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RESEARCH REPORT

Caesarean section deliveries in public sector hospitals in South Africa, 2001-2009.

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

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CANDIDATES DECLARATION

I, Fiorenza Monticelli (student number 7930410) am a post-graduate student registered for the degree Masters of Public Health (MPH) at the University of the Witwatersrand, School of Public Health.

I am submitting written work for the research report component of the aforementioned degree.

I hereby declare the following:

- I confirm that the work submitted for the above course is my own work, except where I have stated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.

Signed: _____

Date: _____

DEDICATION

I dedicate this work to all the women who give birth in public sector health facilities, past present and future, the health workers who assist them, the administrators who record the relevant data and the National Department of Health who enable the monitoring and evaluation of these events through the District Health Information System for planning purposes.

Fiorenza Monticelli

ABSTRACT

Introduction

There is concern that C-section rates are increasing in the public health sector in South Africa and wide variation has been reported between districts, provinces and hospitals. This study is a comprehensive analysis of C-section rates in all public sector hospitals during 2000/01-2008/09 by facility, district and province. It aims to inform decision makers in maternal health services of the trends and patterns occurring in C-section rates in South African public sector hospitals. Variation in C-section rates is described to highlight the differences in care that pregnant women receive in different parts of the country and to illustrate where inequity of resource allocation is occurring, as well as highlighting possible data quality problems.

Methodology

This is a descriptive study using quantitative methods of analysis on secondary data obtained from the National Department of Health's routinely collected data specific to Caesarean sections in the DHIS. C-section averages are weighted by taking the number of deliveries per facility and level into consideration.

Results

1. **Wide variation is noted between individual facilities, between and within provinces and districts and within the different levels of hospitals in 2008/09.**

   The mean weighted C-section rate ranges from 17.2% in District Hospitals to 40.7% in Specialised Maternity Hospitals. A 3.7 fold difference between the highest and lowest district average C-section rates is seen for District Hospitals. Within provinces, average District Hospital C-section rates vary by as much as 3.5 fold between districts. Inter-district variation in Regional Hospitals shows a 3.3 fold difference between the lowest and highest average district rates. Among the eight National Central Hospitals there is a 2.5 fold difference between the highest (79.7%) and lowest (31.7%) facility C-section rates. Nationally a total of 23 District Hospitals had C-section rates below 5% and nine hospitals of varying levels had rates of over 50%

2. **Caesarean Section rate trends, 2000/01 – 2008/09 are increasing.**

   Nationally the average C-section rate in South Africa increased by 6.3 percentage points from 18.1% in 2000/01 to 24.4% in 2008/09, with an average annual compounded growth rate of 3.8%. Bivariate linear regression analysis confirms there is a positive linear relationship between time (year) and C-section rate ($p<0.001$). All levels of hospitals showed an increasing trend over the nine years, ($p<0.001$), with the rate in Provincial

Hospitals having increased by the highest amount (1.40%) year on year and District Hospitals, the least (0.48%). Trends within certain districts and individual hospitals however, show a decline.

3. **A strong relationship between level of deprivation and C-section rate exists when adjusting data for provincial variation**

   Bivariate linear regression analysis revealed no association between the level of deprivation of the population at district level and the mean C-sections rate per district (p=0.130). Multiple regression analysis adjusted for the effect of province, reveals a significant association (p=0.044). A negative association between the DI (p=0.006) and C-section rate is seen in eight out of nine provinces.

4. **Data quality of C-sections and deliveries in the DHIS needs improving**

   Data quality in the DHIS leaves uncertainty in some instances whether C-section rate trends are a true reflection or not. The C-section rate indicator on its own is unable to inform on the full spectrum of emergency obstetric care. The definition of C-section rate for primary health care currently only considers deliveries in District Hospitals. The national C-section rate for primary health care in the country however, reduces from 17.2% to 13.2% when including the deliveries which take place in CHCs.

Conclusions

The quality of data relating to C-sections (number of births, C-sections and hospital categorisation) in the DHIS needs to be improved in order to enable accurate monitoring and should include deliveries and C-sections which take place in Community Health Centres to allow for a more accurate reflection of C-section rate in primary health care.

The C-section rate indicator on its own is insufficient to adequately inform on the full spectrum and quality of the provision of emergency obstetric care in South Africa. Including additional indicators to the DHIS, such as the UN process indicators, could improve on the current knowledge and monitoring of the provision of emergency obstetric care in South Africa.

The wide variation in C-section rates seen among District Hospitals and the C-section rates between and within districts and provinces, suggest inequity in resource allocation and irregular service delivery patterns. Reasons and solutions for these wide differences need to be found, which are likely to be unique to each district and province.

Further studies are needed to investigate the access of poorer women, especially those in remote rural areas to emergency obstetric care services.

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ACGR	Annual (average) compounded growth rate (also see CAGR)
EOC	Essential Obstetric Care
EmOC	Emergency Obstetric Care
EC	Eastern Cape
CAGR	Compound annual growth rate
CHC	Community Health Centre
DI	Deprivation Index
DHIS	District Health Information System
ESMOE	Essential Steps in Managing Obstetric Emergencies
FS	Free State
GP	Gauteng
HISP	Health Information Systems Programme
HIV	Human Immunodeficiency Virus
ISRDP	Integrated Rural Sustainable Development Programme
KZN	KwaZulu-Natal
LP	Limpopo
MDG	Millennium Development Goal
MOU	Maternal Obstetric Unit
MP	Mpumalanga
NC	Northern Cape
NCCEMD	National Committee on the Confidential Enquiries into Maternal Deaths
NDOH	National Department of Health
NIDS	National Indicator Data Set
NSDA	Department of National Health's Negotiated Service Delivery Agreement
NW	North West
PCA	Principal Compound Analysis
SEQ	Socio-economic Quintile
UN	United Nations
WC	Western Cape
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

As outlined in the National Department of Health's Saving Mothers policy and management guidelines[1], and the "Saving Mothers" report[2], the maternal mortality ratio in South Africa is unacceptably high and needs to be addressed as a matter of urgency. Every year worldwide, some 536 000 women die of complications during pregnancy or childbirth, with most maternal deaths occurring in the African Region[3]. The Millennium Development Goals, specifically MDG5[4], require that by 2015 the maternal mortality ratio is reduced by three quarters. Little progress has been made in reducing maternal mortality despite increasing proportions of facility-based births[5] and interventions to address major causes of maternal deaths. Although improving maternal health care is a top priority for the national government and all Provincial Health Departments, clearly more needs to be done to address the full spectrum of care for pregnant women, of which essential obstetric care (EOC)[6] forms an integral part. Caesarean sections (C-sections) are one of the most effective means of reducing maternal mortality and are performed as part of essential obstetric care.

The C-section rate is considered to be an important indicator of access to essential obstetric care in developing countries[7] and in South Africa it is among one of the key maternal health indicators used in the evaluation of safe motherhood programmes[8]. C-sections are meant to be performed at every hospital level in the public sector, with the more complicated obstetric cases requiring specialist care being referred to secondary and tertiary level hospitals.

According to the Fourth Report of the National Committee for the Confidential Enquiries into Maternal Deaths in South Africa 2005-2007 (NCCEMD), 42% of births in public sector facilities occur in District Hospitals[2] and the 2008/09 District Health Information System (DHIS) data[5] reports a figure 49%. However, due to shortage of resources and skills in some District Hospitals, many patients may in fact be referred to higher levels of care within a district and it is therefore important to look at the C-section rates of all levels of hospitals in order to have a clearer picture of what is happening within a district.

Problem statement and justification for the study

Wide variation and increasing trends in public sector C-section rates in South Africa

Wide variation and increasing trends in the public sector's C-section rates[i] have been observed in the District Health Information System (DHIS) [5] and reported in the District Health Barometer[9] and are of concern. The reasons for the variation and increase are unclear and the extent has not been investigated in much detail.

The reasons why it is important to assess and describe the variation of C-section rates across the country is first and foremost to highlight differences in the care that pregnant women receive in different parts of the country. Very low or non-existent rates would draw attention to those areas and facilities where women do not have access to emergency obstetric care services. From a planning and management perspective excessively high C-section rates are important to note as they directly affect the costs involved in running a hospital. Such rates could also signal inequity of resource allocation as some hospitals may carry the load of nearby under-resourced hospitals. Extreme outliers in values would also draw attention to the possibility of poor data quality and the need for validation of the figures.

In the 12 month period April 2008 - March 2009, the mean C-section rate in South Africa's District Hospitals as reported through the DHIS[5] was 17.2% and varied from a high of 32.5% in Nelson Mandela Bay Metro (Eastern Cape Province) to a low of 8.7% in Dr Kenneth Kaunda District Municipality (North West Province) and there were no C-section data reported in districts such as Xhariep, Siyanda and Amajuba[ii].

These wide variations are concerning and could be due to a number of contributing factors, which currently remain speculative as there is no literature that formally explores C-section variation in the South African context, other than those relating to the wide differences between the rates in the public and private sectors[10, 11]. In the public sector, very low rates at district level could suggest that women are either not receiving the care they need or are being referred to a District Hospital in another district, or to a higher level of care within the district. It could also reflect the inability of a district to record this important indicator. It is unlikely that high rates seen in public sector hospitals are due to elective C-sections or patient demand. The National Committee for Confidential Enquiries into Maternal Deaths

[i] The C-section rate as measured in the DHIS is defined as the number of C-sections as a proportion of all births in public sector facilities.
[ii] These districts have missing records in the DHIS with respect to deliveries and C- sections.

(NCCEMD)[2], found that of the 477 210 women who underwent C-sections in the public sector during the years 2005 – 2007, 92.2% were emergency C-sections, with only 7.8% being elective operations[12]. It is also doubtful that too many C-sections are being done unnecessarily. Rothberg and McLeod[11] argue that public sector rates might actually be lower than appropriate, not only because of the high rates of HIV infection found in antenatal clinic attendees, but also because of limited public-sector resource issues (trained and skilled staff for example) might result in vaginal delivery of cases that would more appropriately be delivered by C-section.

Clearly it is beneficial to understand and adjust for variation in health care services. In the United Kingdom, investigative studies in the National Health System (NHS) have been done to determine the causes of natural and artificial causes of variation for a number of health priorities. Tools are made available to guide and outline the different strategies for reducing artificial variation once sources have been identified[13]. Natural variation covers factors such as case mix, socioeconomic and demographic differences in patients, whereas artificial variation is created by the way systems are set up and managed, for example differing local referral patterns, availability of trained health care staff and resources and how priority cases are managed. The NHS found that there is a lot of evidence to suggest that significant variation is caused by how systems are set up in healthcare and patterns of working. Recommendations to deal with this include for example reducing variation in clinical practice, analysing capacity and demand, and allocating resources to minimise variation in capacity.

The District Health Barometer[9], which is available as a resource in the public domain, and reports on current health indicators at primary health care level, currently reports on the C-section rates for District Hospitals only. Whilst this is a useful information source, the information on C-sections is limited as the report only provides district level averages with no information available at facility level or of higher levels of care. This approach can conceal important discrepancies and differences between hospitals and levels of care. For example, the average of the C-section rate in a particular district may be increasing year on year, but without data available at facility level, one cannot be sure if this is true for all hospitals. It also does not inform on the variation in C-section rates among the hospitals within a district. Therefore, there is a need for comparative information on C-section rates by facility and

hospital level to understand the full picture with regard to C-section service provision within a district.

In South Africa, the mean C-section rate for all public sector hospitals as recorded in the DHIS[5], has steadily increased from 18.1 % in 2000/01 to 24.4 % in 2008/09. The rate in District Hospitals increased from 13.5% to 17.2% over the same time period. An increasing trend in C-sections beyond the WHO recommended rate of 15%[14] is not unique to South Africa, and has been observed in numerous other (mostly industrialised) countries. In South Africa, the increasing trend in the C-section rate may be due to a number of factors including the increasing numbers of women who are ill with TB and HIV related problems. However, research is required to ascertain if this increasing trend is true for all hospitals as there are both health risks and health systems costs associated with high C-section rates.

No clarity on recommended C-section rates for different hospital levels

There are no formally recommended C-section rates per level of hospital published in South Africa. The only document with current suggested rates is the National Indicator Data Set (NIDS), which is a document produced by the National Department of Health to guide the collection, reporting and interpretation of the DHIS indicators. The Department of Health needs further research and investigation in to C-section rates to inform what the appropriate rates should be for each level of hospital.

The discussion below looks at the reasons why a study of this nature is necessary and how it could be useful in improving maternal and child health.

C-section rates are useful in assessing if women are receiving appropriate maternal care

To date there is no known recent comprehensive analysis of C-section rates in all public sector hospitals over an extended period done by facility, district and province. It is in the interest of leaders, policy makers and managers at all levels in maternal health services to have this kind of information available, for planning and providing C-section rate services in line with quality maternal health outcomes. Since delivery by C-section is a more costly procedure than a natural birth, there are cost implications to the health sector. The provision of a C-section service requires careful resource planning, trained staff and adequate facilities. Adequate access to comprehensive EOC of which C-sections form a crucial part, directly affects the wellbeing and health of both mother and baby.

Studies have shown that the C-section rate is a useful tool (process indicator) to monitor for safe obstetric delivery and health of mother and child[15], particularly if the maternal mortality rate data are of unreliable quality and difficult to obtain[16]. There is thus a need to compare C-section rates across hospitals using data that are collected routinely in a uniform manner. Within the framework of clinical governance, these comparisons are useful as they enable hospitals managers to compare their C-section rates to average national, province and district rates, as well as with similar hospitals across the country. It will allow them to monitor and potentially improve their practice over time. It can also be useful in evaluation of the effectiveness of interventions that have been used to reduce or increase C-section rates to appropriate levels and improve quality of care provided to women giving birth. It is acknowledged however, that as mentioned in the United Nations (UN) Guidelines for Monitoring Availability and Use of Obstetric Services[6], and the Human Rights Watch's recent report,[17] C-section rate data on its own is insufficient to inform on the spectrum of the availability of EOC in the health system and that the Health Department should make a concerted effort to include more indicators in this area. Such indicators would inform on whether the need for obstetric care was met in all cases, the number and types of facilities which provide full EOC services by district and province, and number of health practitioners trained in EOC.

Is the current definition of the C-section rate in the public sector adequate?

The C-section rate for the public sector is a facility-based indicator and is calculated and reflected in the DHIS as the number of C-sections as a proportion of all deliveries in public sector hospitals. Deliveries in private sector facilities and home births are not considered because accurate data are difficult to obtain as they heavily depend on the quality of birth registration data. Therefore, the C-section rate is considered to be more accurate when calculated as a facility based indicator. However, deliveries and C-sections which may occur in public sector facilities other than in hospitals, such as in Community Health Centres (CHCs), Community Day Centres (CDCs) and stand-alone Maternal Obstetric Units are not included. In 2008/09 the DHIS recorded close on 109 000 deliveries in 228 CHCs alone. Inclusion of these figures is thought to have an impact on the C-section rate and there is therefore a need to take these into account when calculating the rate.

Do women of different socioeconomic status in SA receive equal access to C-section services?

C-section services should be available in all public sector hospitals. Resources are limited in the public sector, especially in the rural regions of the country. The quality and availability of maternal care is thus inconsistent. In rural areas, large distances and inadequate transport systems are additional barriers preventing women from receiving the necessary maternal care. On the basis of equitable access to maternal health services, there is thus a need to identify any inequalities in access to C-sections across the districts and to identify if women who live in rural districts with a lower socioeconomic status, receive significantly fewer C-sections than those in the better-resourced districts.

1.2 Aim of the Study

The study's aim is to describe patterns in C-section rates for all public sector hospitals during 2000/01-2008/09 by district and province.

1.3 Study objectives

1. To describe the variation in C-section rates between facilities and across districts for the 2008/09 period.
2. To describe and analyse the trend in C-sections from 2000/01-2008/09 for the country, by province, district and facility.
3. To investigate if there is a relationship between the average C-section rate in a district and the level of deprivation of the population in the district.
4. To assess if the contribution of deliveries and C-sections which occur in Community Health Centres in South Africa have an effect on the overall provincial and national C-section rates.

Chapter 2: Literature review

This chapter reviews published literature which explores national and international research and evidence on maternal health and C-section rates.

The Department of National Health's Negotiated Service Delivery Agreement (NSDA)[18], has identified decreasing infant, child and maternal mortality rates as one of its four prioritised outcomes which are to be implemented at all levels of the health system. The recent (November 2011) Department of Health's Newsletter of the District Health System stated that the National Department had appointed a team of experts to review all data on infant, under five and maternal mortality in order to reach agreement of mortality rates. The document further states that *"these agreed mortality rates were publically launched by the Minster of Health. The agreed upon national maternity mortality rate is 310/100 000"* The goal is to reduce this by 10% to 270/ 100 000 by 2014[19]. Monitoring the maternal mortality rate has its challenges as it depends heavily on vital registration data and is difficult and costly to do accurately. Monitoring the processes or interventions aimed at reducing maternal mortality are simpler to do and are also essential for guiding policies and programmes to improve maternal health and reduce the maternal mortality rate.

In South Africa, the C-section rate is the only indicator that we have to monitor maternal health care at the point of birth in a facility by means of routinely collected (DHIS) data and the only available indicator that measures access to emergency obstetric care. Although the UN[6] have recommended additional process indicators for monitoring access to emergency obstetric care, there is no data available nationally to measure the availability, or the unmet need thereof[20]. The UN's six EOC[6] process indicators have been used successfully in a wide variety of settings and countries. Table 2.1 provides a short summary of the definitions, targets and use of these indicators. The Averting Maternal Death and Disability (AMDD) Program of Columbia University has done extensive work on needs assessments using the UN process indicators. In their paper which reflects on a decade of experience of using these indicators, Paxton et al[21] conclude that although these indicators may be challenged by the usual availability and data quality issues experienced with any health information system, they are particularly useful when monitored and analysed as a set. These indicators inform on a health system's capacity to provide adequate obstetric emergency care and the likelihood of reducing maternal mortality.

Table 2.1: The UN EOC process indicators

Indicator	Definition and Target	How calculated	Use
1. Availibility of EOC	The number of facilities that provide EOC in relation to the size of the population. Target: for every 500 000 population there should be at least 4 basic and 1 comprehensive EOC facility*	Direct inspection and counting of facilities in catchment area	Informs if enough EOC facilities exist to service the population
2. Geographic distribution of EOC facilities	The distribution of EOC facilities by subnational geographic area. Target: The recommended level is 100% of sub-national areas have the minimum acceptable numbers of EOC facilities.	Ratio of facilites to population of sub-national geographic area	Informs on equitable distribution of facilities. (mapping draws attention to underserved areas)
3. Proportion of expected births delivering in EOC facilities	Proportion of expected births in EOC facilities in a given area. The recommended minimum level is 15% based on the assumption that 15% of pregnancies in any population will develop obstetric complications.	Number of deliveries in EOC facilities as a proportion of all live births in the catchment population.	Institutional delivery indicator. Partly informs on utilisation of EOC facilities by women in the catchment area.
4. Met need for EOC	The proportion of pregnant women expected to have complications who are admitted for treatment.The recommended level is 100%	Numerator: Number of women with direct obstetric complications seen in EOC facilities. Denominator: number of women expected to develop obstetric complications in catchment population, which is estimated at 15% of the expected live births in the population	Informs of whether women with obstetric complications are receiving this care
5. Caesarean sections as a proportion of all births	The proportion of deliveries in which a C-section is performed. The recommended level is 5-15%.	Numerator: Number deliveries by C-section. Denominator: Number of expected live births in the population	Informs if this life saving intervention is performed in sufficient numbers.
6. Case fatality rate	The proportion of fatalities to women with obstetric complications in the facility over a specific time period.	Numerator; Number of deaths of women with obstetric complications in the facility. Denominator: Number of women with obstetric complications seen in the facility over the same time period.	Informs if women treated in an EOC facility are likely to survive and provides insight into quality of care provided
* Facilities are considered EOC if they provide a series of services known as signal functions over a designated 3 month period. (6 signal functions for classification as basic and 2 additional signal function for classification as comprehensive)			

The NCCEMD[2] has reported that for 2005-2007, there were problems with the overall emergency obstetric care provided to women and that in District Hospitals 29% of cases requiring emergency obstetric care had not been managed correctly, 30.3% in Regional Hospitals and 19.8% in Provincial Tertiary and Academic Hospitals. This clearly will have an impact on the maternal mortality rate.

There is concern about the increasing national C-section rate, but it is not clear if this pattern is true for all districts, hospitals and levels of care in the public sector, as no comprehensive study has been done in South Africa on this topic to date.

What is an optimal C-section rate?

It is unclear what the optimal C-section rate should be. In 1985 the WHO[14] suggested a lower limit of 5% and an upper limit of 15% which was based on a survey of C-section rates of developed countries with the lowest maternal and neonatal mortality rates in the world. The upper limit of 15% was arbitrarily adjusted upwards from the initial 10%, to account for developing countries, as they had a larger population at risk[22] .The optimum maximum and minimum rates continue to be debated in numerous journal articles, editorials, opinion pieces, blog sites and conferences and may never be resolved [23,24,25]. For example, a clinical opinion paper in the American Journal of Obstetrics and Gynaecology argues that there is no direct way to test the hypothesis that there is an ideal C-section rate and that the C-section rate is a consequence of individual value-laden judgements made[26]. What is highlighted in the literature however, is that although appropriate rates could differ among populations, rates below 5% probably indicate unmet need and inadequate skills and resources, particularly in low-income countries[27]. Rates that are significantly in excess of 15%, particularly at a primary care level, are costly and a burden to health systems on limited budgets and may represent an unnecessary risk for women and their babies, particularly if the there is no clinical indication for a C-section[28, 29]. Although C-sections cost more than vaginal deliveries, failure to do an emergency C-section or a delayed C-section can be much more costly as a result of a lifetime of brain damage to the baby due to complications arising such as cerebral hypoxia.

Two ecological studies which included research in developing countries, by Althabe et al[22] and Belizan et al.[30], found that when C-section rates rise substantially above 15%, risks to reproductive health outcomes outweigh the benefits to maternal and neonatal health. In 2000,

the Ministry of Health in Brazil, concerned with the escalating C-section rates, particularly with private sector rates at 70%, imposed an upper limit at 35% for all public hospitals[31]. Joffe et.al[32] concluded that rates above 10-12% in general maternity units were of no benefit.

HIV may have an impact on C-section rates. Numerous international studies have shown that C-sections have a protective effect by lowering the risk of mother-to-child transmission of HIV infection during childbirth. The paper by Dunn et al.[33], for example, concludes that C-sections have a clinically important protective effect, whilst Parazzini et al[34] have found that C-sections lower the risk of mother-to-child transmission of HIV infection without a significantly increased risk of complications for the mother. The South African PMTCT guidelines[35] do not recommend the routine use of C-sections delivery for HIV infected women. The Department of Health's Guidelines for Maternity Care in South Africa[36], in the section which deals with the mode of delivery of HIV positive women (p132), states the following; *"The mode of delivery may also influence the risk of MTCT. Elective Caesarean section has births have been shown to reduce the risk of MTCT. However, in the public sector, it is currently not feasible to offer elective C/S to all HIV positive women."* Therefore, it is probably left to the discretion of the clinician to make a decision when faced with a severely ill HIV positive pregnant woman with a high viral load, who is not on antivirals, which fits the description of many women currently presenting at antenatal clinics throughout the country, despite the national ARV programme having been rolled out.

