08	3.28	19.9
VLBW	37	(75.5)	12	(24.5)	<.0001	49.3	21.1	115.2
ELBW	26	(59.1)	18	(40.9)	<.0001	82.4	37.9	179.2
Macrosomia	34	(100.0)	0	(0.0)		not estimable		

N frequency, *ANC* antenatal care, *SGA* small for gestational age, *AGA* weight appropriate for gestational age, *LGA* large for gestational age, *LBW* low birth weight, *VLBW* very low birth weight, *ELBW* extremely low birth weight, *NEC* necrotising enterocolitis, *IDM* Infant of a diabetic mother, *LNND* late neonatal death

Table 9: Multivariable regression analysis for stillbirths

Multivariable Model:	Alive		Stillbirth		p-value	RR for stillbirth	95% CI for RR	
Variable	n	Row %	n	Row %				
Access to Antenatal Care (ANC)								
Yes	1890	(98.2)	34	(1.8)		1.00	reference	
No	94	(82.5)	20	(17.5)	0.00	2.47	1.49	4.09
Weight category (n=2012)								
Normal	1603	(99.5)	8	(0.5)		1.00	reference	
LBW	263	(96.0)	11	(4.0)	<.0001	7.68	3.12	18.9
VLBW	37	(75.5)	12	(24.5)	<.0001	36.0	14.9	86.8
ELBW	26	(59.1)	18	(40.9)	<.0001	60.0	26.5	136.0
Macrosomia	34	(100.0)	0	(0.0)		not estimable		

N frequency, *ANC* antenatal care, *LBW* low birth weight, *VLBW* very low birth weight, *ELBW* extremely low birth weight, *NEC* necrotising enterocolitis, *IDM* Infant of a diabetic mother, *LNND* late neonatal death

Figure 1. Age distribution of adolescent Pregnancies at CHBAH

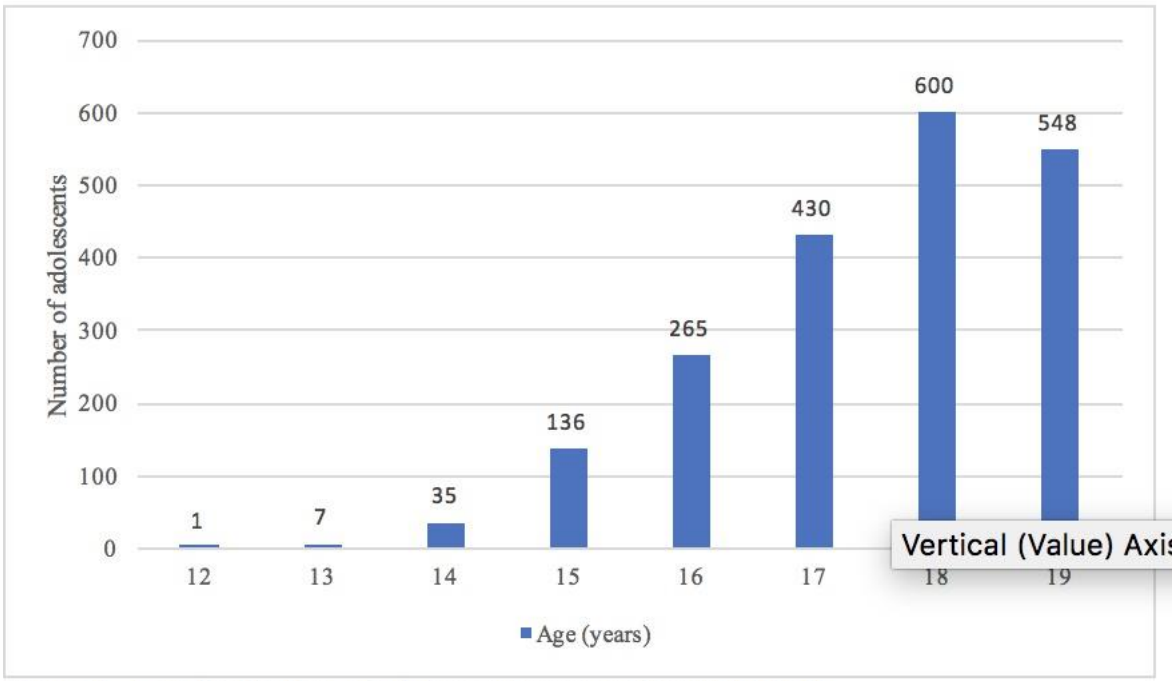

Figure 1. Age distribution of adolescent pregnancies at CHBAH

Research Protocol

A Descriptive Study of the Obstetric and Neonatal Outcomes of Adolescent Pregnancies at a Tertiary Academic Hospital