The rates in South Africa

The number of deliveries and C-section rates in public sector hospitals are collected by each facility as part of routine health information and then collated into the DHIS[5]. The current data from the DHIS show both a wide variation and an increasing trend in C-section rates. The overall percentage of deliveries taking place in district health facilities under supervision of trained personnel, has however also shown an increase from 70.4% in 2003/04 to 86.6% in 2008/09.

The private health sector, which in 2007 covered an estimated 14.3% of the population in South Africa[37], is reported as having a C-section rate of 37% in the South African Demographic Health Survey of 2003[38]. Recent data from the Risk Equalisation Fund estimates the private sector C-section rate as being over 61.9%[39]. These very high rates could

possibly be due to it being a profit motivated sector and prone to over-servicing, as well as being driven by both patient- and physician-induced demand.

Increasing trends in C-section rates in South Africa

Trends in C-sections are increasing throughout the world, both in developed and developing countries[31]. An increasing trend in C-sections will result in an inevitable additional burden and demand on the health system, especially in the training and deployment of health professionals, infrastructural requirements and service requirements. The average unit cost for maternity patients was found to be more than double the average unit cost for medical patients in a study done in District Hospitals in South Africa.[40]

No published guidelines on C-section rates by the Maternal and Child Health sector of the National Department of Health were found. However, a document called *The National Indicator Data Set 2010* (NIDS), revised in January 2011, is produced by the National Department of Health and guides the collection, reporting and interpretation of the DHIS indicators. District Health Information Managers in the Department of Health use the NIDS as a reference for reporting purposes for district and provincial health planning of health indicators. The NIDS states the following guideline C-section rates per level of hospital; 15% for District Hospitals, 25% for Regional Hospitals, 25% for Provincial Tertiary and 50% for National Central (academic) Hospitals. Although the NIDS is widely used as a reference and planning guide, there is no evidence to suggest that these guideline C-section rates per level of hospital are founded on evidence based research or how they were derived. One can therefore not conclude with confidence that these rates are the appropriate rates for C-sections by level of hospital in South Africa.

Wide variation

The wide variation (8.7%-32.5%) in the C-sections across districts and the five percentage point difference between the average C-section rate of rural (ISRDP) 15.2% and metro districts (20.3%) as reported in the District Health Barometer 2008/09[9] is of concern as it may suggest that women in rural and underserved areas may have less access to C-section than those living in better served metropolitan districts. It also may imply that there could be a higher demand for C-sections in metropolitan areas. KwaZulu-Natal had the highest average C-section in District Hospitals of all the provinces and five of its eleven districts fell into the

ten highest district values in the country[9]. This province also registered the highest percentage of maternal deaths in SA in 2007.[2]

However, wide variation in C-section rates is not particular to South Africa, but has been observed world-wide. Numerous international studies have sought to investigate the causes and have reflected on a wide range of contributing factors such as case mix, women's preferences, physicians' individual practice style, clinical uncertainty, differing levels in the quality of obstetric care, availability of resources and staff, access problems, inadequate policies and guidelines on maternal care, inequities in the health system and socio-economic differentials [41, 42, 43, 44].

A study conducted by Sufang et al.[41] quantified the influence of increasing use of health-care services on rising rates of caesarean section in China. Multiple logistic regression models were used to estimate the effect of health-care factors on the odds of a caesarean section, controlling for time and selected variables. The study found that in addition to an increase in institutional births during 1993 and 2002, there was a corresponding increase in the number of C-sections. The authors concluded however, that the increase in C-section rate could not be fully explained by increases in institutional births alone, and was likely to also be driven by physicians' preference and women's demand for the procedure. The findings also highlighted that there were considerable differences between the C-section rates in different types of hospitals.

An international journal of obstetrics and gynaecology, published a British cross- sectional study which concluded that 34% of the variation in C-sections rates between maternity units could be ascribed to case-mix differences. The study also found that the odds of C-section (before and in labour) increased with maternal age.[42]

In a study conducted on 1 533 affluent women at low risk of obstetrical complications who were cared for by 11 obstetricians in a single community hospital, the results showed that the mean rate of delivery by C-section was 26.9 per cent, but the rate ranged from 19.1 to 42.3 per cent, according to the physician. As the variation in C-section rates was not attributable to the practice setting, the patient population, the degree of obstetrical risk, the physician's recent medico-legal experience, or neonatal outcomes, the authors concluded that individual practice style may be an important determinant of the wide variations seen in the C-section rates.[43]

Differences in socio-economic status of women giving birth in developing countries were explored by Ronsmans et al.[44] The findings were that C-section rates were extremely low in the poorest of countries whilst in some mid-income countries, mostly Latin American, the C-section rates for half the population were found to be in excess of medical need.

Association of C-Section rates with maternal and neonatal health outcomes

Several studies have sought to investigate the association between C-section rates and neonatal and maternal outcomes in a number of countries. The results have varied, ranging from those finding no association in highly developed countries like Sweden[45], to a clear association between high rates of emergency C-sections and neonatal mortality in certain African countries. In these African countries the use of C-section delivery is limited and emergency C-sections, when performed, were often too late to reduce perinatal deaths due to delays in seeking, accessing and receiving quality care.[46]

Reduced mortality rates for very low birth weight infants were found in facilities with higher C-section rates in England[32], and an ecological study found no association between C-section rates and maternal or neonatal mortality in high and middle-income countries.[22]

The Human Rights Watch[17] reports on numerous examples of women giving birth in Eastern Cape hospitals who experienced inadequate, negligent and poor quality of care, poor referral systems and insufficient accountability of health workers. In a number of cases quoted, women were turned away from the facility without examination while in labour, were ignored by nurses when they called for help, or were denied referrals to specialised care. These shortcomings result in deleterious effects on maternal health which adversely impacts the morbidity and mortality of women in the province.

The NCCEMD report, identified problems with emergency obstetric care provided by health workers in 58% of deaths at level 1(District Hospitals), 49% at level 2 (Regional Hospitals) and 30.1% of maternal deaths at level 3 (Provincial Tertiary and National Central Hospitals).[2,20] The report also identified that the most common indications for C-sections were prolonged obstructed labour, including very prolonged second stages. A special comment was made in the report about the apparent lack of surgical skills for C-sections in the chapter on obstetric haemorrhage. "*The large number of deaths due to caesarean section associated bleeding raises concern about technical skills, particularly at level 1 hospitals."* Findings of the report also commented on the limited resources, in particular those affecting

level one hospitals, where urgent C-sections for obstructed labour could not be done causing patients to be transferred to a level 2 hospital for a procedure which should have been done at level one hospital.

Press reports on negligence are increasing and as recent as December 2011, an article in the Pretoria News reported that the MEC for Health in Gauteng agreed to pay R345 000 in damages towards the maintenance of a child whose mother died due to clinical negligence in a District Hospital where she had bled to death after having undergone a C-section[47].

Association of C-Sections with socio-economic status

Data from 42 Demographic and Health Surveys in sub-Saharan Africa, south and southeast Asia, Latin America and the Caribbean have found that C-section rates are linked to socio-economic status[44]. The ecological study by Belizan, et al[30], found that better socioeconomic status was linked to higher C-section rates and a study by Gould et al[48] concluded that C-section rates varied directly with socioeconomic status. Furthermore, they found that the association was independent of differences found in maternal age, parity, birth weight, race, ethnic group, or complications of pregnancy or childbirth. There is no doubt that a correlation exists between income status and health. South Africa is now considered to be the country with the widest gap between rich and poor. The Gini coefficient stood at 0.679 in 2009, and has deteriorated over the last decade[49]. It is thus important to investigate if women of lower socioeconomic status have adequate access to maternal health care.

Policies and guidelines

The National Department of Health's Women's Health and Genetics Directorate is responsible for the antenatal care programme and for the development, facilitation and monitoring of Policy and Management Guidelines for Maternal and Neonatal Health Services which lay the foundation of how maternity services should be rendered. A number of important policy documents and guidelines have been produced[1, 35, 36]

The NCCEMD in the *Saving Mothers 2005-2007 report,* puts forward ten key recommendations[2], four of which are relevant to C-sections. These are: Recommendation 1, which deals with the availability of protocols on management of important conditions causing maternal deaths; Recommendation 2, improvement of anaesthetic and surgical skills of doctors, particularly in level 1 (District) hospitals; Recommendation 4, availability of

established criteria for referral and referral routes and emergency transport facilities; Recommendation 7, availability for blood for transfusions where C-sections are performed.

The responsibility for implementing these recommendations, as well as the policy and management guidelines, lies with each level of care and institution. The Report also found that the most frequent healthcare provider avoidable factors were failure to follow standard protocols and poor recognition and initial assessment.

The extent to which the abovementioned guidelines are implemented and adhered to, will determine the quality of emergency maternal care that is provided in a facility.

Chapter 3: Methodology

3.1 Study Design

This is a descriptive study using quantitative methods of analysis on secondary data obtained from the routinely collected data in the District Health Information System (DHIS). The DHIS is a routine health data collection and management system belonging to and managed by the National Department of Health. It functions as a district and national database which contains data that is submitted by facilities on a routine basis. The NDOH use this information regularly at district through to national level for reporting, decision making and planning purposes. Examples of where it is used include the District Health Plans, Annual Reports and the District Health Expenditure Review. The hardware, data programming, maintenance and development of the DHIS is sub-contracted to an external organisation, the Health Information Systems Programme (HISP). The day-to day and month-to-month data validation, cleaning and maintenance is meant to be managed by the Information Officers and Managers in the Department of Health, although HISP provide support in this area as well. Due to extreme staff shortages, resources and skills, in the area of health information management in the Department and lack of a central unit which has overall responsibility of the DHIS, minimal feedback, validation and checking takes place and for some indicators the quality of data is inadequate and not representative of the situation on the ground. The C-section rate data from the DHIS has been monitored by the District Health Barometer[9] reports for a number of years and is considered to be relatively stable and accurate as compared to many other indicators, although the gaps, unusual values and missing data will be investigated in this report.

Study Population and Sample

The study population includes all women who have given birth in a public sector hospital and Community Health Centre between 2000/01 and 2008/09. No sampling was required as all District, Regional, Provincial Tertiary and National Central and Specialised Hospitals as well as Community Health Centers were included.

3.2 Data Sources and collection

The data was obtained from the National Department of Health's DHIS. The NDOH identified a Minimum Data Set which is a list of data elements (representing approximately 200 indicators) that facilities are required to report on, on a monthly basis and is known as the

National Indicator Data Set (NIDS). The number of C-sections performed and the total number of deliveries in facilities, are part of the data elements specified in the NIDS. The facilities collect and compile these data elements on a daily basis by patient and submit these on a monthly basis to their respective District Offices, which check, validate and then import the data into the DHIS central database. The various data elements are then stored in the DHIS database. By way of the DHIS software they can be aggregated as needed into higher levels such as sub-district, district, province and national level.

The researcher obtained specific approval from the NDOH to use the DHIS data specific to C-section rates (Appendix 1). The total number of C-sections reported for all hospitals and CHCs, by facility, hospital type and district, by year from 2000/01 to 2008/09, as well as the number of deliveries, was exported from the DHIS database into an Access database and thereafter imported into STATA. Data for clinics were not included as there were minimal records of deliveries in clinics. The data elements extracted from the DHIS database (using specific DHIS nomenclature) are detailed below in Table 3.1.

Table 3.1: Data elements extracted from the DHIS.

Data element extracted from DHIS	**Description**
fyPeriod	Financial years 2000/01 - 2008/09,
Dist_MDB	District code per district
OrgUnitType	Each hospital level and CHC
orgUnit5	Facility name
IndicatorShort CSection_Rate	Caesarean section rate
SumOfNumeratorValue	Total number of C-sections for financial year,
SumOfNumxFactor	Total number of C-sections for year x 100,
SumOfDenominatorValue	Number of deliveries in facility.

The data were scrutinised and cleaned, removing any invalid data such as duplications and improbable outliers (i.e >100% C-section rate).

Numerical variables

Missing records of hospitals over the nine years and hospitals with zero values were noted and these were summarised by district, province and level of hospital and a data completeness table was compiled as well of a list of all hospitals which recorded zero C-section values per year (available as Appendix 2). During analysis, these gaps were taken into account when interpreting the data. For instance, records were missing for Gauteng Province for all hospitals in 2000/01, which resulted in the growth values 2000/01 – 2008/09 to seem unusually low and thus were recalculated excluding 2000/01. Further analysis such as the

calculation of averages and the linear and multiple regression models did not take the missing data into account.

Amongst the five levels of hospitals, the highest number of missing records were for District Hospitals. District Hospitals in the Eastern Cape and Northern Cape had the lowest completeness overall. Missing records and zero values caused fluctuating trends over the nine years, such as is seen in O.R Tambo District in the Eastern Cape, Pixley ka Seme District in the Northern Cape and most of the North West Districts.

The year of data with the largest number of missing records was in 2008/09. The reason for this was investigated and it was found that the data extracted from the DHIS database had no records of hospitals with zero values for the latest year, 2008/09. In the analysis therefore these hospitals have been detailed under missing records for 2008/09.

Missing data were not replaced by estimated or average values for a number of reasons, but primarily to ensure that DOH officials and managers investigate the reasons why there are missing and correct these. The districts and hospitals with missing C-section rates are listed in the appendices (Appendix 2.3) for the following reasons:

1. Data quality management: Highlighting the data quality gaps in the DHIS for this particular indicator shows the effect that it has on monitoring trends relating to maternal health. It is important that information managers and officers are made aware of these omissions and gaps so that they can retroactively collect the missing data from the facilities and update the data in the DHIS database.
2. Resource allocation: Sometimes missing data can mean that a hospital does not provide a C-section service because it may not have sufficient clinical staff and resources or have inadequate data capturers and information officers to collect the data. It is important to know which these facilities are in order to correct the situation and ensure appropriate resource allocation for optimal service provision.

Categorical variables

Corrections were made to hospitals which had changed name during the nine years, so as to ensure that these hospitals were not seen as two separate facilities. An example of this is Johannesburg Hospital which was recorded as such during 2000/01 to 2007/08 and then changed its name to Charlotte Maxeke Hospital in 2008/09. Misspelt names of hospitals and

various name versions were also corrected so as to ensure one single record for each hospital throughout the nine year timeframe.

Other categorical variable corrections included correcting erroneous hospital level changes which occurred over the nine years. Errors in the data relating to this for example include a hospital which was classified as a District Hospital during 2000/01 to 2005/06, changed to a Regional Hospital in 2006/07, and was then back to a District Hospital in 2007/08 and 2008/09. This example of change in hospital categorisation is most probably due to poor data quality, as in reality hospitals ordinarily only undergo reclassification in a formal way such as when the Minister issues a notice in the Government Gazette in terms of sections 3(1)(c) and 23(1) of the National Health Act, 2003. Corrections were made so as to ensure one single hospital level for each hospital throughout the nine year timeframe. The level chosen was the level at which the hospital was classified for the majority of the time.

It should be noted however, that in reality a hospital may be categorised as being a different level to its classification in the DHIS data set, and this depends on the accuracy and regular checks done by the Health Information Officers of the facility and Health Information Managers of the district and DHIS. The most recent official regulations relating to categories of hospitals containing lists of designated public hospitals per province by category of hospital was issued as Government Notice No. R655 of 12 August 2011[50], with two months made available for comments and substantiations. These changes have not been formalised or finalised and are thus have not been incorporated in the DHIS or into the analysis of this report.

The Deprivation Index

The Deprivation Index (DI) was used to quantify deprivation and in the analysis to determine if there is any correlation between the C-section rate in a district and the level of deprivation of the population in the district. The DI values per district were obtained from the District Health Barometer 2008/09[9].

The methodology used to calculate this DI was adapted from the methodology used in the paper by McIntyre and Okorafor[51] prepared for National Treasury, which the Health Systems Trust adapted for their use in the District Health Barometer as an aid to assessing the relative socioeconomic status of districts when comparing health systems and health outcome indicators at district level.

The DI is intended to be a measure of relative deprivation across districts within South Africa and is a composite measure derived from a set of variables. These variables were obtained from the Community Survey 2007. The index was generated by using principal components analysis (PCA), where each variable was weighted based on its linear association with the underlying process. The PCA generates a distribution of deprivation based on patterns of variation across all variables, and then assigns weights to the variables based on their association with the pattern of variation. The weighted variables were used to construct the deprivation index. The level of analysis was at the sub-place and municipal levels[iii].

Variables from the Community Survey 2007 used for calculating the Deprivation Index include:

1. The proportion of the area's population that are children below the age of 5
2. The proportion of the area's population that are black Africans
3. The proportion of the area's population that are from a household that is headed by a female
4. The proportion of the area's population whose household heads have no schooling
5. The proportion of area's adults between 25 and 59 classified as both not working and looking for work or not working and not looking
6. The proportion of the area's population that live in traditional dwelling, informal shack or tent
7. The proportion of the area's population that have no piped water in their house or on site
8. The proportion of the area's population that have a pit or bucket toilet or no form of toilet
9. The proportion of the area's population that do not have access to electricity or solar power for lighting, heating or cooking

The formula which was used for calculating the deprivation index is as follows:

$$D = 0.12391 \times \left(\frac{P\_Child_1 - \overline{P\_Child}}{SP\_Child} \right) + ... + 0.14423 \times \left(\frac{P\_Noclenergy_1 - \overline{P\_Noclenergy}}{SnP\_Noclenergy} \right)$$

Where D is the deprivation index; the numbers are the scoring coefficients for the respective variables; and the expressions in brackets are the standardised deviations of each variable from the overall mean of the variable for each sub-place.

[iii] A sub-place is a combination of a few coterminous enumerator areas, and is a geographic area that is small enough for the population to be homogeneous, yet large enough to allow for statistical analysis.

The resulting deprivation index scores ranged from negative values to positive values. Higher values represent higher levels of deprivation, and lower values represent lower levels of deprivation[iv]. The deprivation index was normalised by moving the indices to the positive number scale so that it would be easier to interpret. Consequently, the district with a deprivation index score of 1 is the least deprived and districts with higher values are relatively more deprived than districts with lower values. A table listing each district with its respective DI and SEQ score is available in Appendix 3.

Definition of terms

The table below summarises the definition of terms used in this study.

Table 3.2: Definition of Terms

Average compounded annual growth rate	The average compounded annual growth rate is the rate at which a value (the C-section rate) grows over a period of years, taking into account the effect of annual compounding. It is a smoothed annualised gain of a value over a given time period. The formula is: $\mathrm{CAGR}(t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)}\right)^{\frac{1}{t_n - t_0}} - 1$ Where $V(t_0)$: start value, $V(t_n)$: finish value, $t_n - t_0$: number of years
Caesarean section rate	The number of Caesarean section deliveries expressed as a percentage of all deliveries in the facility.
DHIS	District Health Information System. The DHIS is a health management information system functioning as a district and national 'data warehouse' which collects data that is submitted from facilities on a routine basis.
Essential Obstetric Care	Essential obstetric care is the term used to describe the elements of obstetric care needed for the management of normal and complicated pregnancy, delivery and the postpartum period. Basic *essential obstetric care* services at the health centre level should include at least the following: parenteral antibiotics, parenteral oxytocic drugs, parenteral sedatives for eclampsia, manual removal of placenta, manual removal of retained products. *Comprehensive essential obstetric care* services at the district hospital level (first referral level) should include all the above plus surgery (Caesarean Section), anaesthesia, and blood transfusion.(World Health Organization.

[iv] Higher values reflect higher levels of deprivation because of the way the variables have been measured. For any sub-place, if the proportion of the population without access to proper toilet facilities is high, it is an indication of higher levels of deprivation. The same is applied to all variables included in the PCA.

	Fact Sheet No 245. WHO, Geneva; June 2000).
Emergency obstetric care	Emergency Obstetric care refers to care provided in health facilities to treat direct obstetric emergencies that cause the vast majority of maternal deaths during pregnancy.[20]
Financial years 2000/01-2008/09	These are 12 month periods, from 1April to 31March, based on the Department of Health's financial year cycle. The term year and financial year are used interchangeably throughout the report.
District Hospital	(Level 1 hospital). A hospital which receives referrals from and provides generalist support to clinics and community health centres, with health treatment administered by general health care practitioners or primary health care nurses. The package of services provided includes trauma and emergency care, in-patient care, out- patient visits and paediatric and obstetric care. The number of beds range from no less than 50 beds to no more than 600 beds. (Appendix 4: Definitions of categories of hospitals. Extract from Government Gazette No.9570. Regulations Relating to Categories of Hospitals, 12 August 2011).
Regional Hospital	(Level 2 hospital). A hospital which receives referrals from and provides specialist support to one or more district hospitals and where health care users require the expertise of teams led by resident specialists. These specialists are in the disciplines of general surgery, orthopaedics, general medicine, paediatrics, obstetrics & gynaecology. A Regional Hospital has between 400 and 800 beds (Appendix 4: Definitions of categories of hospitals. Extract from Government Gazette No.9570. Regulations Relating to Categories of Hospitals, 12 August 2011).
Provincial Tertiary Hospital	(Level 3 hospital) A hospital which receives health care users from and provides specialist and sub-specialist support to one or more Regional Hospitals, not limited to provincial boundaries. Most care provided will be at level 3 and will require the expertise of teams led by specialists. Provincial Tertiary Hospitals have between 400 and 800 beds. (Appendix 4: Definitions of categories of hospitals. Extract from Government Gazette No.9570. Regulations Relating to Categories of Hospitals, 12 August 2011).
National Central Hospital	A hospital which consists of very highly specialised national referral units that together provide an environment for multi-specialty clinical services, innovation and research. It provides training to health care workers and receives patients referred to it from more than one province. National Central Hospitals are attached to a medical school and has a maximum of 1200 beds. (Appendix 4: Definitions of categories of hospitals. Extract from Government Gazette No.9570. Regulations Relating to Categories of Hospitals, 12 August 2011).

Specialised Hospital	A Specialised Hospital provides health specialised services in one specific health area such as tuberculosis services, treatment of infectious diseases or rehabilitation services and has a maximum of 600 beds. (Appendix 4: Definitions of categories of hospitals. Extract from Government Gazette No.9570. Regulations Relating to Categories of Hospitals, 12 August 2011).

3.3 Data analysis

Analysis for Objective 1: **A description of the variation in C-section rates in 2008/09.**

This objective described the variation in C-section rates between facilities (by level of hospital) and across districts in South Africa for the 2008/09 period

The number of C-sections and number of births in each facility for the latest year available at the time (2008/09) were used, so that the most current situation could be investigated. The C-section rate was calculated by dividing the number of C-sections by the number of births in facility, and multiplying by 100. The weighted and un-weighted mean C-section rates were calculated for each level of hospital, each district and each of the nine provinces using STATA. The un-weighted mean C-section rate is the calculation of the average of the C-section rates of each hospital level, each province and each district. The weighted mean takes the number of deliveries (births) which occur in each hospital into consideration. It is considered to be a more accurate way to look at variation as each hospital is not counted equally, but is weighted according to number of deliveries.

Distribution of the data was explored by drawing histograms of the C-section rate values using STATA. The C-section rates were firstly analysed for the whole country by hospital level, and then compared by province and level of hospital per province. The C-section rates were also compared by district and individual hospitals.

The main method used to examine variation in the data was by looking at outliers. The data were not adjusted for outliers, case mix differences or any other variable related to C-section rate. The highest and lowest deciles of C-section rates were identified for District and Regional Hospitals and the hospitals in those deciles were listed. In addition, hospitals with C-section rates below 5% were identified and listed. Various tables and graphs were created in Excel and STATA for illustration purposes and are presented in the results section and in the Appendices. Variables used for this section of the analysis are detailed in the table below.

Table 3.3 Variables used in the analysis of Objective 1

Variable	**Variable Type**
Number of C-sections	Numerical continuous
C-section rate	Numerical continuous
Average compound growth rate	Numerical continuous
Number of births in facility	Numerical discrete
Hospital type	Categorical nominal
Hospital name	Categorical nominal
District code	Categorical nominal
Province	Categorical nominal
Financial Year	Categorical nominal

Analysis for Objective 2: A description and analysis of the trend in C-section rates 2000/01-2008/09

The objective analysed the trend in C-section rates from 2000/01-2008/09 for the country, by hospital level, province, district and facility.

The number of C-sections and number of births in facility for each year, 2001/02 to 2008/09, were used to calculate the C-section rates by year for each facility by dividing the number of C-sections in each facility by the number of births in facility and multiplying by 100. The analysis of this objective consisted of a number of sub-sections;

1. *Trend analysis by hospital level*. The C-section rates for each facility were calculated for each year 2000/01-2008/09, and the facilities were grouped by hospital level. The mean, C-section rates were then were calculated by level using STATA (aggregated at the level of number of births per facility). The compound average growth rate (CAGR) of the mean C-section rates for each level of hospital over the nine years was calculated. The formula for the average compound growth rate used is as follows

$$\text{CAGR} = \left(\frac{\text{Ending Value}}{\text{Beginning Value}}\right)^{\left(\frac{1}{\#\text{ of years}}\right)} - 1$$

   Graphs and tables were prepared in Excel illustrating how the C-section rates differ by level of hospital and how the trends compare. Variables used for this section are included in the table below.

Table 3.4: Variables used in the analysis of Objective 2 trend analysis by hospital level

Variable	**Variable Type**
Number of C-sections	Numerical continuous
C-section rate	Numerical continuous
Average compound growth rate	Numerical continuous
Number of births in facility	Numerical discrete
Hospital type	Categorical nominal
District code	Categorical nominal
Hospital name	Categorical nominal
Province	Categorical nominal
Financial Year	Categorical nominal

2. *Trend analysis by district and province*. The facilities were grouped into their respective districts and provinces and stratified by hospital level. The mean C-section rates were calculated per district and province for all hospital levels as a total and then for each individual hospital level per year using STATA (aggregated at the level of number of births per facility). The CAGR was for each province over the nine years was calculated, first for the total of all hospitals, and then by level of hospitals. Tables and graphs using STATA and Excel were prepared to illustrate the trends and to compare the mean C-section trends amongst the nine provinces and of districts within their respective province. Tables illustrating how each district and province compares to the national trend were also prepared. Variables used for the analysis are included in Table 3.5.

Table 3.5: Variables used in the analysis of Objective 2 trend analysis by district and province

.Variable	**Variable Type**
Number of C-sections	Numerical continuous
C-section rate	Numerical continuous
Average compound growth rate	Numerical continuous
Number of births in facility	Numerical discrete
Number of hospitals	Numerical discrete
Hospital type	Categorical nominal
District code	Categorical nominal
Hospital name	Categorical nominal
Province	Categorical nominal
Financial Year	Categorical nominal

3. *Regression analysis*. A linear regression analysis was done using STATA, for C-section rates of each hospital level individually over the nine years.

Multiple linear regression analysis was done using STATA to determine if the variables Year, Hospital Level and Province have a significant effect on the C-section rate. Graphic representation (a line graph) of the linear regression trends for each hospital level, was done in Excel. The variables used in this section are included in the table below.

Table 3.6: Variables used in the analysis of Objective 2 - regression analysis

Variable Type	**Variable**
Numerical continuous	C-section rate
Categorical nominal	Hospital type
Categorical nominal	Province
Categorical nominal	Year (Financial Year)

Analysis for Objective 3: Investigation of the relationship between level of deprivation and C-section rate

The analysis aimed to investigate the relationship between the average C-section rate in a district and the level of deprivation of the population in the district.

The latest available (2007/08) Deprivation Indices (DI) and Socio-economic quintiles SEQ) per district were obtained from the District Health Barometer 2008/09**Error! Bookmark not defined.**. The C-section rates by facility were calculated in STATA for the same year (2007/08) and were grouped by district in order to calculate the average C-section rate by district for that year. A linear regression analysis was done for the country as a whole. Thereafter, adjusting for province a multiple linear regression analysis was done to determine if the DI had a significant effect on the C-section rate. A scatter plot and regression tables were prepared to illustrate the findings.

Analysis for Objective 4: C-sections rate including Community Health Centres

This analysis aimed to determine if the number of deliveries and C-sections which occur in Community Health Centres in South Africa, impact on the overall C-section rates per

province and in South Africa. The number of C-sections and number of births in facility for 2008/09 were used to calculate the C-section rates by year for each facility by dividing the number of C-sections in each facility by the number of births in facility and multiplying by 100. The facilities were grouped by level (CHC, District Hospital, Regional Hospital, Provincial Tertiary Provincial Hospital, National Central Hospital and Specialised Hospital) and the mean C-section rate was calculated by province for each level using STATA. The C-section rates and births were compared by facility level and province. The mean C-section rate for each province and facility level was calculated including and excluding the number of births in CHCs. The variables used in this section are included in the table below.

Table 3.7: Variables used in the analysis of Objective 4

Variable	**Variable Type**
number of C-sections	Numerical continuous
C-section rate	Numerical continuous
Number of births in facility	Numerical discrete
Facility type	Categorical nominal

3.4 Limitations of the study

The data available through the DHIS is routinely collected data and is thus of variable quality. Differential reporting due to resource issues, data capture errors and inaccurate data for denominators and duplications will cause values for a number of hospitals to be invalid or unavailable, which will also have an effect on the averages and trends.

Previous obstetric history of pregnant women, AIDS-related illnesses, maternal age, preference of the provider (medical officer on duty), case mix, limited resources and staffing, late presentation and limited emergency transport in rural areas are all confounders which have an influence on the C-section rate. The DHIS is not a dataset designed to collect or test C-section rates specifically, but collects a wide range of health related data. This makes it impossible to adjust for confounders.

People tend to move across district and province borders to access services. There is no way to quantify or adjust for this. The aggregated analysis by district and province may thus not match the catchment areas and district and province geographic boundaries due to this movement. Doing purely facility-level comparisons however, is not very useful as one is then

unable to get a picture of how trends between districts and within and between provinces compare.

The C-section rate in this study differs from the WHO-based definition (Births by Caesarean section - percentage) [52] which measures the percentage of births by Caesarean section among all live births in a given time period. The denominator of the C-section rate in the DHIS, and thus in this study, only measures those births that take place in a public sector facility and thus excludes all deliveries outside of public facilities, (i.e. at home or in a private facility). The mean C-section rates calculated in this analysis therefore only represent the deliveries taking place in a public facility which ranged from 74.3% in 2001 to 87.8% in 2008 of all expected deliveries per year (Table 3.8).

The Delivery rate in Facility indicator measures the proportion of all deliveries that take place in public health facilities under supervision of trained personnel. It is a proxy measure of access to the public sector facilities as well as a measure of the utilisation of these facilities by pregnant women. The numerator for this indicator is the number of deliveries in all facilities while the denominator is the total expected number of deliveries in the target population. The indicator is not without its problems as its accuracy is highly dependent on the denominator. The data quality of the denominator is questionable due to the variable quality of birth registration data, the fertility rate estimates and number of home deliveries which are not accurately known.

Table 3.8 shows the delivery rate in facility 2001 – 2008 as recorded in the DHIS[5]. The C-section rates calculated in 2001 therefore do not represent 25.7% of estimated total deliveries of all women in SA and 12.2% in 2008. The analyses and results in this report are thus specific to public sector facilities and do not apply to deliveries which take place elsewhere.

Table 3.8: Delivery rate in facility (public sector) 2001 - 2008

Year	2001	2002	2003	2004	2005	2006	2007	2008
Delivery rate in facility (%)	74.3	72.8	74.3	82.6	83.1	78.4	83.3	87.8

The C-section rate calculated also does not provide information on the reason for performing a C-section and includes those that were performed without a clinical indication (on patient demand), elective C-sections and emergency C-sections.

3.5 Ethical considerations

The researcher has followed the required ethical principles and procedures relevant to conducting research on secondary data relating to C-sections obtained from the DHIS. Application was made for ethical approval to the University of Witwatersrand Human Research Ethics Review Board (Medical) for clearance of research and a clearance certificate was obtained and is attached in Appendix 5.

1 Consent

Permission was obtained from the National Department of Health, Chief Director: Information, Evaluation and Research by completing the Data User's Agreement for extraction of the relevant data set from the DHIS. A copy of the signed data User's Agreement approval is attached in Appendix 1. The researcher agrees that the data set belongs to the National Department of Health and that the Department is acknowledged as the source of the data in any reports or articles published or presented. A copy of the report produced will be submitted to the Chief Director: Information, Evaluation and Research.

The data related to C-sections which was extracted from the DHIS has no information related to or links to individual patient records or personal information. There is thus no requirement to get approval from individual patients.

2 Autonomy and confidentiality

As there are no data or information relating to or links to individual patients or health practitioners involved in C-sections and deliveries, full confidentiality is maintained. In this study, no attempt has been made to link, or permit others to attempt to link the data with personally identifiable records from any other source.

The information obtained through the DHIS relating to C-sections is acknowledged as being the property of the National Department of Health and will not be used for commercial purposes or purposes other than for this study. The results showing C-section rate data by individual hospitals will in no way be used for propaganda, negative press or punitive purposes, or released to any party without prior permission from the National Department of Health.

3 Justice and equity

The hospitals selected and used in the analysis represent all hospitals - including rural and urban areas, thus representing both the under-resourced and more affluent populations. The C-sections of all SEQs are analysed, to assess if the C-section rate for people in the poorer districts of the country differs from those living in the wealthier quintiles.

Chapter 4: Results

4.1 Variation in C-section rates, 2008/09

The nine provinces and fifty-two districts in South Africa have diverse and unique features, not only socially, geographically and demographically, but also with respect to health profiles and service delivery. Sections 4.1.1 through to 4.1.6 explore the variation in C-section rates throughout the public sector in South Africa in 2008/09 by level of hospital, district, province and facility. Graphs of each province showing the C-section rates for each of the hospitals in the province, colour coded by level, are made available in Appendix 6. These graphs clearly illustrate the variation within each hospital level and between hospital levels in a province.

4.1.1 Variation by hospital level

The results that follow present the weighted and un-weighted average C-section rates of each level of hospital in the public sector in South Africa in 2008/09.

In 2008/09 there were 730 089 recorded deliveries in all public sector hospitals in the country and 178 020 C-sections performed. Table 4.1 shows how the average rate differs distinctly by the five different hospital levels.

Table 4.1 Variation in C-Section rate by hospital level

Hospital Level	No. of Hospitals [v]	Mean C-section rate (unweighted) (%)	Standard Deviation	Median	Min	Max	No. of C-sections	No. of Deliveries	C-section rate (Weighted by no.births per hospital) (%)
District Hospital	199	15.8	8.8	15.1	0.2	59.2	61 495	357 989	17.2
Regional Hospital	47	30.1	11.1	29.2	11.2	61.9	70 002	243 478	28.8
Provincial Tertiary	11	36.7	18.5	32.9	17.8	77.7	20 999	62 010	33.9
National Central	8	50.4	18.8	46.3	31.7	79.7	21 689	57 193	37.9
Specialised Maternity	1	40.7	0.0	40.7	40.7	40.7	3 835	9 419	40.7
South Africa	**266**	**20.3**	**13.2**	**23.4**	**0.2**	**79.7**	**178 020**	**730 089**	**24.4**

The un-weighted mean C-section is the average of the C-section rates of the hospitals in each hospital level. The weighted mean takes the number of deliveries (births) which occur in each hospital and thus each level into consideration. We considered it to be a more accurate way to

[v] This is the total number of hospitals with records as recorded in the DHIS. Hospitals with missing records are not included.

look at variation as each hospital is not counted equally, but is weighted according to number of deliveries. For example, in 2008/09 the un-weighted mean C-section rate for National Central Hospitals (which is the average of the range of C-section rates of each of the eight National Central Hospitals) is 50.4% (Table 4.1), but when taking the deliveries in each of the hospitals into account, the rate is 37.9% (weighted mean). This is a more realistic figure, as some hospitals although they may have a very high C-section rate, recorded very few deliveries in this time period. The results discussed in the following parts of this section will therefore deal with the weighted means when looking at variation.

The highest average C-section rate in 2008/09 is found at the Specialised Maternity Hospital level, 40.7%, and the lowest rate at District Hospital level, 17.2%. Although District Hospitals reflect the lowest mean C-section rate in the country, these hospitals recorded the largest number of deliveries in 2008/09. The C-section rates are more closely clustered around the mean than for other hospitals, (sd=8.8). (See Appendix 8 'Graphics of Data Distribution' for histograms of C-section rate distribution of the different hospital levels).

The largest number of deliveries by C-section in 2008/09 in South Africa, (70 002), was in Regional Hospitals, with an average rate of 28.8%. More women delivered in a National Central Hospital, (21 689), than in a Provincial Tertiary level hospital (20 999), although the C-section rate was higher in National Central Hospitals.

The range of C-section rates is very wide within each level suggesting possible inequity in service delivery and resource allocation. The very low rates noted for some hospitals, suggests that they are unable to provide emergency obstetric care services such as C-sections to women who need to access these services. Very high C-section rates noted in other hospitals could be due to these hospitals carrying the load of nearby under-resourced hospitals. The widest range in C-section rate among the hospital levels is in District Hospitals (0.2% to 59.2%) with these extremes being far below the minimum acceptable rate of 5% and far over the suggested norm of 15% for this level of hospital.

4.1.2 C-section rates in District Hospitals, 2008/09

This section compares the C-section rates of District Hospitals across districts within the country, within provinces and between hospitals within a district. The last part of the this section explores those District Hospitals with C-section rates which fall into the highest and lowest deciles.

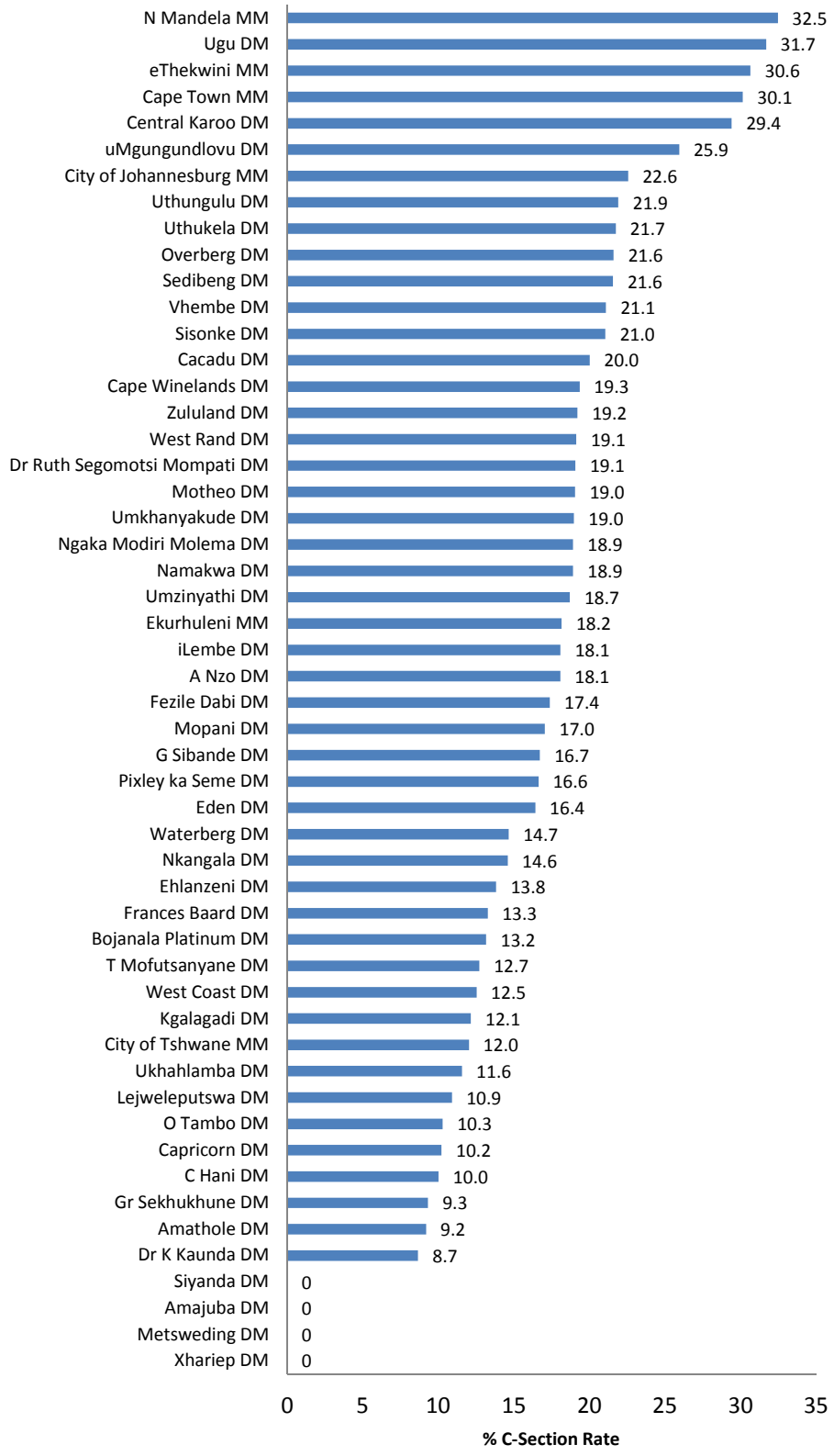
4.1.2.1 District Hospital C-section rates compared by district

The weighted mean C-section rate for District Hospitals in 2008/09 is 17.2%. Figure 4.1 shows the weighted C-section means for each district ranked from highest to lowest. The NIDS states that the C-section rate expected for a District Hospital should be in the region of 15%

Four districts in the total of 52 districts in South Africa do not have C-section values. These are: Xhariep District which has missing records for all three of its District Hospitals, Metsweding District which has no District Hospitals, Amajuba District and Siyanda District which have missing records for each of their District Hospitals in 2008/09.

Thirty-one (64.6%) of the 48 districts which have C-section rate data, had average rates higher than 15% (Appendix 7.3) and the rates of half (49.7%) of all District Hospitals in the country (99/199) were above 15%. As can be seen in Figure 1, there is a 3.7 fold difference between the lowest mean rate for a district, (8.7%) in Dr Kenneth Kaunda District in North West (3 hospitals), and the highest, (32.5%) in Nelson Mandela District in the Eastern Cape (1 hospital).

Figure 4.1: C-Section rate by district for District Hospitals 2008/09



4.1.2.2 District Hospital C-section rates compared by province

Wide variation is seen among the weighted mean C-section rates of districts within a province.. Table 4.2, which shows the highest and lowest mean C-section rates within each province, illustrates the wide variation in the Eastern Cape Province, where there is a 3.5 fold difference between the rate in Amathole District (9.2%) and Nelson Mandela Metropolitan Municipality (32.5%). The second largest difference in average rates between districts in a province is in Western Cape with 2.4 fold difference between the highest (30.1% Cape Town MM) and lowest (12.5% West Coast DM) average rates. However, there are also examples of minimal variation, such as in Mpumalanga Province with only a 2.9 percentage point difference between Ehlanzeni District's (13.8%) and Gert Sibande District's (16.7%) mean C-section rates. The province with the highest mean weighted C-section rate is KwaZulu-Natal (22.8%), and the lowest, Eastern Cape (13.4%).

Table 4.2 District Hospital highest and lowest mean C-section rates by province, 2008/09

Province	Province mean C-section rate % (weighted ave)	District Highest mean C-section rate % (weighted ave)		District Lowest mean C-section rate % (weighted ave)		Percentage point difference	Ratio high:low
Eastern Cape	13.4	N Mandela MM	32.5	Amathole DM	9.2	23.3	3.5
Free State	14.7	Motheo DM	19.0	Lejweleputswa DM	10.9	8.1	1.7
Gauteng	16.1	City of Johannesburg MM	22.6	City of Tshwane MM	12.0	10.6	1.9
KwaZulu-Natal	22.8	Ugu DM	31.7	iLembe DM	18.1	13.6	1.8
Limpopo	14.7	Vhembe DM	21.1	Gr Sekhukhune DM	9.3	11.8	2.3
Mpumalanga	14.9	G Sibande DM	16.7	Ehlanzeni DM	13.8	2.9	1.2
North West	15.9	Dr Ruth Segomotsi Mompati DM	19.1	Dr Kenneth Kaunda DM	8.7	10.4	2.2
Northern Cape	14.3	Namakwa DM	18.9	Kgalagadi DM	12.1	6.8	1.6
Western Cape	20.8	Cape Town MM	30.1	West Coast DM	12.5	17.6	2.4

4.1.2.3 District Hospital C-section rates compared within districts

Wide variation in C-section rates occurs not only among districts within provinces, but also among hospitals within districts. The largest variation within a district occurred among Cape Town Metropolitan Municipality's four District Hospitals and ranged from 0.3% to 59.4% followed by Motheo District with four hospitals from 6.9% to 36.0%.(Table 4.3). The table shows those districts with the highest and lowest variation in rates among District Hosptials.