Investigator:

Dr E Cremona

Supervisors:

Dr FL Nakwa, Chris Hani Baragwanath Academic Hospital

Dr J Jeebodh, Chris Hani Baragwanath Academic Hospital

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Background Literature Analysis and Critique

The World Health Organization (WHO) estimates that approximately 17 million girls under the age of 19 give birth every year, with an estimate that 95% of these births occur in low and middle income countries. These 17 million births account for 11% of all births globally. The WHO further estimates that 50% of all adolescent pregnancies occur in Sub-Saharan Africa where the estimated birth rate in the 15-19 year age group, in this region, is 121 per 1000 (1). Adolescent mothers, defined as pregnancy in girls aged 10 to 19 years, tend to have poorer outcomes with a high risk of maternal morbidity and mortality (1, 2). Globally, pregnancy and perinatal complications are the second highest cause of death in females in the 15-19 year-old group, however this also includes the consequences of unsafe abortion practices, (1). This remains a social, health and economic concern (3-5). The United Nations Population Fund suggests that a country's gross domestic product can potentially be increased by billions of dollars with a reduction in adolescent pregnancy (6).

South Africa has national datasets to capture live births. These datasets are coordinated by the Department of Home Affairs and include births registered at the department, births registered at health facilities and births to South African Citizens while in foreign countries (7). Births captured in delivery registers in labour wards and operating theatres act as a way of in-house record keeping. It is however, difficult to accurately estimate the number of miscarriages and induced abortions in South Africa (8). This makes for a reasonably accurate estimate the adolescent fertility rate (number of live births) but, an accurate estimation of adolescent pregnancy rate (live births, abortions, still births and miscarriages) remains difficult (8).

It is estimated that approximately 30% of female South African teenagers have "ever been pregnant", with the majority of pregnancies being unplanned (9). It has also been documented that 30% of all 19 year olds in South Africa have given birth at least once (10). Teenage pregnancies in South Africa are more likely to occur in rural areas, in black and coloured females and in those with a lower level of education (11). More than 176 000 South African teenagers were pregnant in 2013, with 72 891 deliveries to females under the age of 18 between April 2012 and March 2013. Approximately 2903 of these girls were 13 years old. The biggest group, the 19 year olds accounted for 65014 pregnancies (12). Between 2013 and 2014, Gauteng province is estimated to have the highest number of school pregnancies, followed by the Eastern Cape and Mpumalanga; the North West province recorded the lowest number of pregnant school girls (13).

The United Nations Populations Division annually submits a report indicating adolescent (females between 15 and 19 years of age) fertility rates per country. When viewed over time, the general trend globally, is one of decline. High income countries such as Sweden currently have an adolescent fertility rate of 7 per 1000 live births. Low income African Countries such as the Democratic Republic of the Congo (DRC) and Zimbabwe have current adolescent fertility rates of 135 and 60 per 1000 respectively (14).

Between 2004 and 2008, the WHO conducted a global survey on maternal and perinatal health. This was a multi-country, facility based, cross-sectional study which included low and middle income countries where various maternal characteristics and perinatal outcomes were reviewed with a specific focus on the outcomes of adolescent pregnancies (1, 2). The survey found, and multiple other authors agree, that younger mothers have poorer obstetric and perinatal outcomes. Significantly, they were more likely to require caesarean sections for cephalo-pelvic disproportion (CPD), especially the younger the adolescents, experience pre-term labour, have pre-eclampsia and eclampsia, puerperal sepsis and a lower third trimester haemoglobin level (1, 2, 4, 15-19). Girls, younger than 15 years have been found to be four times more likely to die, while 15 to 19 year olds are two times more likely to die than older mothers from pregnancy related complications (20). A South African study by Baxter et al in 2015, reported that adolescents are more likely to die from hypertension related complications, while other causes of death included severe haemorrhage, sepsis and consequences of unsafe abortion practices (21).