Table 4.3 District Hospital C-section rates within districts, 2008/09

District	Province	No. of hospitals	District mean C-section rate (%) Weighted ave	Hospital lowest C-section rate (%)	Hospital highest C-section rate (%)	Percentage point difference
Cape Town MM	Western Cape	4	30.1	0.3	59.2	58.9
Motheo DM	Free State	4	19.0	6.9	36.0	29.1
C Hani DM	Eastern Cape	8	10.0	1.1	27.3	26.2
Pixley ka Seme DM	Northern Cape	3	16.6	0.3	24.6	24.3
T Mofutsanyane DM	Free State	7	12.7	0.3	24.1	23.8
O Tambo DM	Eastern Cape	9	10.3	0.3	23.1	22.8
Umzinyathi DM	KwaZulu- Natal	4	18.7	15.9	21.9	6.0
Overberg DM	Western Cape	4	21.6	18.3	23.8	5.5
Kgalagadi DM	Northern Cape	2	12.1	10.1	14.2	4.1
uMgungundlovu DM	KwaZulu- Natal	2	25.9	24.2	26.2	2.0

The eight hospitals in Chris Hani district in the Eastern Cape not only show very low minimum C-section rates (1.1%) but also wide variation (a 26.2 percentage point difference between high and low), as is also seen for the nine hospitals in O Tambo District in the same province (0.3% - 23.1%). In Pixley ka Seme District the C-section rates of its three hospitals range from 0.3% to 24.6%.

Some districts however, had much less variation between their hospitals, such as uMgungundlovu with a 2 percentage point difference and Kgalagadi with a 4.1 percentage point difference.

4.1.2.4 C-section rates in the lowest and highest deciles, 2008/09

The results that follow present the C-section rates in District Hospitals per decile in 2008/09 (Table 4.4) and goes on to list those facilities with C-section rates which fall into the lowest and highest deciles (Table 4.5).

As can be seen in Table 4.4, the 20 hospitals which fall into the lowest decile have a mean C-section rate of 1.5%, whilst the 19 hospitals in the highest decile have a mean of 31.2%..

Table 4.4 Mean C-section rates per decile in District Hospitals, 2008/09

Decile	No. of hospitals	no. of C-sections	no. of births	C-section rate (%)
1	20	214	15 367	1.4
2	20	2 009	30 514	6.6
3	20	3 951	39 055	10.1
4	20	4 047	32 006	12.6
5	20	6 205	43 060	14.4
6	20	6 652	40 001	16.6
7	20	7 039	37 383	18.8
8	20	8 004	37 769	21.2
9	20	9 508	38 375	24.8
10	19	13 866	44 459	31.2
Total	199	61495	357989	17.2

The lowest decile represents hospitals with C-section rates well below 5% and ranges from 0.2% for Nala Hospital to 3.1% Ventersdorp Hospital. (Figure 4.5) The WHO has labelled a C-section rate below 5% to be a 'highly inadequate' rate[10], one that most probably does not provide adequate service delivery or cover the needs of the population of pregnant women. This suggests that that there is an underperformance of this life-saving procedure in these hospitals or that there is inadequate recoding of the number of C-sections.

Eastern Cape Province has the most hospitals in the lowest decile (7/41), representing 17% of District Hospitals in this province. Free State Province has five hospitals in this decile, representing 26% of its 19 District Hospitals. It is noteworthy that four of these five hospitals in the Free State fall within Thabo Mofutsanyane District which collectively recorded only 27 C-sections for 2 968 deliveries in District Hospitals in 2008/09. The two Regional Hospitals in this district, Dihlabeng and Mofumanadi Manapo Mopeli hospitals, recorded high C-section rates of 61.9% and 45.3% respectively, suggesting that these hospitals are carrying the load of C-sections which are not being provided in the four District Hospitals.

The C-section rates of the 19 District Hospitals in the highest decile range from 26.2% for Northdale Hospital in uMgungundlovu (KwaZulu-Natal Province) to 59.2% for Khayelitsha Hospital in City of Cape Town Metropolitan Municipality (Western Cape Province). KwaZulu-Natal has the most hospitals in this decile (7) representing 19% its 37 District

Hospitals. All the District Hospitals in the highest decile have C-section rates higher than the average expected rate for Regional Hospitals in the NIDS (25%).

Table 4.5 District Hospitals in the highest and lowest C-section rate deciles, 2008/09

Decile	Province	District	Hospital name	C-section rate (%)	No. of Births
Lowest Decile	Free State	Lejweleputswa	Nala Hospital	0.2	985
	Free State	Thabo Mofutsanyane	Phumelela Hospital	0.3	367
	Northern Cape	Pixley ka Seme	Manne Dipico Hospital	0.3	347
	Western Cape	City of Cape Town	Wesfleur Hospital	0.3	964
	Eastern Cape	O.R. Tambo	Nessie Knight Hospital	0.3	949
	Free State	Thabo Mofutsanyane	Phuthuloha District Hospital	0.3	929
	Western Cape	City of Cape Town	False Bay Hospital	0.7	582
	Free State	Thabo Mofutsanyane	Itemoheng Hospital	0.8	912
	Eastern Cape	Chris Hani	Sterkstroom Hospital	1.1	91
	Eastern Cape	Chris Hani	Cofimvaba Hospital	1.3	1 221
	Limpopo	Capricorn	Helene Franz Hospital	1.8	2 455
	Limpopo	Capricorn	Zebediela Hospital	1.8	1 540
	Western Cape	West Coast	Radie Kotze Hospital	1.9	323
	Free State	Thabo Mofutsanyane	Nketoana Hospital	2.1	778
	Eastern Cape	Ukhahlamba	Cloete Joubert Hospital	2.2	278
	Eastern Cape	Amathole	Stutterheim Hospital	2.4	751
	Eastern Cape	Amathole	Victoria Hospital	2.7	594
	Western Cape	West Coast	LAPA Munnik Hospital	2.7	333
	Eastern Cape	Amathole	Tafalofefe Hospital	3.0	396
	North West	Dr Kenneth Kaunda	Ventersdorp Hospital	3.1	572
Highest Decile	KwaZulu- Natal	uMgungundlovu	Northdale Hospital	26.2	6 317
	KwaZulu- Natal	Umkhanyakude	Bethesda Hospital	26.4	1 513
	Limpopo	Vhembe	Messina Hospital	26.4	1 708
	Mpumalanga	Gert Sibande	Standerton Hospital	27.2	1 896
	Eastern Cape	Chris Hani	Cradock Hospital	27.3	827
	Free State	Motheo	Dr JS Moroka Hospital	28.5	916
	KwaZulu- Natal	eThekwini	Osindisweni Hospital	28.5	2 953
	KwaZulu- Natal	eThekwini	St Mary's Hospital (Mariannh	28.9	5 403
	Western Cape	Central Karoo	Beaufort West Hospital	29.4	813
	Eastern Cape	Cacadu	Settlers Hospital	29.4	1 481
	North West	Dr Ruth Segomotsi Mo	Ganyesa Hospital	30.3	558
	Limpopo	Vhembe	Louis Trichardt Hospital	30.8	1 414
	KwaZulu- Natal	Ugu	St Andrew's Hospital	31.6	2 451
	Eastern Cape	Nelson Mandela Bay M	Uitenhage Hospital	32.5	3 312
	KwaZulu- Natal	Ugu	GJ Crooke's Hospital	35.4	4 370
	Free State	Motheo	Botshabelo Hospital	36.0	1 381
	Western Cape	City of Cape Town	Karl Bremer Hospital	36.3	4 980
	KwaZulu- Natal	eThekwini	McCords Hospital	40.2	1 647
	Western Cape	City of Cape Town	Khayelitsha (Tygerberg) Hos	59.2	519

Eight District Hospitals have C-section rates that are higher than the expected average for Provincial Tertiary Hospitals (30%).

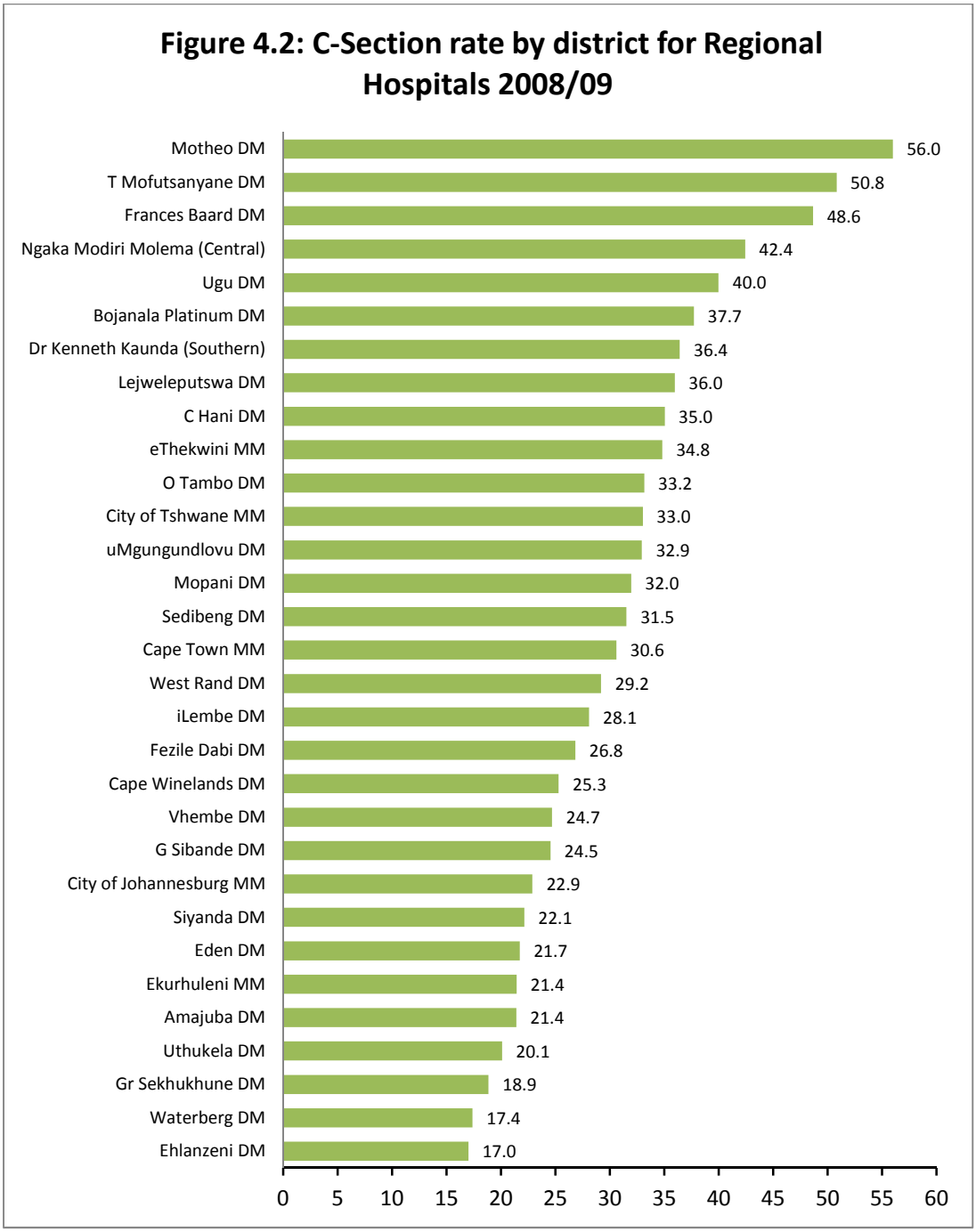
4.1.3 C-section rates in Regional Hospitals, 2008/09

This section compares the C-section rates of Regional Hospitals across districts within the country, within provinces and between hospitals within a district. The last part of the results in this section lists those Regional Hospitals with C-section rates which fall into the highest and lowest deciles.

4.1.3.1 Regional Hospital C-section rates compared by district

There are 47 Regional hospitals situated in 31 districts in South Africa. Figure4.2 shows the mean weighted C-section rates per district for those districts that have Regional Hospitals. The average district rates are ranked from the highest to lowest rate in 2008/09. There is a 3.3 fold difference between the lowest rate of 17% in Ehlanzeni District (2 hospitals) and the highest rate of 56% in Motheo District (1 hospital).

The weighted mean C-section rate for Regional Hospitals in 2008/09 is 28.8%. The average C-section rate expected in Regional Hospitals is 25%, according to the NIDS. The weighted mean C-section rate of Regional Hospitals in 19 of the 31(61%) districts is higher than this expected rate.



4.1.3.2 Regional Hospital C-section rates compared by province

There was a 2.4 fold difference between the mean weighted C-section rate of Regional Hospitals in Mpumalanga Province and Free State Province. Wide variation was also seen between districts within certain provinces, suggesting inequitable resource allocation between the districts. As can be seen in Table 4.6, the C-section rate among districts with Regional Hospitals in the Free State Province varies from a high of 56.0% in Motheo District to a low

of 26.8% in Fezile Dabi District. Other provinces with a two-fold or higher difference between the highest and rates include KwaZulu-Natal and Northern Cape Province.

Table 4.6 Regional Hospital highest and lowest mean C-section rates by province, 2008/09

Province	Province mean C-section rate % (weighted ave)	District Highest mean C-section rate % (weighted ave)		District Lowest mean C-section rate % (weighted ave)		Percentage point difference	Ratio high:low
Eastern Cape	34.1	C Hani DM	35.0	O Tambo DM	33.2	1.9	1.1
Free State	43.9	Motheo DM	56.0	Fezile Dabi DM	26.8	29.2	2.1
Gauteng	24.0	City of Tshwane MM	33.0	Ekurhuleni MM	21.4	11.6	1.5
KwaZulu-Natal	31.7	Ugu DM	40.0	Uthukela DM	20.1	19.9	2.0
Limpopo	21.9	Mopani DM	32.0	Waterberg DM	17.4	14.6	1.8
Mpumalanga	18.6	G Sibande DM	24.5	Ehlanzeni DM	17.0	7.5	1.4
North West	37.9	Ngaka Modiri Molema	42.4	Dr Kenneth Kaunda DM	36.4	6.0	1.2
Northern Cape	38.6	Frances Baard DM	48.6	Siyanda DM	22.1	26.5	2.2
Western Cape	27.4	Cape Town MM	30.6	Eden DM	21.7	8.9	1.4

4.1.3.3 Regional Hospital C-section rates compared within districts

Amongst districts with more than one Regional Hospital, wide differences in the minimum and maximum C-section rates were seen. The rates in Ekurhuleni Metropolitan Municipality's five hospitals ranged from 11.2% to 33.5% and in eThekwini Metropolitan Municipality from 29.0% to 49.6% (Table 4.7). Even wider variation was seen in districts such as the Cape Winelands with two hospitals, (18.9% to 41.6%). In Amajuba's two hospitals the rate ranged from a low of 15.3% to 32.6% and T Mofutsanyane's two hospitals had high rates ranging from 45.3% to 61.9%. The reasons for such widely differing C-section rates needs to be investigated, especially in cases where there are only two Regional Hospitals in a district and one records double or more the C-section rate of the other.

Table 4.7 Regional Hospital C-section rates within districts, 2008/09

District	Province	No. of hospitals	District mean C-section rate (%) Weighted ave	Hospital lowest C-section rate (%)	Hospital highest C-section rate (%)	Percentage point difference
Cape Winelands DM	Western Cape	2	25.3	18.9	41.6	22.7
Ekurhuleni MM	Gauteng	5	21.4	11.2	33.5	22.3
eThekwini MM	KwaZulu- Natal	5	34.8	29.0	49.6	20.6
Amajuba DM	KwaZulu- Natal	2	21.4	15.3	32.6	17.3
T Mofutsanyane DM	Free State	2	50.8	45.3	61.9	16.6
Dr Kenneth Kaunda DM	North West	2	36.4	29.0	40.0	11.0
Cape Town MM	Western Cape	2	30.6	24.1	33.5	9.4
Ehlanzeni DM	Mpumalanga	2	17.0	12.0	20.9	8.9
Gr Sekhukhune DM	Limpopo	2	18.9	15.0	22.5	7.5
City of Johannesburg MM	Gauteng	2	22.9	20.3	23.8	3.5

4.1.3.4 C-section rates in the lowest and highest deciles, 2008/09

The results that follow present the mean C-section rates in Regional Hospitals per decile in 2008/09 (Table 4.8) and lists those facilities with C-section rates which fall into the lowest and highest deciles (Table 4.9).

Table 4.8 Mean C-section rates per decile in Regional Hospitals, 2008/09

Decile	No. of hospitals	No. of C-sections	No. of births	mean C-section rate (%)
1	5	3 646	25 723	13.9
2	5	6 296	32 090	19.3
3	5	6 122	27 045	22.2
4	4	5 057	20 410	24.6
5	5	7 405	25 862	28.4
6	5	9 769	30 254	32.2
7	4	8 591	25 939	33.1
8	5	9 055	25 895	35.1
9	5	6 318	15 333	41.9
10	4	7 743	14 927	54.0
Total	47	70 002	243 478	28.8

Five Regional Hospitals fall into the lowest decile of C-section rates for this category of hospitals. The mean C-section rate is 13.9%, which is lower than the average expected rate for District Hospitals (15%). Values ranged from 11.2% in Pholosong Hospital to 16.3% for

Far East Rand Hospital, both situated in Ekhuruleni Metropolitan Municipality in Gauteng Province (Table 4.9).

The four Regional Hospitals in the highest decile had a mean C-section rate of 54.0% which is significantly higher than the average rate expected for Provincial Tertiary Hospitals of 30%. Two of the four hospitals, Dihlabeng Hospital (61.9%) and Pelonomi Hospital (56.0%) recorded rates higher than those expected for National Central and academic-level hospitals (50%).

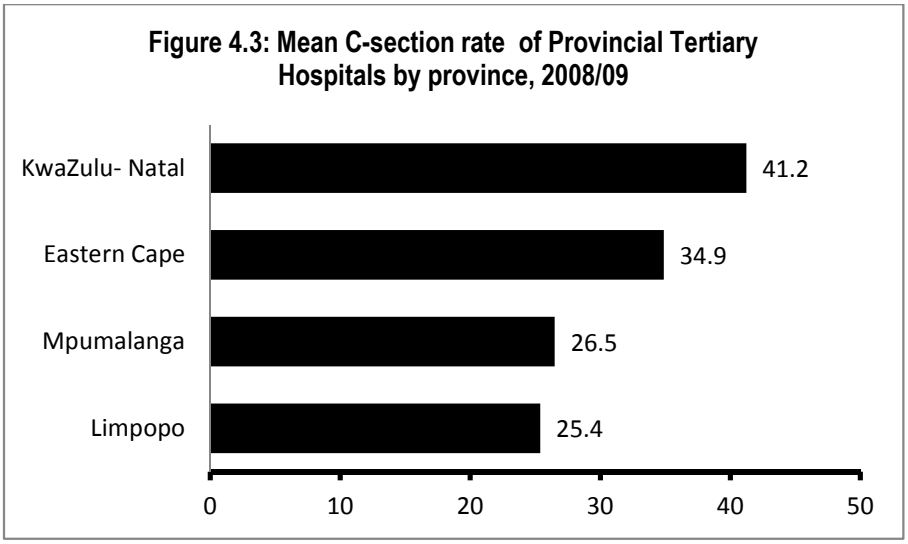
Table 4.9 Regional Hospitals in the lowest and highest C-section rate deciles, 2008/09

Decile	Province	District	Hospital name	C-section rate (%)	No. of births
Lowest Decile	Gauteng	Ekurhuleni	Pholosong Hospital	11.2	4 981
	Mpumalanga	Ehlanzeni	Mapulaneng Hospital	12.0	4 205
	Limpopo	Greater Sekhukhune	Philadelphia Hospital	15.0	4 605
	KwaZulu- Natal	Amajuba	Madadeni Hospital	15.3	4 854
	Gauteng	Ekurhuleni	Far East Rand Hospital	16.3	7 078
Highest Decile	Northern Cape	Frances Baard	Kimberley Hospital	48.6	3 359
	KwaZulu-Natal	eThekwini	King Edward VIII Hospital	49.6	6 564
	Free State	Motheo	Pelonomi Hospital	56.0	4 118
	Free State	Thabo Mofutsanyane	Dihlabeng Hospital (Bethlehem)	61.9	886

4.1.4 C-section rates in Provincial Tertiary Hospitals, 2008/09

This section compares the C-section rates of Provincial Tertiary Hospitals across districts and provinces within the country.

In 2008/09 there were 11 Provincial Tertiary Hospitals located in eight districts within four provinces in South Africa and the mean weighted C-section rate was 33.9%. There was a 1.6 fold difference between the weighted mean C-section rate of Provincial Tertiary Hospitals in Limpopo (25.4%) and KwaZulu-Natal (41.2%). as depicted in Figure 4.3.



Five of the eight districts have one Provincial Tertiary level hospital only, whilst Amathole and O Tambo districts in the Eastern Cape and Capricorn District in Limpopo have two each. As can be seen in Table 4.6, there is a wide (4.2 fold) difference between the C-section rates of the two Provincial Tertiary Hospitals in O Tambo District, ranging from 18.6% to 77.7%, whilst in Amathole District the rates of the two hospitals are very similar (32.5% and 33.3%).

Table 4.10: Provincial Tertiary Hospital C-section rates within districts, 2008/09

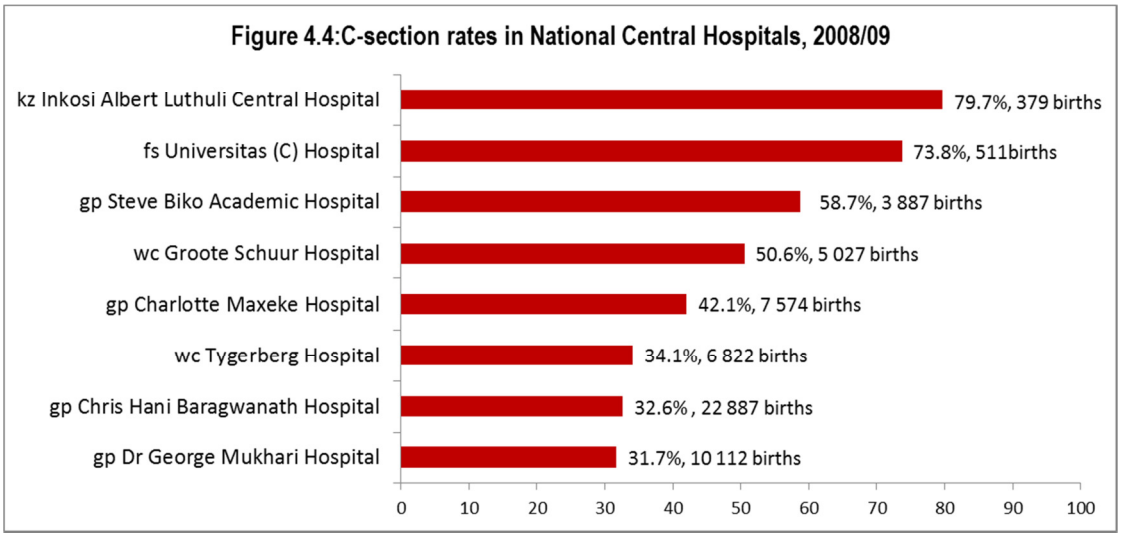
Province	District name	No. of Hospitals	No. of C-sections	Deliveries	Mean C-section rate % (weighted)	Hospital lowest C-section rate (%)	Hospital highest C-section rate (%)
Eastern Cape	N Mandela MM	1	3 657	11 127	32.9	32.9	32.9
Eastern Cape	Amathole DM	2	3 909	11 885	32.90	32.5	33.3
Eastern Cape	O Tambo DM	2	3 757	9 452	39.70	18.6	77.7
KwaZulu- Natal	Uthungulu DM	1	4 202	11 221	37.40	37.4	37.4
KwaZulu- Natal	uMgungundlovu DM	1	1 239	1 977	62.70	62.7	62.7
Limpopo	Capricorn DM	2	2 207	8 694	25.4	17.8	39.9
Mpumalanga	Ehlanzeni DM	1	606	3 167	19.1	19.1	19.1
Mpumalanga	Nkangala DM	1	1 422	4 487	31.7	31.7	31.7
Total	**8**	**11**	**20 999**	**62 010**	**33.9**	**17.8**	**77.7**

The very high C-section rate of 62.7% as seen for uMgungundlovu District is contributed by Grey's Hospital and the low rate of 19.1% in Ehlanzeni by Rob Ferreira Hospital. Further investigation is needed into the widely differing rates of these hospitals as their C-section rates are at extremes of what is expected for this level of hospital. Nelson Mandela Academic Hospital in O Tambo District recorded a C-section rate of 77.7%, and has recently been reclassified as a National Central Hospital in the Government Notice of 12 August 2011.

4.1.5 C-section rates in National Central Hospitals, 2008/09

This section looks at the inter-facility variation in C-section rates of National Central Hospitals across South Africa.

In 2008/09 there were eight National Central Hospitals situated in five districts in South Africa. City of Johannesburg and City of Tshwane in Gauteng Province and Cape Town Metropolitan Municipality in the Western Cape each have two National Central Hospitals, whilst Motheo District in the Free State and eThekwini Metropolitan Municipality in KwaZulu-Natal, have one each. The weighted mean C-section rate for this level of hospitals is 37.9%. The expected rate for this level of hospitals according to the NIDS is 50%. As depicted in Figure 4.4, the C-section rate varies from 31.7% in Dr George Mukari Hospital (10 112 deliveries) to 79.7% in Inkosi Albert Luthuli Central Hospital (379 deliveries), which is a 2.5 fold difference between the highest and lowest rate.



4.1.6 C-section rates in Specialised Maternity Hospitals, 2008/09

There is only one Specialised Maternity Hospital in South Africa, Mowbray Maternity Hospital, which is situated in Cape Town Metropolitan Municipality. The C-section rate in 2008/09 for this hospital was 40.7% for 9 419 recorded deliveries.

4.1.7 C-section rates below 5% and above 50%, 2008/09

C-section rates below 5% are considered to be 'highly inadequate' and most probably do not provide adequate maternal service delivery[10]. In 2008/09 there are a total of 23 hospitals with C-section rates below 5%, and all are District Hospitals. This represents 11.6% of District

Hospitals in 2008/09 and 8.7% of all hospitals. These hospitals are spread throughout the country and are situated in seven out of the nine provinces, with the highest proportion (34.8%, 8 hospitals) being in the Eastern Cape followed by the Free State (21.7%, 5 hospitals) and Western Cape (21.7%, 5 hospitals). Limpopo has two hospitals, with Mpumalanga, North West and Northern Cape having one hospital each. The list of hospitals with C-section rates lower than 5% are listed in Appendix 7.1.

According to the NIDS, a C-section rate of 50% is one that is expected only in National Central Hospitals (tertiary and academic level). The nine hospitals that recorded C-section rates above 50% in 2008/09, included one District Hospital in Western Cape Province, two Regional Hospitals in Free State Province, two Provincial Tertiary Hospitals (Eastern Cape and KwaZulu-Natal) and four National Central Hospitals (KwaZulu-Natal, Free State, Gauteng and Western Cape). The list of hospitals with C-section rates lower than 5% are shown in Appendix 7.2.

Summary

This section has presented results which demonstrate the variation in average C-section rates between and within the five levels of hospitals in the public sector in South Africa. In 2008/09, the mean weighted C-section rate ranges from 17.2% in District Hospitals to 40.7% in Specialised Maternity Hospitals.

Variation is evident when comparing the C-section rates of District Hospitals by district, where there is a 3.7 fold difference between the highest and lowest district weighted mean C-section rates. Among districts within a province there was wide variation, such as the 3.5 fold difference between the rate in Amathole District and Nelson Mandela Metropolitan Municipality in the Eastern Cape.

The largest variation in C-section rates among District Hospitals within a district occurred in Cape Town Metropolitan Municipality with a 58.9 percentage point difference between the highest and lowest rates in the metro.

Inter-district variation in Regional hospital C-section rates showed a 3.3 fold difference between the lowest and highest district weighted mean C-section rates. Within provinces such as Free State, Northern Cape and KwaZulu-Natal the differences between the highest and lowest district average C-section rates was two-fold and higher. Amongst districts with more

than one Regional Hospital, wide differences in the minimum and maximum C-section rates were seen between facilities.

Among Provincial Tertiary Hospitals there is a 1.6 fold difference between the lowest and highest mean weighted district C-section rates. Very wide differences between individual Provincial Hospitals within two districts were observed.

Among the eight National Central Hospitals there is a 2.5 fold difference between the highest (79.7%) and lowest (31.7%) facility C-section rates.

Nationally a total of 23 District Hospitals had C-section rates below 5% and nine hospitals of varying levels had rates of over 50%

4.2 C-section rate trends from 2001/02 to 2008/09

Sections 4.2.1 and 4.2.2 reflect on the trends in C-section rates by level of hospital with details of these trends set out by hospital level (sections 4.2.1.1 – 4.2.1.5) and then by province (4.2.2). This is followed by a Linear Regression analysis in section 4.2.3, which tests for statistically significant trends.

4.2.1 National C-section rate trends by level of hospital

Both the C-section rate and the number of deliveries in public sector hospitals increased between 2000/01 and 2008/09. The number of deliveries increased by 67.3% over the nine years, with a 6.6% annual compound growth rate. Over five million deliveries (5 740 670) were recorded with increases seen in all levels of hospitals. As expected, the largest number of deliveries, 2 852 133 (49.7%) occurred at a primary level, in District Hospitals. Regional Hospitals which contribute 33.5% to total deliveries had the largest increase in number of deliveries (76.1% since 2000/01) with an average annual compound growth rate of 7.3%. Higher levels of care (Provincial Tertiary, National Central and Specialised hospitals) contributed to 16.8% of total deliveries between 2000/01 and 2008/09.

The mean C-section rate for all hospitals in the country (weighted by number of births) increased by 6.3 percentage points from 18.1% to 24.4% between 2000/01 and 2008/09, with an average compounded annual growth rate of 3.8%. The weighted mean C-section rates showed a positive percentage point increase for of all hospital levels (Table 4.11).

Table 4.11: Weighted mean C-Section rate by year and level of hospital 2000/1 - 2008/9

Hospital level	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	ACGR 2000/1-2008/9	Percentage point change 2000/1-2008/9
All Hospitals	18.1	18.7	18.9	19.3	19.9	20.8	22.1	22.3	24.4	3.8%	6.3
District	13.5	13.4	13.1	12.9	13.4	13.9	15.2	15.7	17.2	3.1%	3.7
Regional	22.7	21.6	22.6	22.9	23.5	25.1	26.7	27.3	28.8	3.0%	6.1
Provincial Tertiary	23.3	24.7	23.6	26.0	28.1	30.4	31.4	31.6	33.9	4.8%	10.6
National Central	36.3	30.6	29.2	32.7	33.2	33.2	34.2	35.1	37.9	0.5%	1.6
Specialised	35.2	36.8	33.8	34.7	35.9	38.5	38.8	40.3	40.7	1.8%	5.5

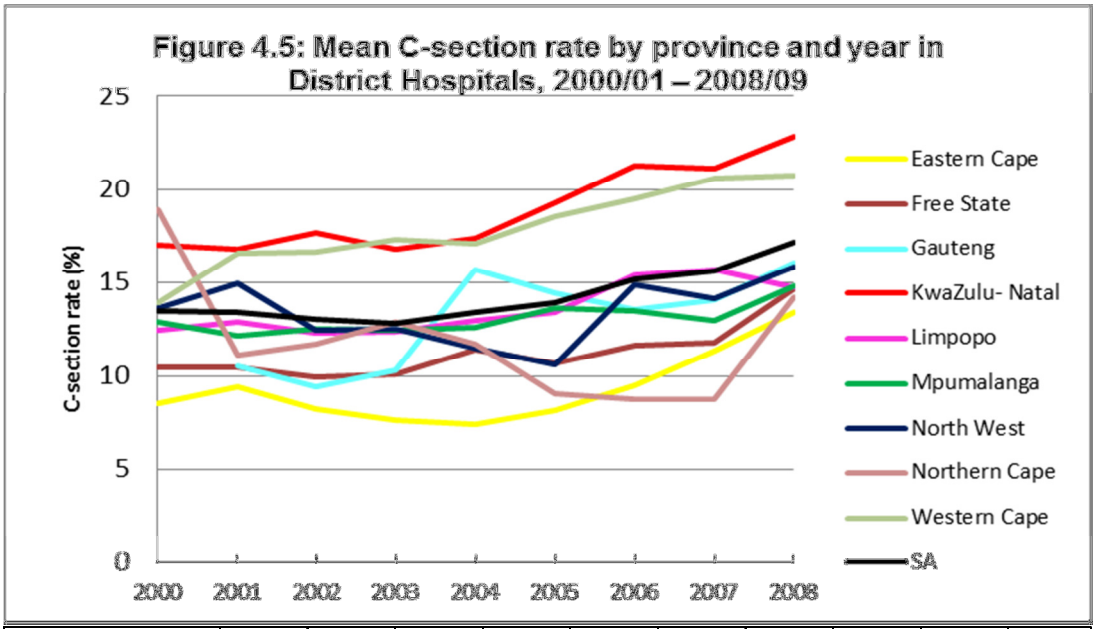
4.2.1.1 District Hospital C-section rate trends

A detailed table illustrating the C-section rates for District Hospitals from 2000/01 to 2008/09, by year and by district within their respective provinces can be found in Appendix 8, section 8.2.

The weighted mean C-section rate in District Hospitals in South Africa increased by 3.7 percentage points from 13.5% to 17.2 % between 2000/01 - 2008/09, with an average compound growth rate of 3.1% (Table 4.11). The highest annual compounded growth rate was in Gauteng Province (6.2%) where the C-section rate increased from 10.6% to 16.1%, between 2001/02 and 2008/09, followed by Eastern Cape with an increase from 8.6% to 13.4% in 2000/01 to 2008/09 with an ACGR of 5.7% (Figure 4.5). The rate in the Northern Cape increased the least among the provinces, from 13.0% to 14.3% with an ACGR of 1.2%.

Five districts in the country recorded decreasing C-section rates over the nine years with negative average compound growth rates. These were Xhariep District in Free State Province, John Taolo Gaetsewe, Pixley ka Seme and Siyanda districts in Northen Cape Province, and Dr Kenneth Kaunda in North West Province. The reason for the decreases in Xhariep and Siyanda districts is due to zero values and missing records for all District Hospitals for the most recent years.

Among the largest increases in C-section rate among districts were in Alfred Nzo in the Eastern Cape (3.0% to 18.1%), East Rand in Gauteng (5.6% to 19.1%) and iLembe in KwaZulu-Natal (4.8% to 18.1%).



Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	ACGR
Eastern Cape	8.6	9.4	8.3	7.7	7.5	8.2	9.6	11.4	13.4	5.7
Free State	10.5	10.5	10.0	10.1	11.4	10.7	11.6	11.8	14.7	4.3
Gauteng	no data	10.6	9.4	10.3	15.7	14.4	13.6	14.1	16.1	6.2
KwaZulu- Natal	17.0	16.9	17.7	16.8	17.4	19.3	21.1	21.1	22.8	3.7
Limpopo	12.5	12.9	12.4	12.4	13.0	13.4	15.4	15.7	14.7	2.0
Mpumalanga	13.0	12.2	12.6	12.5	12.6	13.6	13.5	13.0	14.9	1.7
North West	13.7	15.0	12.5	12.6	11.5	10.6	14.9	14.1	15.9	1.9
Northern Cape	13.0	11.2	11.7	12.9	11.7	9.1	8.8	8.8	14.3	1.2
Western Cape	14.0	16.6	16.7	17.4	17.1	18.6	19.5	20.7	20.8	5.1
South Africa	**13.5**	**13.4**	**13.1**	**12.9**	**13.4**	**13.9**	**15.2**	**15.7**	**17.2**	**3.1**

4.2.1.2 Regional Hospital C-section rate trends

The weighted mean C-section rate in South Africa's 60 Regional Hospitals has increased over the nine years by 6.1 percentage points from 22.7% to 28.8% with each of the provinces showing a positive growth rate (Table 4.12). The largest increase in C-section rate was in North West Province from 17.2% to 37.9% (ACGR 10.4%), and the lowest in KwaZulu-Natal 27.2% to 31.7% (ACGR 1.7%).

The largest increases in C-section rate in Regional Hospitals is seen in two districts in Limpopo Province; Mopani District (from 10.6% to 32.0%) with an ACGR of 14.8% and Waterberg District (from 6.2% to 17.4%) with an ACGR of 13.8%.

Two districts, Nelson Mandela Bay Metro and uMgungundlovu recorded negative mean C-section growth rates over the nine years. In Nelson Mandela Bay Metro the C-section rates decreased between 2000/01 and 2003/04 for both hospitals, Livingstone Hospital and Port Elizabeth Hospital and there were no further delivery or C-section records for either of the

hospitals, except for 50 deliveries in Port Elizabeth Hospital in 2007/08. In uMgungundlovu the decrease in mean C-section rates is due to the sharp drop in number of recorded C-sections performed in Edendale Hospital between 2007/08 and 2008/09.

A detailed table illustrating the C-section rates for Regional Hospitals from 2000/01 to 2008/09, by year and district within their respective provinces can be found in Appendix 8, section 8.3.

Table 4.12: Mean C-section rate by province and year in Regional Hospitals, 2000/01–2008/09

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	ACGR
Eastern Cape	21.4	19.8	19.7	15.9	11.9	15.7	20.1	28.1	34.1	6.0
Free State	28.4	29.0	33.6	34.9	35.3	36.5	41.3	42.4	43.9	5.6
Gauteng	no data	18.7	18.5	18.6	19.4	20.2	21.7	22.0	24.0	3.6
KwaZulu- Natal	27.7	26.3	28.6	29.2	29.3	31.7	32.0	31.8	31.7	1.7
Limpopo	15.0	16.1	15.4	16.1	17.7	20.1	20.0	19.6	21.9	4.8
Mpumalanga	10.9	11.5	13.3	11.8	13.1	15.2	14.7	17.5	18.6	6.9
North West	17.2	18.4	18.4	20.4	21.9	23.1	28.9	33.0	37.9	10.4
Northern Cape	22.8	27.3	31.5	29.7	34.3	36.7	40.9	39.2	38.6	6.8
Western Cape	20.8	24.0	24.7	24.8	25.9	26.9	27.3	26.4	27.4	3.5
South Africa	**22.7**	**21.6**	**22.6**	**22.9**	**23.5**	**25.1**	**26.7**	**27.3**	**28.8**	**3.0**

4.2.1.3 Provincial Tertiary Hospital C-section rate trends

The Mean C-section rate for Provincial level hospitals has increased by 10.6 percentage points from 23.3% in 2000/01 to 33.9% in 2008/09 with an average annual compound growth rate of 4.8% (Table 4.13). Year-on-year, KwaZulu-Natal recorded the highest average C-section rate, which was mostly due to the very high C-section rates recorded in Grey's Hospital in uMgungundlovu District. The lowest growth rate in C-sections in Provincial Tertiary Hospitals was recorded in Limpopo Province, with an increase from 19.3% to 25.4% (ACGR 3.5) between 2000/01 and 2008/09.

Among districts, Nelson Mandela Metropolitan Municipality had the largest increase in mean C-section rate in Provincial Tertiary Hospitals over the nine years (from 2.7% to 32.9%) and Amathole District, the lowest (from 26.8% to 32.9%).

Table 4.13: Mean C-section rate by province and year in Provincial Tertiary Hospitals, 2000/01 – 2008/09

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	ACGR
Eastern Cape	23.4	22.7	21.6	24.8	27.0	30.7	31.8	33.5	34.9	5.1
KwaZulu- Natal	28.0	29.9	27.2	29.2	31.3	34.4	37.0	37.8	41.2	4.9
Limpopo	19.3	23.3	22.2	24.7	28.4	24.3	25.5	24.3	25.4	3.5
Mpumalanga	17.7	22.7	24.4	24.2	26.6	28.8	27.0	24.8	26.5	5.2
South Africa	**23.3**	**24.7**	**23.6**	**26.0**	**28.1**	**30.4**	**31.4**	**31.6**	**33.9**	**4.8**

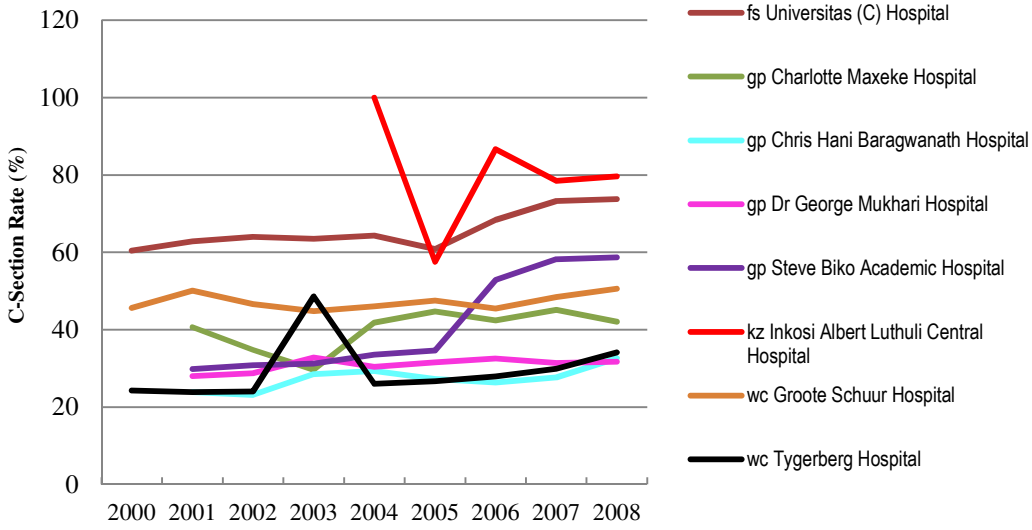
A detailed table illustrating the C-section rates for Provincial Tertiary Hospitals from 2000/01 to 2008/09, by year and district within their respective provinces can be found in Appendix 8, section 8.4.

4.2.1.4 National Central Hospitals C-section rate trends

The weighted mean C-section rate across the nine years for National Central Hospitals increased nationally by 1.6 percentage points from 36.3% to 37.9% with an ACGR of 0.5% per annum. KwaZulu-Natal Province is the only province that recorded a decrease in mean C-section rate, caused by the erratic C-section rates recorded in Inkosi Albert Luthuli Hospital between 2004/05 and 2008/09 (Figure 4.6). Tygerberg Hospital in the Western Cape Province, which had among the lowest C-section rates for National Central Hospitals over the nine years, recorded an unusual peak of 48.6% in 2003. The reason for this peak is unclear.

A detailed table illustrating the C-section rates for National Central Hospitals from 2000/01 to 2008/09, by year and district within their respective provinces can be found in Appendix 8, section 8.5.

Figure 4.6: Mean C-section rate by hospital and year in National Central Hospitals, 2000/01 - 2008/09



4.2.1.5 Specialised Hospital C-section rate trend

There is only one Specialised Hospital recorded in the DHIS data, the Mowbray Maternity Hospital which is situated in the City of Cape Town. The hospital provides primary and secondary level of care, whilst tertiary obstetric services are provided at the Maternity block of Groote Schuur Hospital. The C-section rate increased by an ACGR of 1.8% per year, from 35.2% in 2000/01 to 40.7% in 2008/09.

4.2.2 C-section rate variation and trends within provinces (all hospital levels)

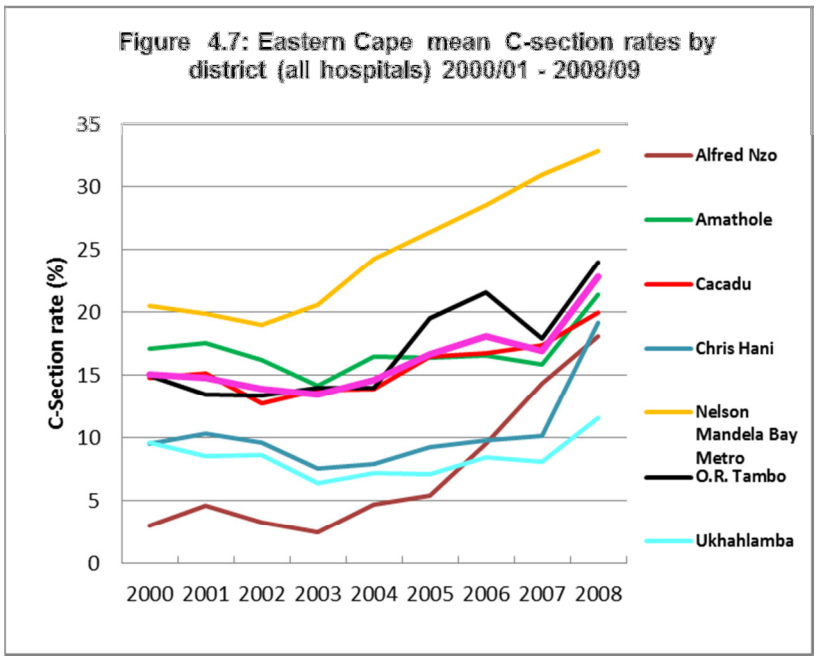
The weighted C-section rate in all provinces has increased between 2000/01 and 2008/09, with positive annual compounded growth rates. The C-section rates and trends of districts within provinces vary considerably and a detailed table illustrating the rates for all provinces and districts from 2000/01 to 2008/09, by hospital level can be found in Appendix 8, section 8.1. Table 4.14 below, summarises the weighted mean C-section rates and growth rates per province 2000/01 - 2008/09, showing that the largest average year on year growth in C-section rate occurred in North West Province (6.8%) and the lowest in Limpopo Province (3.0%). Short summaries follow the table demonstrating: a) variation in the C-section rate trend and values between districts in a province (i.e. in Eastern Cape, Western Cape), b) Decreasing C-section rate trends in districts within certain provinces (i.e. in Free State, Limpopo, Northern Cape), c) diverging C-section rate trends between different levels of hospitals in a province (i.e. in Northern Cape) and d) wide variation in trend and rate among same level hospitals in a province (i.e. in Mpumalanga).