When the WHO compared African mothers to Latin American and Asian mothers, African adolescents were more often single and less educated (43.9% with no education compared to 3% and 9.4% in Latin American and Asian mothers respectively). They frequently gave birth prematurely (37.6% compared to 20.2% and 22.1%) and their infants were more commonly low birth weight (32% compared to 22.8% and 11.7%). Perinatal mortality was also significantly higher amongst African mothers (1). The WHO found that in African adolescents, the maternal mortality rate was 102.2/100000 (1). In Sub-Saharan Africa the perinatal mortality rate (PNMR) in babies born to adolescents has been documented to be 39.68 deaths/1000 lives births, compared to non-adolescent females where the PNMR is 23.47 deaths/1000 live births (22).

Adolescent pregnancies often complicate due to the physical immaturity of the young mother. This physical immaturity, poor knowledge regarding their own bodies and preparation regarding pregnancy, together with poor social circumstances, poor psychosocial support and incomplete schooling contribute to an increased risk of adverse events (4, 19, 21, 23). Young mothers either do not access antenatal care or access it at a much more advanced stage of their pregnancy (4, 15, 21, 24). This trend occurs in low as well as high income countries (18, 19). Concerns around disclosure of the pregnancy, difficult access to care in terms of clinic operating hours and transport costs, negative health care provider attitudes, feeling well and not acknowledging a need for or benefits of antenatal care and difficult family relations prevent access to care (21, 24). The WHO recommends at least four antenatal care visits for an uncomplicated pregnancy; this has been adopted by South African Maternity Guidelines. However, early “booking” of the pregnancy, before 12 weeks’ gestation, is highly encouraged (25, 26). Outcomes are improved when adolescents utilize antenatal care, receive nutritional support and negative social circumstances are addressed (24, 27). Sexually transmitted disease including Human Immunodeficiency Virus (HIV) are an additional health risk a in

sexually active population (28). Adolescents (males and females) account for 5% of all people infected with HIV; 82% of these adolescents reside in Sun-Saharan Africa (29).

Multiple factors influence the adolescent fertility rate including a younger age at menarche and first sexual activity and poor contraception use, despite good knowledge of available options (30). Adolescent pregnancy has been postulated to be derived from and to be a consequence of social deprivation within a community. Deprivation however, as a circumstance is difficult to define and quantify as it is subjective and multi-factorial. A study conducted in Aberdeen City, Scotland, analyzed changes in adolescent fertility and social deprivation over a 60-year period. It was reported that overtime there was a decline in the overall adolescent fertility rate as well as the overall fertility rate as there was an increase in skilled labour in each area. Only the most deprived areas still had relatively high adolescent fertility rates (31).

Adolescent females who fall pregnant are likely to be single, be less educated, have parents from poor socioeconomic backgrounds, often single parents or have poor parental supervision, have been exposed to domestic violence, lack knowledge around issues such as sexuality and reproductive health and be influenced by peer groups and sisters who have a history of adolescent pregnancy. They commonly have family instability and disorganization which may contribute to both poor social and economic circumstances (16, 32-36). Adolescents in Sub-Saharan Africa also suffer from co-morbid conditions such as HIV, syphilis, malaria and tuberculosis more frequently than older females (17). Of concern is the cessation of formal education once the adolescent falls pregnant. In the KwaZulu-Natal province has noted that only 30% of girls between the ages of 14-19 who had dropped out of school for pregnancy related reasons had returned to school after (21).
Lower adolescent fertility rates have been attributed to good sexual education, high rates of contraception use, delayed age of sexual debut, traditional values often discouraging teenage marriages and social stigmatization around the issue of adolescent pregnancy.
Adolescent parenthood is seen as a disadvantage in a society that encourages extended education where careers for women, two-income households and delayed childbearing are becoming the norm (37).

Babies born to adolescents are more likely to be delivered prematurely and with severe neonatal conditions including low birth weight (LBW) very low birth weight (VLBW) and have a 5-minute Apgar score of less than 7 (2, 4, 15, 18, 21). The risk of neonatal admission into an intensive care unit, and intra-hospital early mortality was higher in adolescent mothers compared with adult mothers (2, 4). Many studies have found age to be an independent risk factor for poor maternal and neonatal outcomes including death (1, 15, 30, 34, 38).
The aim of this study is to highlight adolescent pregnancy with background demographic and biological characteristics, the perinatal outcomes of their newborns as well as maternal morbidity in a Tertiary

Academic Centre at Chris Hani Baragwanath Academic Hospital (CHBAH). This hospital is the main referral centre for several peripheral maternal and obstetric units in Soweto, Johannesburg and is reflective of a predominantly black, urban population.

Study Objectives

- To describe the demographic parameters and obstetric outcomes of adolescent females, who deliver neonates at a tertiary academic hospital
- To describe the demographic parameters, complications and neonatal outcomes of neonates born to adolescent mothers in a tertiary academic hospital
- To determine the predictors of maternal, perinatal and neonatal death within the study population.

Methods

Population to be studied

This is a retrospective study of obstetric, perinatal and neonatal outcomes adolescent females, younger than 20 years on day of delivery, who gave birth at the Obstetric Unit of the Chris Hani Baragwanath Academic Hospital (CHBAH) from the period January to December 2015.
Inclusion criteria will include mothers who are younger than 20 years on the day of delivery.

Mothers will be identified from the delivery registers in the labour ward, high care area and caesarian section theatre at the CHBAH obstetrics department. Registers in the maternity admissions ward and "first stage" area will also be reviewed to identify patient who delivered on admission or while awaiting transfer to labour ward.

Eligible mothers who deliver in referral clinics will not be included in data collection; should their neonate require medical attention, they would be transferred to CHBAH and their data captured for analysis with the neonate outcomes.

The complete maternal and perinatal data set will be collected from the maternal case record (including antenatal records, admission records, patient bed letters and the neonatal section of the maternal records) and neonatal records such as patient bed letters and files onto standardized data collection sheets (Appendix 2). Records will be accessed from archives within the obstetric and neonatal units at CHBAH. Where a maternal or perinatal diagnosis is made and noted in the records, it will be assumed that it is correct and in keeping with correct case-definitions for that diagnosis.

In addition to reviewing the above data, the researcher will collect the number of deliveries to adolescent females from eight units within the Soweto region that regularly refer to CHBAH in order to accurately estimate incidence and outcomes within this population. Record reviews of these patients will not take place. The following maternity and obstetric units (MOU) will be included: Lillian Ngoyi Community Health Centre (CHC), Zola CHC, Mofolo CHC, Itereleng CHC, Chiawelo CHC, Lenasia South CHC, Stretford Clinic and Bheki Mlangeni District Hospital.

Endpoint of Study

On completion of the study, the investigator aims to have qualitatively and quantitatively described the obstetric and neonatal outcomes of adolescent fertility at CHBAH.

Data Analysis

The sample size was calculated based on worst-case (for sample size) estimates of 50%, 5% precision and the 95% confidence level. A sample size of 385 is required. The anticipated sample size for the study is approximately 700 patients is, thus more than adequate.

Categorical variables will be expressed by frequency and percentage tabulation and will be illustrated by means of bar charts. Continuous variables will be summarized by the mean, standard deviation, median and interquartile. The chi-test will be used to assess the relationships between categorical variables. Fisher's exact test will be used for 2 x 2 tables or where the requirements for the X^2 test cannot be met. Univariate and multivariate analysis will be performed to identify risk factors associated with poor outcome.

Data analysis will be carried out in SAS version 9.4 for Windows. A p value of >0.05 will be regarded as significant.