Table 4.14: Mean C-section rates and growth rates per province 2000/01 – 2008/09

Province	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	ACGR 2000/01 - 2008/09	Percentage point change 2000/01 -
EC	15.1	14.8	13.9	13.5	14.6	16.7	18.1	16.9	22.8	5.3	7.7
FS	17.9	17.7	18.4	18.9	19.5	19.0	21.3	21.6	25.4	4.5	7.5
GP (2001/02 - 2008/09)	no data	20.8	20.2	21.2	22.9	22.6	23.3	23.9	26.0	3.2	5.2
KZN	22.2	21.6	23.1	23.1	23.6	25.7	27.1	26.9	28.0	2.9	5.8
LP	13.6	14.5	13.9	13.9	15.5	15.9	17.3	17.3	17.2	3.0	3.6
MP	13.2	13.4	14.3	13.8	14.3	15.7	15.4	15.3	17.0	3.2	3.8
NW	15.7	16.9	15.8	17.0	17.3	16.4	21.5	23.4	26.6	6.8	10.9
NC	16.8	17.2	19.3	19.4	19.9	18.7	20.1	20.9	24.7	4.9	7.9
WC	22.2	24.9	24.7	26.3	25.3	26.6	27.3	28.0	29.1	3.4	6.9
SA	18.1	18.7	18.9	19.3	19.9	20.8	22.1	22.3	24.4	3.8	6.3

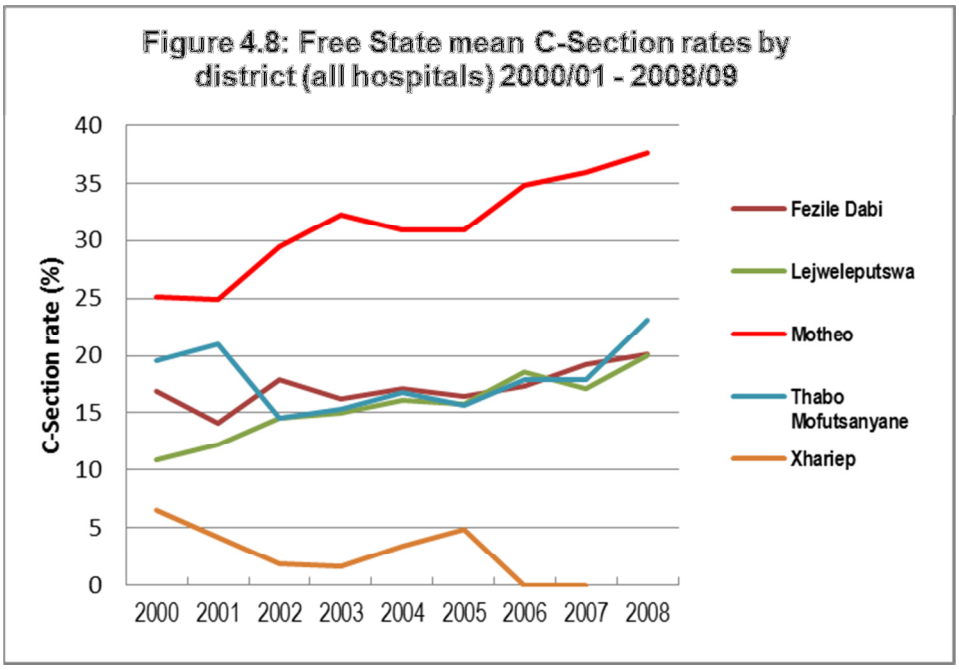
Eastern Cape

The highest year on year average C-section rate among the eight districts in the Eastern Cape was in Nelson Mandela Bay Metro (Figure 4.7), with the rate in 2008/09 (32.8%) being 10 percentage points higher than the province average, suggesting that the majority of C-section services occur in the metro areas of Eastern Cape, as compared to the more rural districts.



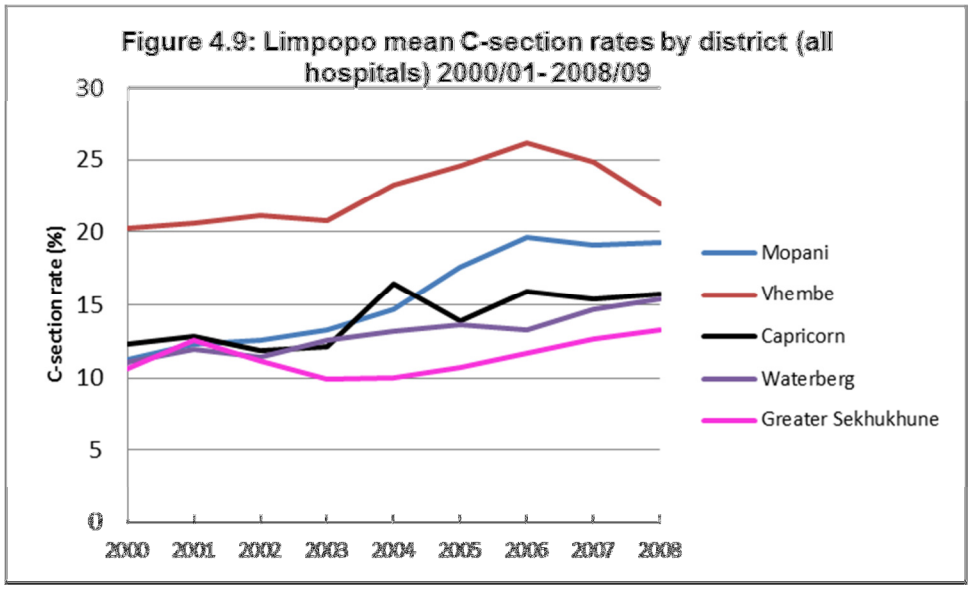
Free State

Whilst three of the five districts in this province show similar trends, the mean C-section trends of Xhariep and Motheo districts (Figure 4.8), are diverse. In Xhariep District the mean C-section rates of the three District Hospitals are very low and dwindle to nothing, despite a total of more than 1 000 deliveries being recorded each year. The mean C-section rate in Motheo District, which is a mostly urban district, containing four District Hospitals, one Regional Hospital and one National Central Hospital is the highest of all the districts throughout the nine years, and increases by 12 percentage points over the nine years



Limpopo

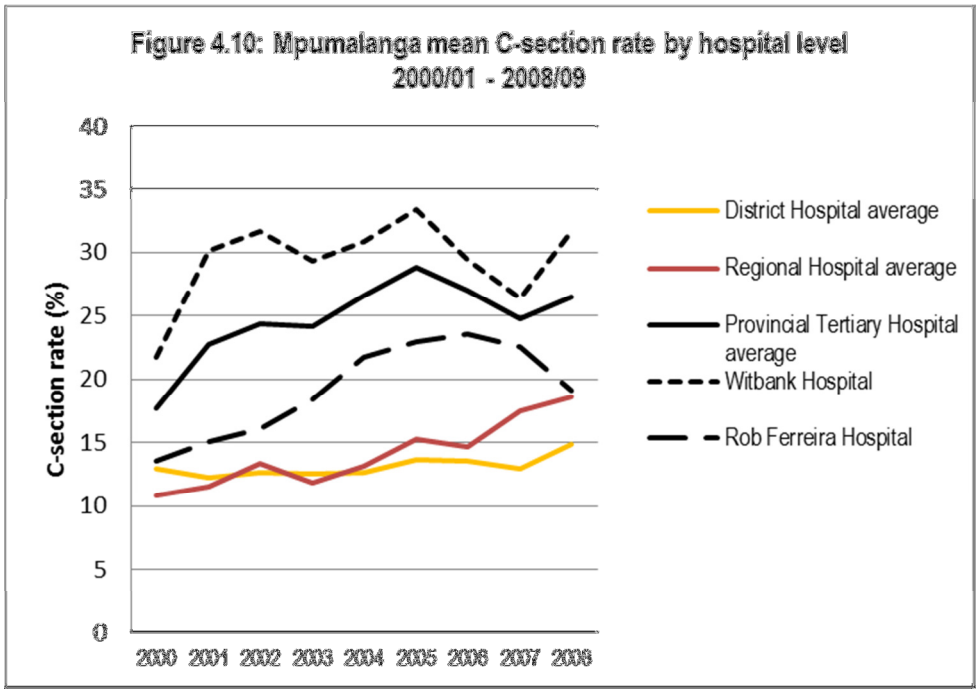
The province consists of 5 districts with a total of 31 District Hospitals, five Regional and two Provincial Hospitals. Vhembe District had the highest mean C-section rates among the districts throughout the nine years, but had the lowest increase over the nine years (1.7 percentage points). This is due to a drop in C-section rate between 2006/07 and 2008/09 (Figure 4.9), caused by decreasing C-section rates in two of its Regional Hospitals and two District Hospitals.



Mpumalanga

The mean C-section rate values in Mpumalanga Province increased from 13.2% to 17.0% over the nine years, although on average it has the lowest mean C-section rates among the

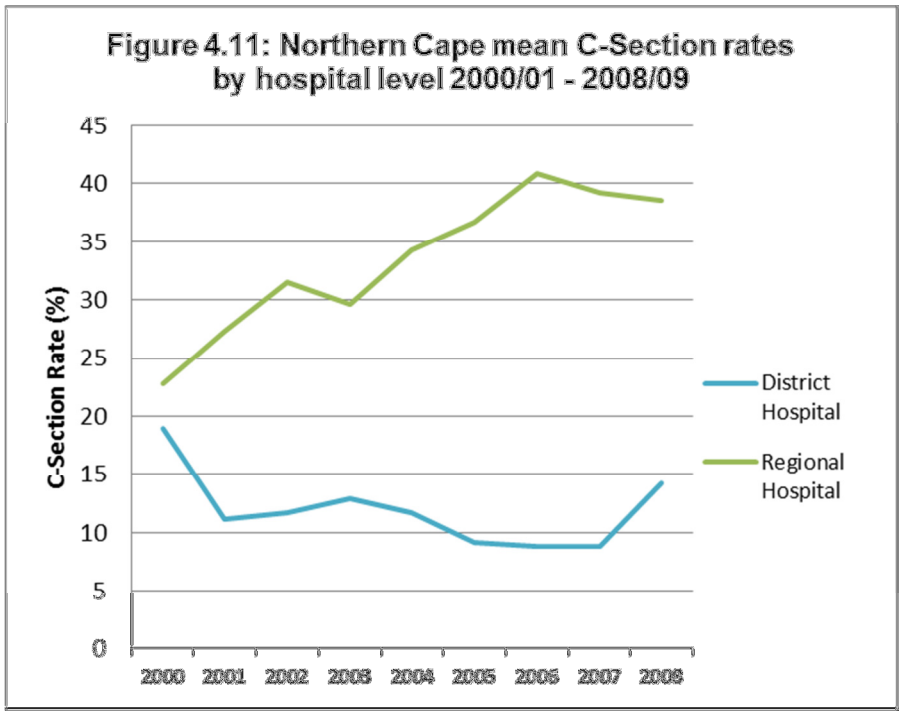
provinces. Whilst the mean C-section rates of the three districts have remained closely grouped over the last nine years, the mean C-section among the three levels of hospitals in this province vary. This is illustrated in Figure 4.10 and demonstrates that whilst the Regional and District Hospital average C-section rates and trends are fairly close, the Provincial Tertiary Hospital rates are much higher. Within this level are two hospitals, Witbank and Rob Ferreira Hospitals which show widely differing rates and trends, with the latter showing a downward trend in the last two years.



Northern Cape

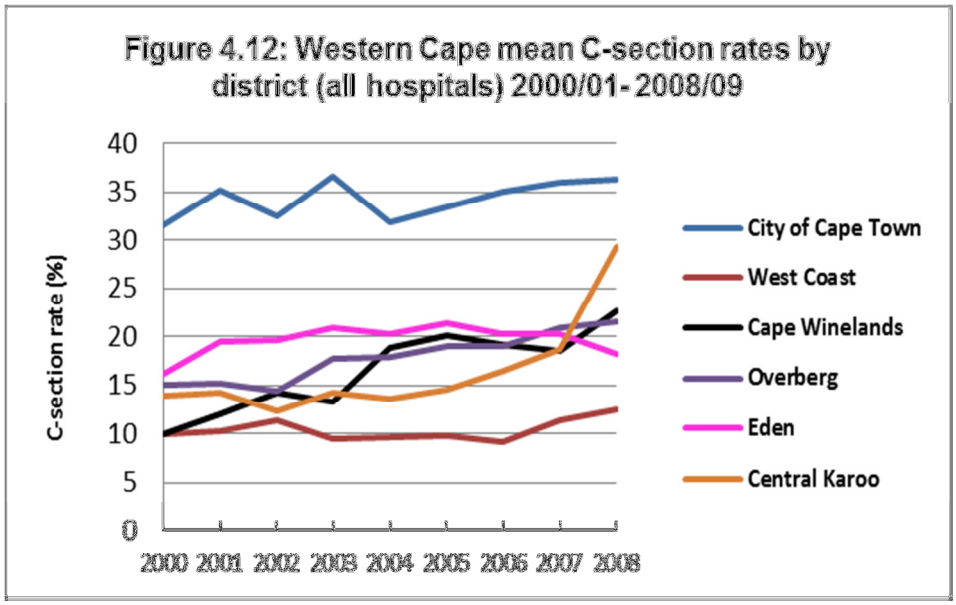
The increase in mean C-section rates in the province is mostly contributed by two Regional Hospitals (Figure 4.11), whilst many of the District hospitals recorded very low, dwindling or no C-sections over the nine years, which contribute to the decreasing average C-section rate for this level of hospitals.

John Taolo Gaetsewe District recorded a decrease in C-section rate with a negative average compound growth rate of -1.5% per annum. Both District Hospitals in this district show dwindling or low static rates. The five District Hospitals in Pixley ka Seme District recorded a -0.1% average compound growth rate in mean C- section rate over the nine years, with De Aar Hospital recording the majority of C-sections and deliveries in the district, suggesting that in this district, this is the only hospital that provides a consistent C-section service.



Western Cape

City of Cape Town Metropolitan Municipality consistently recorded the highest C-section rates over the nine years, from 31.5% to 36.3% (Figure 4.12). The high rates are contributed by the Specialised Maternity hospital, Mowbray Maternity Hospital, the two National Central Hospitals, Tygerberg and Grootte Schuur and the two Regional Hospitals, Helderberg and Somerset Hospital and Khyelitsha District Hospital, which are all situated in the metro.



4.2.3 Regression analysis

A Bivariate linear regression analysis was done to determine how and to what extent the C-section rate varies as a function of time (year). A regression done of year against the C-section rate of all hospitals, weighted by number of births, yielded the following results as seen in Table 4.15. The results confirm that there is a positive linear relationship between time (year) and the C-section rate ($p<0.001$), where the C-section rate is predicted to increase by 0.76% with each increasing year. The residual ($R^{2)}$ is low, (0.027) meaning that very little of the variance (2.7%) seen in the C-section rate can be accounted for by the year.

Table 4.15 Regression table of year against C-section rate for all hospitals

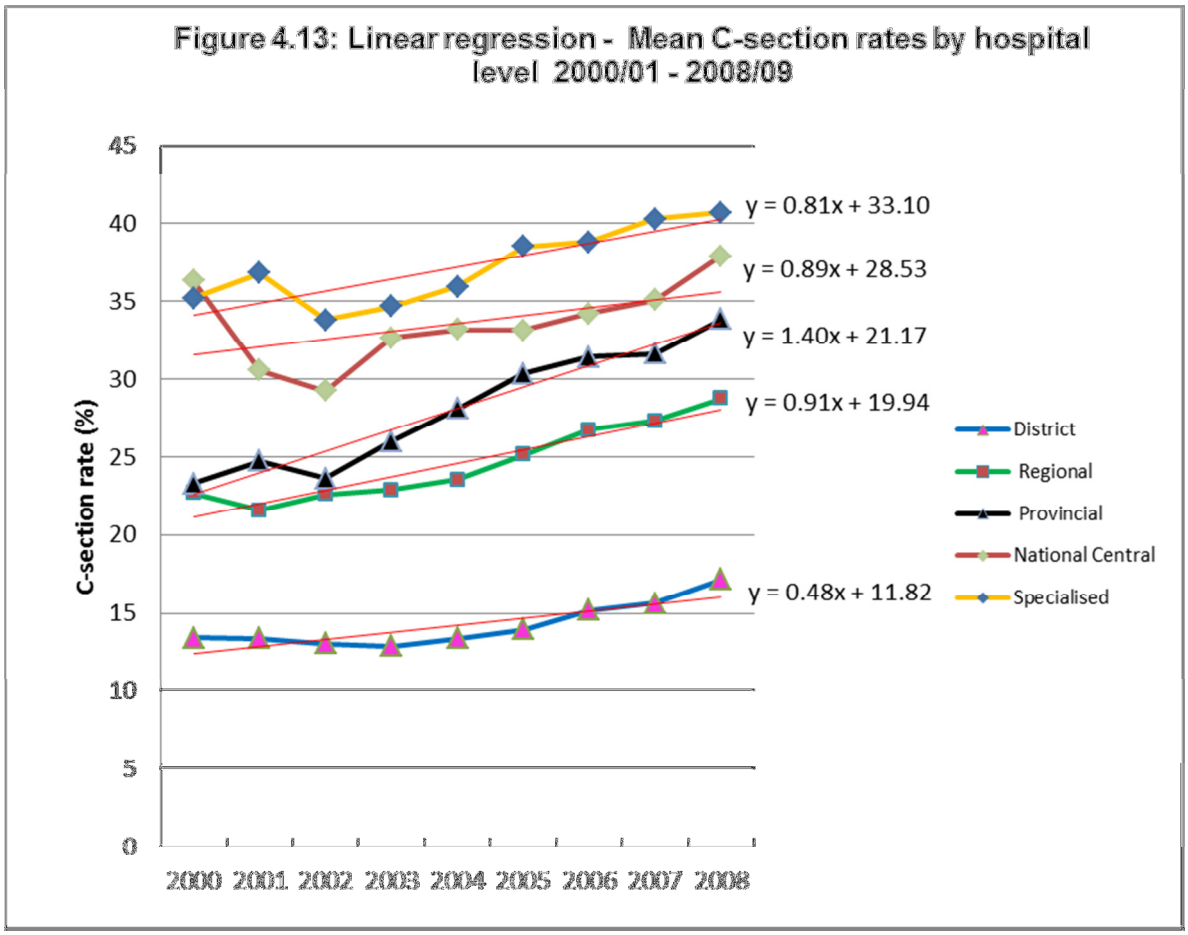
Variable	N (births)	R-squared	Constant	b-coefficient	P-value
CS-rate All hospitals	5740670	0.027	16.689	0.756	<0.001

Separate linear regressions done for each level of hospital individually (weighted by number of births in each case), yielded the results as summarised in Table 4.16 and as illustrated in Figure 4.13.

Table 4.16: Summary table of linear regression done of year against C-section rate for each level of hospital

Variable	P-value	N(births)	R-squared	b-coefficient	Constant
CS-rate District Hospitals	<0.001	2852133	0.021	0.479	11.816
CS-rate Regional Hospitals	<0.001	1925494	0.051	0.914	19.942
CS-rate Provincial Tertiary Hospitals	<0.001	460290	0.081	1.400	21.169
CS-rate National Central Hospitals	<0.001	434089	0.050	0.889	28.526
CS-rate Specialised Hospital	<0.001	68664	0.746	0.810	33.096

The results show that for each level of hospital there is a positive linear relationship between the independent variable, year, and the dependent variable, C-section rate ($p<0.001$). The mean C-section rate of each level of hospital is thus significantly affected by each increasing year, with the rate in Provincial Tertiary Hospitals having increased by the highest amount (1.40%) year on year, and District Hospitals the least (0.48%).



Multiple linear regression analysis was done to look at the C-section rate over time (by year), adjusted for two independent variables, province and level of hospital.

The results (Table 4.17), show that for the 5.74 million deliveries which took place over the nine years, year, province and hospital level had a significant and positive effect on the C-section rate, ($p<001$) and 46% of the variance in C-section rates could be explained by the model. The b-coefficient, (slope) signifies the magnitude of the effect on the C-section rate and indicates the increase in C-section rates in other provinces compared to the Eastern Cape and how the rate differs in other levels of hospital compared to District Hospitals. All b-coefficients were positive, indicating that the C-section rates were predicted to be higher in all other provinces compared to the Eastern Cape and all other hospital levels compared to District Hospitals.

After adjusting for year on year variation and hospital type, the C-section rate in KwaZulu-Natal is predicted to be 8.8% higher than that in the Eastern Cape and Western Cape is next at a 6.2% higher rate. The rate in Gauteng is predicted to have the smallest difference to the rate in the Eastern Cape at 0.8%.

After adjusting for annual variation and province, the C-section rate in Regional hospitals is predicted to be 10.2% higher than District Hospitals, whilst the rate in National Central hospitals is 21.2% higher.

Table 4.17: Multiple linear regression table of the effect of Year, Province and Type on C-section rate

Variable	b-coeff.	95% conf. Interval			P-value
Year	0.797	0.794	-	0.800	<0.001
Eastern Cape					
Free State	6.028	5.993	-	6.063	<0.001
Gauteng	0.085	0.056	-	0.114	<0.001
KwaZulu-Natal	8.795	8.771	-	8.820	<0.001
Limpopo	1.465	1.437	-	1.493	<0.001
Mpumalanga	0.310	0.279	-	0.341	<0.001
North West	3.288	3.250	-	3.326	<0.001
Northern Cape	5.409	5.356	-	5.462	<0.001
Western Cape	6.209	6.175	-	6.243	<0.001
District Hospitals					
Regional Hospitals	10.187	10.170	-	10.203	<0.001
Provincial Tertiary Hospitals	15.722	15.694	-	15.750	<0.001
National Central Hospitals	21.222	21.190	-	21.254	<0.001
Specialised Hospital	20.619	20.550	-	20.688	<0.001
N (no. of births)=5 740 670, Constant=6.336, p<0.001, R-squared = 0.464					

4.3 The relationship between C-section rate in a district and the level of deprivation of the population.

In order to ascertain whether women who live in poorer areas and communities in the country receive similar access to C-section rate services as those who live in better resourced and wealthier districts, one needs to compare a measure of deprivation, such as a deprivation index (DI) against the mean C-section in a district. The measure of the deprivation of a population in a district used for this purpose was the 2007 Deprivation Index (DI)[9]. In sections 4.3.1 to 4.3.2 that follow, the average weighted C-section rates (all hospital levels) per district are compared by the DI, to investigate if there is a correlation.