Ethics

This proposal will be submitted to the University of the Witwatersrand Human Research Ethics Committee. The intended study is retrospective and anonymous in nature and as a consequence informed consent for the use of clinical information in not mandatory. Identifying features will be kept separate from the data set. Permission to access the necessary records and data will be obtained from the Chief Executive Officer (CEO) of the CHBAH, Heads of the Department of Paediatrics, Neonatal and the Obstetrics and Maternal Health Unit of CHBAH.

Timing

	June 2015 to May 2016	May to July 2016	August 2016 to September 2017	September to December 2017	January to April 2018	June 2018
Literature Review and Protocol Development						
Submission to Postgraduate Research Committee						
Submission to Ethics Committee						
Data Collection						
Data Analysis						
Write up of Research Report						
Review of Research Report						
Submission of Research Report						

Funding

All costs incurred will be at the expense of the investigator.

Limitations

1. As a retrospective review, a paucity of relevant details from maternal case records or neonatal records as well as missing records may restrict the collection of a complete set of data. Any data omissions will be noted.
2. Though National guidelines require antenatal clinics to refer all females younger than 16 to a hospital for delivery (25), protocols in practice at this institution require that all clinics refer patients 18 years and younger. It is accepted that at times these mothers may deliver at clinics prior to transfer and thus may not be captured as part of the study. Should their neonates require neonatal care, they would be transferred to CHBAH for paediatric care and if the mother well, it is assumed

that she was discharged home. Maternal peripartum complications would be managed and referred to CHBAH should the need arise.

3. Due to the above referral policy, the incidence of adolescent pregnancy at CHBAH may be underestimated, whereas adverse outcomes and complications may be overestimated. The researcher will stratify such data by age to avoid any bias.
4. The CHBAH obstetric department refers patients for elective delivery by caesarean section to secondary hospitals owing to theatre constraints. This may result in loss of patients that meet the inclusion criteria

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Appendices
Appendix 1: Data Variables

Variable	Definition of Variable
Adolescent	A female between the age of 10 and 19 years of age (2)
Gravidity and Parity	Number of pregnancies and number of previous deliveries
Race	Black, White, Mixed ethnicity or Asian
Uptake into antenatal care	Four or more antenatal visits
Viable pregnancy	≥ 22 weeks of completed gestation or birth weight ≥ 500g
Miscarriage	≤ 22 weeks of completed gestation or birth weight ≤ 500g
Still Birth	Fetal birth ≥22 completed weeks of gestation or fetal weight ≥ 500g with no signs of life at birth
Gestational Age	Number of completed weeks of gestation at time of delivery
Birth weight	Weight of neonate at time of delivery
Mode of delivery	Normal vertex delivery including use of assistive devices (vacuum or forceps) or caesarean section including the indication for surgery
Maternal disease	Including all chronic illnesses prior to pregnancy and those related to and diagnosed during this pregnancy
Ante-natal complication	Morbidity occurring prior to delivery of the fetus
Post-natal complication	Morbidity occurring after delivery of the fetus
Neonatal admission	Admission of the neonate into any of the wards related to the Neonatal Unit
Maternal HIV status at delivery	Positive, negative or unknown
Maternal Syphilis serology	Positive, negative or unknown

Perinatal death	Still births and deaths occurring with the first seven days of life
Early neonatal death	Death occurring from birth to six completed days of life (28)
Late neonatal death	Death occurring from seven completed days to less than 28 completed days after birth (28)
Post neonatal death	Death occurring after 28 days of life, but less than one year of age (39)
Maternal Mortality	Maternal deaths occurring from conception to within 42 days after delivery (28)

Appendix 2: Data Collection Sheet

Data collection reference number: _____

Age: _____

Maternal age	10	11	12	13	14	15	16	17	18	19

Maternal Race: _____

Maternal Race	Black	White	Mixed ethnicity	Asian (including Indian)
Code	1	2	3	4

Maternal marital status: _____

Maternal marital status	Married	Unmarried	Committed relationship
Code	1	2	3

Maternal employment: _____

Gravidity and Parity: _____

Gravidity	1	2	3	4	5	More than 5
Code	1	2	3	4	5	6

Parity	0	1	2	3	4	More than 4
Code	1	2	3	4	5	6

Antenatal care: Yes/No

Care at hospital/clinic: _____

Gestational age at booking:_____

Facility accessed	Hospital	Clinic
Code	1	2

Number of antenatal visits	Not accessed	One visit	Two visits	Three visits	Four visits	More than four visits