4.3.1 District C-section rates compared by DI

The results of the correlation test showed that the correlation between the mean C-section rate per district and the DI was -0.214, with p = 0.130. The correlation coefficient is negative indicating that the C-section rate decreases as the DI increases. However, this correlation is thus not significant because the p value is greater than 0.05. This means that when looking at the whole country at district level, women who live in the more deprived areas, (with a higher DI) have lower C-section rates than women who live in wealthier areas, but the difference is not statistically significant. A scatter plot showing the C-section rate values of 51 districts versus the DI is presented in Figure 4.14. and a Box and Whisker plot of C-section rate by socioeconomic quintile can be seen as Figure 4.15.

Figure 4.14: Scatter plot of C-section rate and Deprivation Index by district, 2007

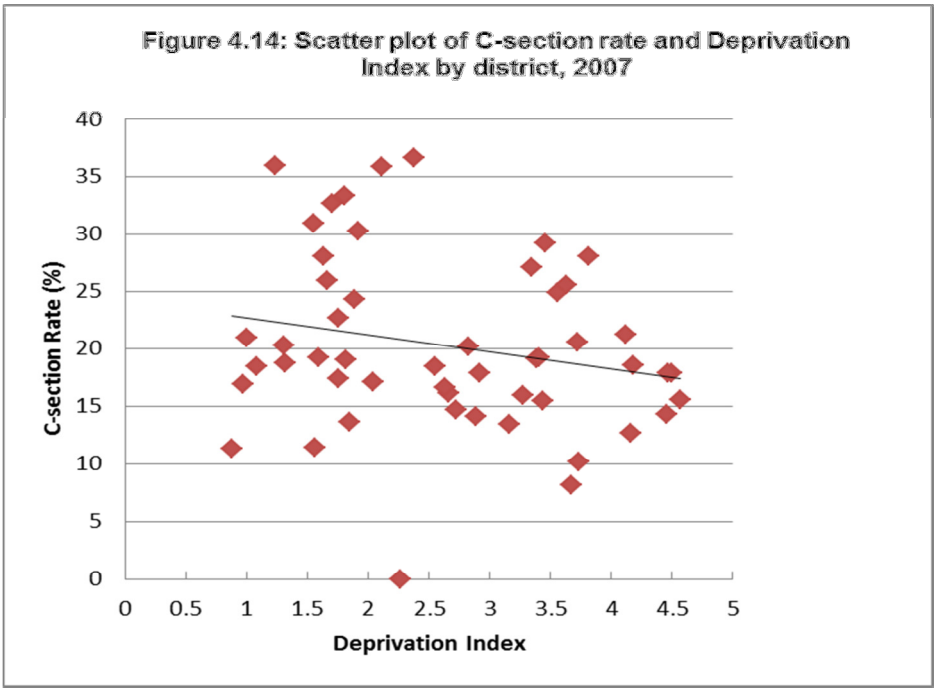
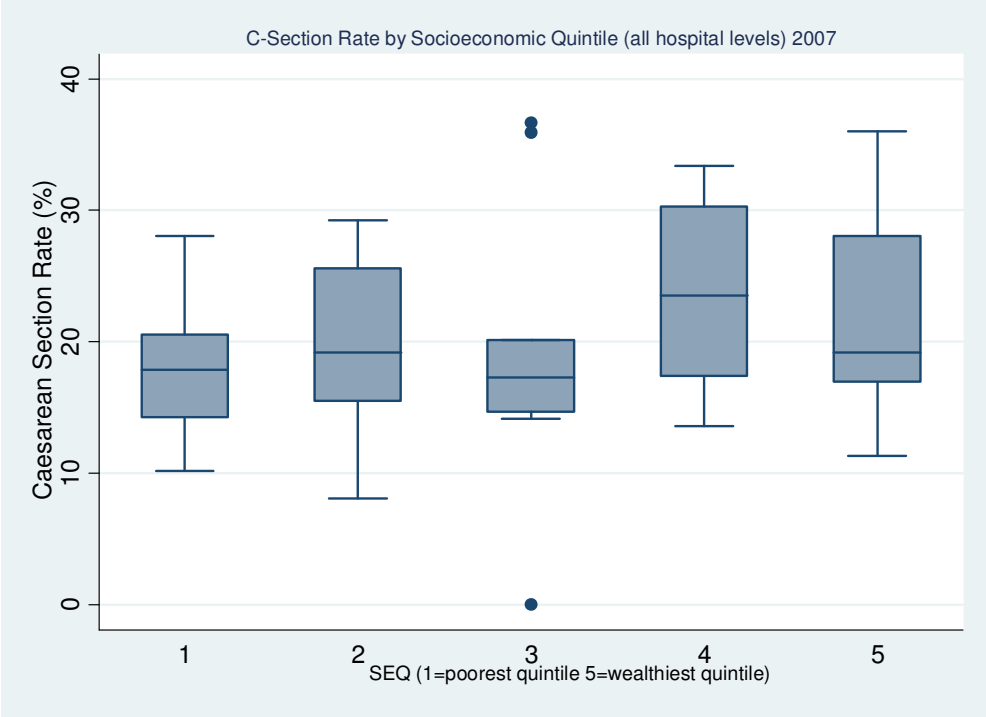


Figure 4.15: Box and whisker plot illustrating the average C-section rate for all hospitals by Socio-economic quintile, 2007



The results of the regression test done for the DI against C-section rate (Table 4.18) , revealed that there is no association between the two variables across the 51 districts (p=0.130) and predicts a negative slope through the model (b-coeff = -1.498) with a 95% confidence interval ranging from -3.454 to 0.457.

Table 4.18 Linear regression table of C-section rate in districts against DI

N (no. of districts)	b-coeff.	95% conf. interval		p-value	R-squared
51	-1.499	-3.455	0.457	0.130	0.046

However, the non-significant result should be interpreted with caution as the small number of districts for analysis (n=51) may result in power problems.

4.3.2 Multiple regression analysis of mean C-section rate of districts, DI, and province

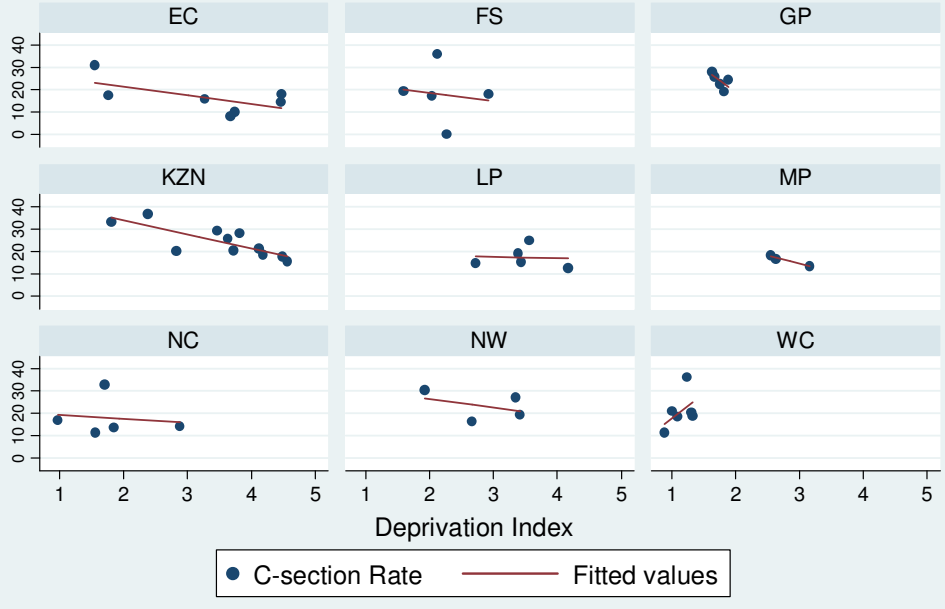
In a different approach, a multiple regression analysis was done, to determine the effect of province and DI on the C-section rate while adjusting for the effect of province. (Table 4.19)

Table 4.19: Multiple linear regression table of the effect of province and DI on average district C-section rates.

Variable	b-coeff.	95% Conf. Interval		P-value
DI	-4.246	-7.224	-1.268	0.006
Eastern Cape				
Free State	-2.991	-11.776	5.795	0.496
Gauteng	1.170	-8.172	10.511	0.802
KwaZulu-Natal	9.024	2.231	15.817	0.010
Limpopo	1.732	-6.453	9.918	0.671
Mpumalanga	-2.331	-12.070	7.408	0.631
North West	4.939	-3.902	13.780	0.266
Northern Cape	-4.921	-14.204	4.361	0.291
Western Cape	-4.501	-14.534	5.532	0.370
Constant	30.301	19.217	41.386	0.000
N (no. of districts)=51 p=0.044 R squared=0.323				

The overall regression model is statistically significant (p=0.04). However, a more complex pattern emerges. After adjusting for provincial differences in the regression, there is a significant relationship between DI and C-section rate (p=0.006). This may be explained by the fact that in eight out of the nine provinces the relationship is negative, meaning that as the DI increases (more deprived population) the C-section rate decreases. This is illustrated in Figure 4.16 below.

Figure 4.16: Multiple regression of C-section rate and DI by province, 2007



4.4 C-sections and deliveries in Community Health Centres

Previous analyses and results so far have looked only at the C-section rate in public sector hospitals. The results discussed below look at the number of deliveries which take place in public sector Community Health Centres (CHCs) in the country in addition to those in hospitals and assesses if these have an impact on the C-section rate.

Whilst the majority of deliveries which occur in public sector facilities are in hospitals, there are records of deliveries which take place in CHCs in the DHIS. There is no differentiation between those CHCs which have a 24 hour maternal obstetric unit (MOU) available and those without, or if the CHC is attached to a District Hospital, although all deliveries and also C-sections that occur in CHCs are meant to be recorded in the DHIS.

Overall, 108 958 (13%) of all deliveries recorded in 2008/09 occurred in CHCs and over half (55.7%) of all deliveries recorded, were at a primary level of care (CHCs + District Hospitals), with the balance occurring at secondary and tertiary levels of care.

Table 4.20: Percentage of deliveries in CHCs compared to hospitals 2008/09

Province	Community Health Centre	District Hospital	Regional Hospital	Provincial Tertiary Hospital	National Central Hospital	Specialised Hospital	Total
Eastern Cape	10.8%	49.8%	8.5%	31.0%	-	-	100.0%
Free State	5.8%	60.9%	32.1%	-	1.3%	-	100.0%
Gauteng	21.4%	16.3%	39.2%	-	23.1%	-	100.0%
KwaZulu- Natal	6.3%	47.2%	39.3%	7.0%	0.2%	-	100.0%
Limpopo	5.4%	66.2%	19.9%	8.4%	-	-	100.0%
Mpumalanga	14.4%	58.5%	16.7%	10.5%	-	-	100.0%
North West	37.2%	32.2%	30.6%	-	-	-	100.0%
Northern Cape	28.4%	41.0%	30.7%	-	-	-	100.0%
Western Cape	3.2%	38.4%	27.2%	-	17.4%	13.8%	100.0%
Grand Total	13.0%	42.7%	29.0%	7.4%	6.8%	1.1%	100.0%

Overall in South Africa, 55.7% of deliveries took place at a primary level (13.0% in CHCs + 42.7% in District Hospitals). In the Eastern Cape, more deliveries took place in CHCs than in Regional Hospitals and the proportion of deliveries at a primary level of care was 60.6%. In Gauteng, the least amount of deliveries for the province, 16.3%, were recorded in District Hospitals, whilst 21.4% occurred in CHCs and most deliveries occurred at secondary and tertiary levels of care (62.3%). North West Province recorded the highest proportion of deliveries in CHCs within a province, (37.2%). The lowest proportion of deliveries in CHCs

was in the Western Cape (3.2%), with 13.8% of deliveries occurring in the Specialised Maternity Hospital.

When comparing total deliveries by facility type, Gauteng and North West recorded the largest number of deliveries in CHCs among provinces, 41 301(37.9%) and 188 08 (17.3%), respectively, whilst Western Cape 2 177(2.0%) and Free State 2 278 (2.1%) recorded the least.

4.4.1 C-sections and C-section rate by facility type including CHCs, 2008/09

Very few (63) C-sections were recorded in CHCs in the DHIS for 2008/09, resulting in a 0.1% C-section rate[vi]. It is possible however, that there may have been many more deliveries by C-section in CHCs, but these were not recorded in the DHIS by the data capturers and health personnel, possibly due to the fact that they are not aware that they should be recording this data as part of the minimum data set for the CHC.

If the number of deliveries in CHCs is taken into consideration, the national C-section rate for all hospitals nationally drops from 24.4% to 21.1% (Table 4.21). This is considered to be a more accurate reflection of the C-section rate, as it includes a larger target population of deliveries, closer to the WHO C-section rate definition which includes deliveries among all live births in a given time period.

Table 4.21: C-section rate by province including and excluding deliveries in CHCs, 2008/09

Province	Weighted mean C-section rate % (all hospitals)	C-Section rate % (all hosp incl births in CHCs)	Percentage point difference
Eastern Cape	22.8	20.4	2.5
Free State	25.4	24.0	1.5
Gauteng	26.0	20.4	5.6
KwaZulu- Natal	28.0	26.3	1.8
Limpopo	17.2	16.3	0.9
Mpumalanga	17.0	14.6	2.4
North West	26.6	16.7	9.9
Northern Cape	24.7	17.7	7.0
Western Cape	29.1	28.2	0.9
South Africa	24.4	21.1	3.3

[vi] All 63 were recorded in Limpopo Province

The effect is more pronounced when comparing the C-section rates by individual province. When including deliveries in CHCs, the weighted mean C-section rate in some provinces drops considerably, (Table 4.21). The mean C-section rate in Gauteng province for instance, drops by 5.6 percentage points to from 26.0% to 20.4%, in North West Province the rate decreases from 26.6% to 16.7% and in Northern Cape Province the rate decreases from 24.7% to 17.7%.

The overall C-section rate of primary level care (when excluding the Regional, Provincial Tertiary, National Central and Specialised Hospitals) drops from 17.2% to 13.2% when including the number of deliveries which rake place in CHCs, (Table 4.22). The largest effect is in provinces with a high proportion of CHC deliveries such as in Gauteng, where the average C-section rate drops by 9.2 percentage points to 6.9%, North West province from 15.9% to 7.4% and in Northern Cape 14.3% to 8.4%. Only two provinces, KwaZulu-Natal and Western Cape have mean C-section rates at level 1 care, which are above 15%.

Table 4.22: C-section rate at primary level of care by province, with and without deliveries in CHCs, 2008/09

Province	Number of C-Sections	Number of Deliveries	C-section rate District Hospitals only (%)	C-section rate Primary Level Care (DH+CHC) (%)	Percentage point difference
Eastern Cape	7 011	52 242	13.4	11.0	2.4
Free State	3 529	24 045	14.7	13.4	1.3
Gauteng	5 045	31 336	16.1	6.9	9.2
KwaZulu- Natal	20 369	89 202	22.8	20.1	2.7
Limpopo	10 141	68 774	14.7	13.6	1.1
Mpumalanga	6 348	42 734	14.9	11.9	2.9
North West	2 582	16 251	15.9	7.4	8.5
Northern Cape	1 032	7 240	14.3	8.4	5.8
Western Cape	5 438	26 165	20.8	19.2	1.6
Total	61 495	357 989	17.2	13.2	4.0

When considering the mean C-section rates nationally and at province level, deliveries which occur in CHCs must be taken into account when looking at the C-section rate at primary level of care, as this gives a far more realistic picture.

However, the variation in C-section rates between the provinces widens at primary level care, with there being a 2.9 fold difference between the rate in KwaZulu-Natal (20.1%) and

Gauteng (6.9%) as compared to the 1.7 fold difference seen in the rates between KwaZulu-Natal and Eastern Cape provinces in District Hospitals.

Chapter 5: Discussion

This detailed analysis done of the C-section rate in public sector facilities over the nine years 2000/01 -2008/09, has led to a number of observations which include:

1. Wide variation in C-section rate is evident between individual facilities, between and within provinces and districts and within the different levels of hospitals in 2008/09
2. C-section rate trends between 2000/01 and 2008/09 are increasing
3. Data quality of C-sections and deliveries in the DHIS needs improving
4. A strong relationship between level of deprivation and C-section rate exists when adjusting data for provincial variation**.**

Each of these observations is discussed in detail in the sections that follow.

5.1 Wide variation in C-section rate, 2008/09

Variation is evident when comparing the C-section rates between individual facilities, between and within provinces and districts and within and between the different levels of hospitals. Wide variation in rates affects the ability to plan the delivery of resources effectively and raises concerns that women are either not receiving the care they need or that C-sections are being done unnecessarily, thus burdening the health system's limited resources.

Variation between hospital levels.

The mean weighted C-section rate in 2008/09 ranges from 17.2% in District Hospitals, 28.8% in Regional hospitals, 33.9% in Provincial Tertiary Hospitals, 37.9% in National Central Hospitals and 40.7% in Specialised Maternity Hospitals. There are no formal guideline C-section rates by level of hospital published by the National Department of Health, and so one cannot be clear as to if the actual rates seen are appropriate for each hospital level or not. The closest to a guideline rate available, are the rates which are set out in the National Indicator Data Set (NIDS) and which provide no indication as to how they were derived or if these values are based on evidence based research. Table 5.1 compares the mean weighted C-section rates by level in 2008/09 as obtained from this analysis, versus the guideline rates from the NIDS.

For District, Regional and Provincial Tertiary level Hospitals the guideline rates are somewhat lower than the actual, but for National Central (academic) and Specialised level of

care they are a lot higher. These guideline rates are actually not useful at all and Hospital, District and Provincial managers need to have clear and evidence-based guideline rates in order to manage and plan for the C-section rates in their respective areas.

Table 5.1: Weighted mean C-section rates per level of hospital 2008/09 compared to NIDS

Hospital Level	NIDS	Actual Rate 2008/09
District	15%	17.2%
Regional	25%	28.8%
Provincial Tertiary	30%	33.9%
National Central	50%	37.9%
Specialised	50%	40.7%

As we have a unique set of circumstances in South Africa. Besides investigating international trends and recommended rates, research is needed into each level of hospital in South Africa in order to recommend appropriate rates for the country. This would involve statistical analyses of current and historical data sets of routinely collected data on deliveries and C-section rates as well as qualitative research to identify and understand unique situations that exist across the country. As international literature shows[24,25,26], there is no optimal rate, but there is evidence that rates do differ between different types of hospitals[41].

The suggestion is that once the research has been analysed, optimal ranges could be suggested by level of hospital, based on the evidence collected. For example, one could use one standard deviation from the mean as being the acceptable range and highlight an alert for any rates that fall outside of this. Or, as was done in Brazil[31], an upper limit for C-sections could be determined for all public sector hospitals.

Variation between and within districts.

Among District Hospitals, a 3.7 fold difference between the highest and lowest district average C-section rates is seen. Inter-district variation in Regional hospital C-section rates showed a 3.3 fold difference between the lowest and highest district weighted mean C-section rates.

The reasons for these wide differences among districts can be various. Each district has a unique set of circumstances, resources, infrastructure and management. It is well documented that some districts are under-resourced (particularly some rural districts), with limited

facilities, staff and equipment being available[53]. As argued by Gaede and Versteeg in the recent South African Health Review 2011[54], the cost of providing C-sections in rural hospitals is proportionately higher than in non-rural hospitals but concerns about cost and workload should not dictate the availability of these services. It is of utmost importance that the National Department practices equitable resource allocation as far as possible. This means that the poorer districts and rural areas should receive extra resources (equity) and not the same amount or equal resources (equality) as other districts.

Resource allocation may also be a contributor to intra-district variation, such as is seen in Cape Town Metropolitan Municipality, with a 58.9 percentage point difference between the highest and lowest rates among District Hospitals, the widely differing rates seen between Regional Hospitals in Cape Winelands, Ekurhuleni and eThekweni districts and wide variation seen between Provincial Tertiary Hospitals in OR Tambo and Capricorn districts.

Variation between facilities

Nationally, by facility, the C-section rate in the 199 District Hospitals ranged from 0.2% to 59.2% and from 11.2% to 61.9% in the 47 Regional hospitals. Amongst districts with more than one Regional Hospital, wide differences in the minimum and maximum C-section rates were seen between facilities. Amongst Provincial Tertiary Hospitals wide differences between individual hospital C-section rates within provinces were observed in Eastern Cape, Mpumalanga and KwaZulu-Natal, as well as in Capricorn District in Limpopo Province. Among the eight National Central Hospitals there is a 2.5 fold difference between the highest (79.7%) and lowest (31.7%) facility C-section rates. Nationally a total of 23 District Hospitals had C-section rates below 5% and nine hospitals of varying levels had rates of over 50%

The variation could be attributable to a number of contributing factors. Besides different levels of availability of resources and staffing being available per facility, differing degrees in the quality of obstetric care also plays an important role in the delivery of C-sections[17]. The extent to which the Department of Health's Women's Health and Genetics Directorate policy documents and guidelines[1,35,36] are adapted and implemented in each facility has an influence on the quality of emergency maternal care that is provided in a facility and thus directly affects the provision of C-sections. The NCCEMD report identified problems with emergency obstetric care provided by health workers in a number of hospitals at all levels of care and has made ten key recommendations[2], four of which are relevant to the provision of

C-sections. It depends on the individual facility to what extent protocols on management of important conditions causing maternal deaths are available, if they are able to conduct training on anaesthetic and surgical skills of doctors and if there are established criteria for referral and referral routes and emergency transport facilities, or to what extent they ensure the availability for blood for transfusions.

As noted in international literature, case mix differences[42], physicians individual practice styles[43], and delays in seeking, accessing and receiving quality of care[46] also affect the C-section rate in facilities. In South Africa, it is highly probable that the case mix of women requiring C-sections is different at each level of care, with the tertiary and academic hospitals dealing with the most complicated cases, as advised in the Guidelines for Maternity care in South Africa 2007[36]. This however, is highly influenced by the local referral patterns. Lack of resources or expertise at a District Hospital level may cause many of the straightforward cases to land up in secondary or even tertiary care. One can thus not assume that a homogenous pattern exists, with the case mix of each level of care being similar throughout the country.

The 23 District Hospitals that recorded C-section rates, below 5% are of concern. This rate is below what is considered to be adequate for maternal health delivery[14]. The results show that where the rates are very low in certain of these District Hospitals, the C-section rates in the Regional hospitals in those districts are unusually high, suggesting that women are referred to this higher level of hospital. The NCCEMD report also suggests that it is advisable for women to undergo C-sections at a Regional Hospital rather than at a District Hospital if it is known that there are inadequate resources at the District Hospital, thus decreasing the chances of maternal mortality[2]. A specific example of this is in Thabo Mofutsanyane District in Free State Province where Phumelela District Hospital, Phuthuloha District Hospital, Itemoheng District Hospital and Nketoana District Hospital all have C-section rates of 2.1% or lower. Conversely the C-section rates in the two Regional hospitals in this district are amongst the highest rates in the province (45.3% and 61.9%), suggesting that these hospitals are carrying the load of C-sections that should be provided in the District Hospitals. Referral of women to a higher level of hospital in order to ensure that they receive the care that they require, will however impact on the costs to the health system.

Very high C-section rates, those higher than the rate recommended for National Central Hospitals (50%) are also of concern, particularly for lower levels of care. International

studies have found that rates significantly in excess of 15% at a primary care level are a burden to the health system and may represent unnecessary risk to mother and child.[28,29] The nine hospitals that recorded C-section rates above 50% in 2008/09, included one District Hospital in Western Cape Province, two Regional Hospitals in Free State Province, two Provincial Tertiary Hospitals (Eastern Cape and KwaZulu-Natal) and four National Central Hospitals (KwaZulu-Natal, Free State, Gauteng and Western Cape). It is possible that although the DHIS classifies these hospitals as a certain level, they may in fact be functioning as a higher level hospital. For example, the Provincial Tertiary hospital, Nelson Mandela Academic Hospital in the Eastern Cape (C-section rate =77.7%) has recently been reclassified to a National Central Hospital in the Recent Government Notice of 12 August 2011[50]. Another possible reason for excessively high C-section rates, is that these hospitals may be situated in catchment areas that have a high antenatal HIV prevalence. It could also mean that they are simply the only hospital in the area with sufficient resources and skills to deal with complicated cases requiring C-sections and thus attend to all the referrals of neighbouring hospitals.

It is doubtful whether patient demand or physician preference are drivers of high C-section rates in public sector facilities in South Africa as they are in the private sector[38,39] and in certain other countries such as in China and Brazil[30,41]. The high HIV prevalence rate however does contribute to higher C-section rates as studies have shown that C-sections have a protective effect by lowering the risk of mother-to-child transmission of HIV infection during childbirth[33,34] . KwaZulu-Natal province registered the highest HIV prevalence in 2008 (38.7%) and nine of the eleven KwaZulu-Natal districts fell in the top ten HIV prevalence rates in the country. It is not surprising therefore that KwaZulu-Natal had the highest average C-section in District Hospitals of all the provinces and that five of its eleven districts fell into the ten highest district C-section rate values in the country.

5.2 C-section rate trends between 2000/01 and 2008/09 are increasing

The mean weighted C-section rate for South Africa increased by 6.3 percentage points from 18.1% in 2000/01 to 24.4% in 2008/09, with an average annual compounded growth rate of 3.8%. This increasing trend is not unique to South Africa as trends in C-sections are increasing throughout the world, both in developed and developing countries[31].

On average, all levels of hospitals showed an increasing trend in C- section rates over the nine years. The largest increase in C-section rate was seen in Provincial Tertiary Hospitals from a rate of 23.3% in 2000/01 to 33.9% in 2008/09 with and ACGR of 4.8%. The smallest increase in C-section rate was in District Hospitals (13.5% to 17.2%) with an ACGR of 3.1%.

An increasing trend in C-sections will result in an inevitable additional burden and demand on the health system, especially in the training and deployment of health professionals, infrastructural requirements and service requirements. The average unit cost for maternity patients was found to be more than double the average unit cost for medical patients in a study done in District Hospitals in South Africa[40] and therefore increasing C-section rates will no doubt have an influence on cost. This will be an important factor to consider in the planning and implementation of the National Health Insurance.

Although generally the C-section rate has increased between 2000/01 and 2008/09, variation in trends is evident throughout the country. The extent of variation in certain instances is of concern. The District Hospital C-section rate trend and values in districts in the Eastern Cape and Western Cape, for instance, show much higher values and sharper upward trends in the metro districts, compared to other districts in the province. This may suggest that the better resourced metro areas may be providing services which are not available in non-metro and rural areas.

There are five districts in the country which recorded decreasing District Hospital C-section rates over the nine years with negative average compound growth rates. These were Xhariep District in Free State Province, John Taolo Gaetsewe, Pixley ka Seme and Siyanda districts in Northen Cape Province, and Dr Kenneth Kaunda in North West Province. It is not clear if these decreasing trends are due to a lack of services or poor data quality, although in Xhariep and Siyanda districts there were zero values and missing records for all District Hospitals for the most recent years. Further investigation in to the reasons of poor quality of data and dwindling C-section rates is urgently needed in order to ascertain if pregnant women in these districts are receiving adequate care.

The diverging C-section rate trends between different levels of hospitals in a province such as in the Northern Cape, where the rate for District Hospitals is dwindling whilst the rate in Regional hospitals is increasing, may suggest inadequate resources at District Hospital level and unnecessary referral to a higher level of care.

The reasons for wide variation in trend and rates between hospitals of the same level in a province, such as is seen between the two Provincial Tertiary Hospitals in Mpumalanga, are unclear. Monitoring the diverse trends on their own is insufficient to give evidence for future resource planning and to ensure that pregnant women receive appropriate tertiary-level care in this province. Further qualitative and investigative research at facility level is needed.

There are a number of actions that could to some extent aid in curbing the upward trend in C-sections, particularly at a primary level of care, by ensuring that women in the community are educated, that their access to care is improved and that the level of care they receive is optimised. This may be possible with the implementation of the recent proposed policy of Re-engineering of Primary Health Care in South Africa, where the NDOH plan on adopting a three stream priority approach to strengthen PHC.[55,56] Two of these streams have potential for ensuring improved service delivery and care of pregnant women.

These are:

- Deployment of ward based PHC outreach teams; and
- Deployment of district based clinical specialist teams.

Deployment of ward based PHC outreach teams: These outreach teams will be made up of PHC nurses, Community Health Workers and where possible a health promoter and an environmental health practitioner. Regular visits by this team to all households in their catchment has potential for pregnant women in the community to be educated and supported regarding pregnancy and childbirth, and to ensure that they attend antenatal care services at their nearest clinic from 20 weeks onwards. This could to some extent reduce the number of women who present late with complications.

Deployment of district based clinical specialist teams: The need to improve the quality of clinical care within most health districts has led to plans to deploy district based clinical specialist teams. Experienced clinicians will be appointed to oversee and strengthen the quality of care at district level, starting with maternal and child health, by supervising, supporting and mentoring existing personnel. The team will include a gynaecologist, a paediatrician, an anaesthetist, a family physician, an advanced midwife, an advanced paediatric nurse and a PHC trained nurse. These increased resources will no doubt assist in reducing the number of pregnant women who may develop complications as a result of late

presentation or poor clinical care leading to the need for a C-section. It may also result in an increase in C-section rates in certain facilities which are currently unable to provide sufficient C-sections due to lack of resources, thereby ensuring that all women who need a C-section receive one. It is hoped that the presence of these teams will ensure that there will be adequate resources and clinical guidance available in cases where C-sections are required, thus preventing unnecessary referral or adverse outcomes.

5.3 Data quality of C-sections and deliveries in the DHIS needs improving

With the DHIS currently being the national tool used to monitor the C-section rate in the public sector, it is important that the information that it provides is as accurate and useful as possible for decision making purposes. The definition used for of C-section rate at a primary health care level needs to be revised. In addition, the overall quality (collection, checking and validation) of data relating to C-sections in DHIS needs to be improved as does the availability of indicators we use to monitor emergency obstetric care. Each of these three areas will be discussed in the sections that follow.

The definition of C-section rate at a primary health care level requires revising

Currently when considering the C-section rate in the public health sector at primary health care level, the norm is to look at the C-section rate in District Hospitals[9]. However, deliveries and C-sections also occur in other facilities such as CHCs, MOUs and even some Community Day Centres. Unfortunately the data obtained from the DHIS 2000/01 to 2008/09 only recorded deliveries in CHCs in addition to those in hospitals. The results of the study show that when these deliveries in CHCs are taken into account, they contributed 13% to total deliveries recorded in the DHIS in 2008/09. The mean national C-section rate, reduces from 24.4% to 21.2% when deliveries in CHCs are included in the denominator.

At a primary care level, the national rate drops from 17.2% to 13.2%. Overall, with the exception of KwaZulu-Natal and Western Cape, all provinces show mean C-section rates at primary level of care of below 15% in 2008/09, when deliveries in CHCs are taken into account. The largest difference is seen in Gauteng province, where the rate drops from 16.1% to 6.9% when deliveries in CHCs are taken into account.

This on its own is significant, but if the DHIS were improved to also record the deliveries which take place in other facilities such as Community Day Centres and MOUs, a much more accurate figure of the C-section rate at primary level would result.

Data quality in the DHIS

The DHIS is a database of routinely collected health sector data and is not a dataset designed to collect or test C-section rates specifically, but collects a wide range of health related data. It is therefore impossible to adjust for confounders. Routinely collected data also has its limitations, as differential reporting due to resource issues, data capture errors and inaccurate data for denominators and duplications will cause values for a number of hospitals to be invalid or unavailable.

Analysis is affected by errors in classification of hospitals. For instance Nelson Mandela Academic Hospital is classified as a Provincial Tertiary Hospital in the DHIS. It has a very high C-section rate for this level of hospital in 2008/09 of 77.7%, causing it to seem like an outlier, but a recent check has found that the hospital has been reclassified as a National Central Hospital.

Missing hospital records, zero values and inconsistent values for deliveries and C-sections across the nine years, leave uncertainty whether the trends of a particular hospital are accurate or not. For instance, it is not clear if the decreasing trends caused by zero values and missing records of District Hospitals in Xhariep and Siyanda districts are due to a lack of services or poor data quality. The District Health Barometer reported that the reason for no recorded C-sections in the last three years for Xhariep were due to the fact that C-sections are not performed there due to a shortage in doctors[9], however there is no information about the reasons for missing records for Siyanda. The lack of district information officers in certain districts may also contribute to missing data and gaps.

Availability of indicators to monitor emergency obstetric care

The C-section rate on its own as collected in the DHIS, is inadequate to describe or monitor with any accuracy the service delivery picture of emergency obstetric care in South Africa.

The UN[6] have recommended five additional process indicators to the C-section rate (Table 2.1) for monitoring access to emergency obstetric care, but as pointed out in the South African Health Review's Maternal Health chapter[20], there is no data available nationally to measure the availability, or the unmet need thereof.

The UN's six EOC[6] process indicators have been used successfully in a wide variety of settings and countries and are of relevance in the South African context as they can add to the understanding of the provision of EOC. Two of the indicators namely, *availability of EOC facilities* and *geographic distribution of EOC facilities,* measure the availability of emergency obstetric care services. Three indicators measure the utilisation of these services, which are; *proportion of expected births delivering in EOC facilities, met need for EOC and C-sections as a proportion of all births*. One indicator addresses the quality of care provided – *Case fatality rate of EOC facilities.*

However, adding these indicators (besides C-section rate which is already in place) to the DHIS data set, and monitoring them on a regular basis is not an easy task, and perhaps is also among the reasons why they are not currently available. There are already a very large number of data elements and indicators which are being collected in the DHIS and adding more would increase the burden on data collection. Besides the complexity of calculating some of the EOC indicators which require estimating the number of live births in a catchment area and the number of women expected to develop obstetric complications in a given catchment population, the classification of the facilities also poses a considerable challenge. It requires that all relevant facilities such as Maternal Obstetric Units, Community Health Centres, Community Day Centres and District Hospitals need to be evaluated whether or not they provide all the signal functions required for basic and comprehensive EOC services over a designated three month period. This would be quite a labour intensive and costly endeavour to do nationally and it would need to be repeated on a regular basis as the changing circumstances of resources in facilities may move them in and out of EOC classification. A decision also has to be made if private sector facilities should be included or not. Excluding private sector facilities will give a skewed picture of the availability of EOC in the country, even though this sector only caters for a small percentage of the population.

The UN have set specific targets for each of these indicators (as set out in Table 2.1), and as discussed in the paper by Paxton et al.,[21] some of these may need to be reconsidered and adjusted for local circumstances. The target for Indicator 3 for instance, which measures the proportion of expected births in EOC facilities, (number of deliveries in EOC facilities as a proportion of all live births in the catchment population), is set at a minimum of 15%. This indicator makes no distinction between normal deliveries and those with complications and the minimum target of 15% is derived from the assumption that 15% of pregnancies will develop obstetric complications. Concern has been expressed about the validity and reliability

of this target in the literature[6, 21] and may not be relevant for South Africa. The 15% target may require adjustment after being informed by local evidence based research done in this area.

Indicator 4, which measures met need for EOC, looks at the proportion of pregnant women expected to have complications who are admitted for treatment, the numerator being the number of women with direct obstetric complications who are seen in EOC facilities and the denominator is the number of women expected to develop complications in a given population. This is a very important indicator and informs whether women who develop complications and need emergency care in a particular area or district, are receiving it. It is not an easy indicator to monitor though, as data quality may be challenged by a number of factors such as diverse interpretation of the definitions of complications, the undercounting or over-counting of complications, double counting of referrals and the complexity of the calculation of this indicator. In addition, the exclusion of private facilities can also cause the met need to be underestimated.

The 5th indicator is the C-section rate, and it informs to what extent this specific procedure is available to women who need it. The denominator in this case is the estimated number of births in the population and not the number of births in facility and thus it differs from the calculation which is done both in the DHIS and in this report. It is perhaps more correct to use all births as the denominator, but it is complicated to do this in the South African context as it would need to include the private sector births as well as all home births. The birth registration data in South Africa is still very weak and it is not easy, nor very accurate to do estimates based on this data. Calculating facility based births is thus considered more accurate.

The recommended target range for this indicator as stated by the UN is between 5% and 15% of all births[6]. The analysis done in this report has shown that in South Africa the average C-section rate of many districts and all hospital levels are well above 15%. It also gives evidence of a number of District Hospitals with rates below 5%. The analysis also shows wide variation across districts, hospital levels and between facilities. The addition of the UN recommended process indicators would certainly shed more light and bring greater understanding on the reasons behind these rates.

A decision has to be made if the C-section rate data for the private sector are to be included as doing so will increase the average rates overall due to the high number of elective C-sections performed [38,39]

The 6th and final indicator in the set is the case fatality rate and the only indicator which sheds some light on the quality of care provided. It is a purely facility based indicator and provides vital information about the functioning of the facility. If for instance the met need for EOC in a particular facility is high, say 80% and the C-section rate is also high at 34%, but the case fatality rate is way above the recommended 1%, then it is clear that there is a problem with quality of care in the facility, as even though women are receiving the services they need, they are clearly not surviving. This indicator, although relatively simple to measure may however have the potential to be underestimated as fear of retribution or rebuke can cause underreporting and misclassification of maternal deaths.

5.4 A strong relationship between level of deprivation and C-section rate exists when adjusting data for provincial variation.

The District Health Barometer's 2007 Deprivation Index (DI) is a measure available in the public health sector at present to illustrate the relative deprivation of the population in the various districts. Correlation and regression analysis using the DI of each district against the average C-section rate per district showed no significant relationship (p=0.130). According to these results therefore, when looking at the whole country at a district level, women who live in the more deprived districts do not necessarily have higher or lower C-section rates than women who live in wealthier areas.

However, when doing a multiple regression analysis and adjusting for the effect of province, the results of the model are statistically significant (p=0.044). A significant relationship between the DI and C-section rate (p=0.006) emerges. In eight out of the nine provinces, a negative relationship between the DI and C-section rate is seen, meaning that as the level of deprivation in the population increases, the C-section rate tends to decrease.

Both of the regression analyses are complicated by the fact that the sample size, being determined by the number of districts, is small (N=51) and causes power problems. If it were possible to do the analysis using deprivation indices and C-section rates at sub-district or

even lower levels such as hospital catchment populations, the results may be more conclusive as the sample size would be larger.

The ecological bias of this analysis gives an overall picture at a district level and does not allow for an understanding of what happens at the individual level. What is reflected for the district therefore is not necessarily true for all women receiving C-sections in the district.

Because the DI gives an average score of the level of deprivation in a district it will not reflect higher levels of deprivation in pockets of extreme poverty that exist in some districts such as for instance in the Northern Cape. Metropolitan areas such as City of Cape Town and City of Johannesburg which have vast degrees of rich and poor, also will reflect an average DI score, which masks the high level of deprivation in the townships situated within the metropolitan areas.

The fact that the results do not show an association between deprivation and C-section rate at a district level, does thus not necessarily mean that within a district, the poorer and underserved communities have the same access to C-section services as communities which live in wealthier and better resourced areas. In poorer communities the ability of women to reach the facility may be impaired by poor road conditions, lack of transport or prohibitive cost of transport. Therefore, to reach a more definite conclusion or understanding of the association of level of deprivation and C-section rate, research rather needs to be conducted at lower levels and with more specific groups, where the individual socioeconomic status of each woman is known with her specific C-section history. Conducting qualitative research on women's access to facilities within sub-districts and sub-sections of large metropolitan areas would also be more accurate and appropriate to determine if women who live in more deprived communities have adequate access to C-section services.

Chapter 6: Conclusions and Recommendations

6.1 Conclusions

1. The wide variation in C-section rates seen between the different levels of hospitals is not unique to South Africa, but formal evidence based guideline rates, which are currently not available in the country, are required for each level of hospital in order to ascertain if the rates seen are appropriate for the level of care provided. These guideline rates need to be specific to South African conditions.

2. The reasons for the wide variation seen in C-section rates and C-section rate trends between districts and within districts, particularly between rural and metropolitan districts (such as within the Eastern Cape and Western Cape provinces)are not clear but may be as a result of inequity in resource allocation, where the better resourced metro areas may be providing services which are not available in non-metro and rural areas.

3. Districts with very low C-section rates in District Hospitals, (less than 5%) recorded high C-section rates in higher level hospitals, in particular Regional Hospitals within the district. This suggests that the higher level care hospitals are carrying the load of C-sections and that women are being referred unnecessarily due to inadequate services being available at District Hospital level.

4. KwaZulu-Natal had the highest average C-section in District Hospitals of all the provinces in 2008/09 and five of its eleven districts fell into the ten highest district C-section rate values in the country. This higher C-section rate may be influenced in part by the fact that the province registered the highest HIV prevalence (38.7%) amongst antenatal clients tested in 2008 in South Africa, with nine of its eleven districts falling in the top ten HIV prevalence rates in the country.

5. C-section rate trends in public sector hospitals have increased between 2000/01 and 2008/09. This is not unique to South Africa as trends in C-sections are increasing throughout the world, both in developed and developing countries. The largest increases in C-section rate between 2000/01 and 2008/09, occurred at a tertiary level of care in Provincial Tertiary Hospitals and the smallest increase at a primary level of

care, in District Hospitals. Increasing C-section rate trends, particularly at higher levels of care, will increase the cost of service delivery in the public sector and will burden the health system's limited budget.

6. The data quality in the DHIS needs improving, particularly with respect to the data completeness of C-sections and deliveries and the classification of hospitals according to level of care. Poor quality of data negatively affects resource planning and also causes uncertainty whether women needing C-sections in the public sector are receiving the service.

7. The C-section rate indicator alone is inadequate to describe or monitor with any accuracy the service delivery picture of emergency obstetric care in South Africa. Additional process indicators such as the UN's EOC process indicators would assist in a better understanding of the provision of emergency obstetric care services and help to identify the changes necessary to improve the services available to women.

8. When considering the C-section rate in the public health sector at primary health care level, the norm is to look at the C-section rate in District Hospitals. A more accurate representation of the C-section rate at primary level results when the number of deliveries and C-sections in CHCs was included. To improve accuracy even further, deliveries and C-sections in MOUs and Community Day Centres should also be included.

9. Regression analysis revealed a negative association between district deprivation and C-section rates when adjusting for provincial variation. This suggests that women in districts with high deprivation may have lower access to C-sections. However, the sample sizes for this analysis were small, the results were not consistent, and there is a risk of ecological fallacy. In-depth qualitative and quantitative research would provide more reliable evidence.

6.2 Recommendations

The following recommendations are relevant to managers in the National Department of Health who deal with the monitoring and evaluation of maternal health indicators, and the collection and management of data in the District Health Information System.

1. Increase the number of indicators to monitor the provision of emergency obstetric care by including the UN Emergency Obstetric Care indicators in the DHIS over a period of time and in a step-wise manner. The addition of each indicator should be accompanied by training and supervision of clinical staff and information officers with regard to the interpretation of definitions and data elements, data collection methods and interpretation of the results. The indicators are
    i. Availability of EOC basic and comprehensive care facilities per district population (by classifying/coding hospitals, CHCs and MOUs as EOC facilities)
    ii. Geographic distribution of EOC facilities (obtaining GPS coordinates of each facility and mapping these by district and province)
    iii. Proportion of expected births delivering in EOC facilities
    iv. Proportion of women with major obstetric complications who are treated in EOC facilities
    v. Direct obstetric care fatality rate
2. Improve the quality of the C-section data in the DHIS by:
    a) stricter observance, monitoring and updating of facility classifications,
    b) improving the collection of C-section and delivery data in primary health care facilities such as CHCs, MOUs and Community Day Centres,
    c) regular maintenance and checking of data related to C-sections in all facilities.
3. Include the number of deliveries and C-sections in CHCs in the calculation of C-section rate at primary level and over time include the deliveries which occur in MOUs and Community Day Care Centres to get an accurate reflection of C-section rate at primary care level.
4. Provide availability of staff trained in emergency obstetric care, ensure implementation of the NCCEMD recommendations and monitor number of qualified and advanced midwives available at facility, sub-district, district, province and national level.

The recommendations that follow are relevant to managers in the National Department of Health dealing with Maternal, Child, Neonatal and Women's Health, District Managers, Hospital Managers and Health Information Managers.

1. Ensure investigation and research into the reasons for the unacceptably low (less than 5%) C-section rate of 23 District Hospitals listed in this report and take steps to improve the situation or correct the data so that it is clear if women living in the surrounding area are ensured of adequate maternal health services.
2. Investigate the reasons causing the C-section rates of over 50% in the District, Regional and Provincial Tertiary hospitals listed in this report and ensure that over-servicing is not occurring.
3. Ensure equity of resource allocation and service provision by investigating the reasons for the wide variation of C-section rates within districts and even between districts and provinces.
4. Hospital managers need to ensure that relevant staff are adequately trained in Essential Steps in Managing Obstetric Emergencies (ESMOE) and that protocols and ESMOE guidelines are available at each facility providing C-sections.

The following recommendations suggest areas of research relevant to research departments in schools of public health and policy who are active in the areas of Maternal and Child Health.

1 In-depth qualitative and quantitative research, specifically in the poorer areas of the country, is needed to provide reliable evidence that women in the lower socioeconomic quintiles of South Africa are receiving appropriate levels of emergency obstetric care such as C-sections, when needed. Qualitative research could gather information on the quality of maternal care and treatment that individual women receive who undergo a C-section in less developed or rural districts of the country. Quantitative research could assess individual socioeconomic status of a specific sample of women versus history of C-sections.
2 Research to support the National Department of Health in their endeavours to provide and monitor equitable access of emergency maternal health services is needed. Specifically, a research group could be established to guide and support health personnel and managers with the inclusion of the UN Emergency Obstetric Care indicators as part of routine data collection in the DHIS.

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