Code	1	2	3	4	5	6

HIV status at delivery:

HIV status	Negative	Positive	Unknown
Code	1	2	3

HIV diagnosed in pregnancy?_____

CD4 count at delivery: _____

HIV Viral load at delivery: _____

Rh positive or negative:_____

Syphilis Serology:

Syphilis status	Negative	Positive	Unknown
Code	1	2	3

If Positive: Completed treatment for Syphilis

Treatment Status	Complete	Not Complete
Code	1	2

Maternal haemoglobin at time of delivery: _____

Maternal comorbid diseases diagnosed prior to pregnancy:

Maternal comorbid disease	Diabetes	Hypertension	Asthma	Epilepsy	Thyroid disease	Other
Code	1	2	3	4	5	6

If "other", specify: _____

Maternal disease diagnosed during or occurring as a result of pregnancy:

Maternal disease related to pregnancy	Hypertensive disorders	Gestational diabetes	Anaemia	Other
Code	1	2	3	4

If "other", specify: _____

Maternal Medication:

1._____2._____

_____3._____

_____4._____

_____5.

_____

Maternal Outcome: _____

Outcome	Discharged home	Maternal Death
Code	1	2

Mode of delivery:

Mode of delivery	NVD	Caesarean section	NVD breech	NVD born before arrival
Code	1	2	3	4

Blood loss:_____

Injuries to perineum:_____

If caesarean section – indication: _____

Indication	Code
Fetal distress	1
Fetal compromise	2
Poor progress	3
Prolonged second stage	4
CPD	5
Breech presentation	6
Multiple pregnancy	7
Antepartum haemorrhage	8
Hypertensive disease	9
Previous Caesarean section	10
Other	

If NVD – Assisted delivery– Yes/No and type: Forceps/Vacuum

Assistive device	Forceps	Vacuum
Code	1	2

Maternal complications:

Ante-partum maternal complications:

Complication	Code
Pre-term labour	1
Pre-labour rupture of membranes	2
Chorioamnionitis	3
Intrauterine growth restriction	4
Gestational diabetes	5
Pregnancy induced hypertension	6
Pre-eclampsia	7
Eclampsia	8
Other	9

1._____2._____

_____3._____

_____4._____

_____

Intra-partum and post-partum maternal complications:

Complication	Code
Post-partum haemorrhage	1
Eclampsia	2
Shoulder dystocia	3
Cord prolapse	4
Puerperal sepsis	5
Other	6

1._____2._____

_____3._____

_____4._____

_____

Gestational age at delivery by best estimate: _____Weeks

Best estimate (dates/sonar/Ballard Score):

_____

Single/twin/triplet

Gender:_____

Birth weight: _____g Head circumference _____cm length _____com

Apgar scores:

1 minute: _____5 minute: _____ 10 minute: _____

Perinatal and neonatal diagnosis made in the neonate:

Diagnosis	Code
Respiratory distress syndrome	1
Neonatal sepsis	2
Neonatal jaundice	3
Necrotising enterocolitis (stage II and higher)	4
Neonatal encephalopathy	5
Meconium aspiration syndrome	6
Congenital pneumonia	7
TTN	8
Other	

1._____2._____

_____3._____

_____4._____

_____

PCR result if mother is HIV positive: _____

Neonatal outcome:_____

Day of life of outcome: _____

Ethics Certificate

R14/49 Dr Elena Cremona

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160763

NAME: (Principal Investigator)	Dr Elena Cremona
DEPARTMENT:	Paediatrics Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	A Descriptive Study of the Obstetric and Neonatal Outcomes of Adolescent Pregnancies at a Tertiary Academic Hospital
DATE CONSIDERED:	29/07/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Firdose Nakwa and Dr Jayshree Jeebodh
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	21/06/2017

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 in Room 10004,10th floor, Senate House/3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. 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 review July and will therefore be due in the month of July 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

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