Assessment of the potential of hospital birth records to estimate the number of births: A case study of Germiston and Nkomazi Local Municipalities

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ABSTRACT

The advantage of a well-developed health information system is the significant role played by records produced by such a system beyond recording medical history of individuals. They are the foundation for birth registrations which when fully complete is an important tool for acquiring data necessary for planning and monitoring child and maternal health in a country.

This study aimed to investigate the potential of hospital birth records to estimate the number of births in the country and supplement birth registrations data. Data was abstracted from public facilities where births occur in two municipalities; Germiston in Gauteng and Nkomazi in Mpumalanga for the period 2014 to 2016. Modified version of the BORN Data Quality Framework (BORN-DQF) of the Ontario Agency for Health Protection and Promotion (2016) was used to assess the contents and quality of hospital birth records. Four dimensions of framework were employed to test the relevance, usability, comparability and accuracy of the data. Hospital records provided evidence of their potential as source of birth data, and for providing detailed information on maternal and child health conditions at birth currently unavailable in the birth register data. However, challenges observed in relation to lack of adherence to documented record management policies and guidelines particularly at lower levels of care, cast doubt on accessibility of these records for research purposes.

For a number of key data items, data was moderately complete with space for improvement. Marked differences were found in quality of recording between the two study areas. Poor quality of data for indicators associated with health of the mother (parity and gestational age) and health of the child (birthweight) may be attributable to lack of awareness of the importance of capturing these data by hospital personnel as these are important indicators for health facilities.

Linked hospital records and birth register data rates obtained point to limited common data items from both sources and questionable quality of reporting as main weaknesses. An assessment of the level of agreement between hospital records and birth register data undertaken showed high agreement and sensitivity for a number of variables, pointing to high quality of matched data. Exception was made for death, fewer numbers available for this data item suggested pervasive misreporting in hospital records. This indicates inability of hospital records in their current state to provide solution to underreporting of child deaths observed in vital registrations data. The challenge is to impress on facilities managers the importance of completing data items important to monitor their own performance and for other stakeholders and to appreciate benefits of birth and other vital data generated within facilities.

For hospital records to be the source of improvements for birth register, quality of recording must improve, this will enable birth register data to serve a wider range of stakeholders including researchers. Interventions and various interim measures such as service level agreements and memoranda of understanding between key role players to improve efficiency of the system are encouraged, however long term legislative reforms needed to improve efficiency of the system must be prioritised by key entities involved for the benefit of the country. A broader study incorporating births in private health facilities will provide clarity on the influence of socio economic status on matching rates observed in this study.

***Keywords**: Census, Registration, Referrals, Completeness, Births, Assessment, Maternity Case Record, Department of Home Affairs, Statistics South Africa, National Population Register.*

DECLARATION

I hereby declare that the *Assessment of the potential of hospital birth records to estimate the number of births: A case study of Germiston and Nkomazi Local Municipalities* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Nhlapo 14/03/2021

Mosidi Sarah Nhlapo **Date**

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DEDICATION

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AIDS:	Acquired Immune Deficiency Syndrome
ART:	Assisted Reproductive Technology
BBA:	Born Before Arrival
BI-24:	Birth notification form
BORN:	Better Outcome Registry and Network
BR:	Birth Register
CAPI:	Computer Assisted Personal Interview
CHC:	Community Health Centre
CIHI:	Canadian Institute for Health Information
CR:	Civil Registration
CRS:	Civil Registration System
CRVS:	Civil Registrations and Vital Statistics
CSIR:	Council for Science and Industrial Research
DAF:	Data Abstraction Form
DHA:	Department of Home Affairs
DHIS:	District Health Information System
DHS:	District Health System
DHSS:	Demographic and Health Surveillance Site
DoB:	Date of Birth

DoH:	Department of Health
DQF:	Data Quality Framework
EDHC:	Ekurhuleni District Health Committee
FDR:	False Discovery Rate
FSB:	Fresh Still Births
GP:	Gauteng Province
HES:	Hospital Episode Statistics
HIV:	Human Immunodeficiency Viruses
HGP:	Hospital Gauteng Province
HMP:	Hospital Mpumalanga Province
HSSREC:	Human and Social Sciences Research Ethics Committee
ICD-10:	International Classification of Diseases 10th Revision
ID:	Identification number
IMR:	Infant Mortality Rate
IOM:	Institute of Medicine
IQ:	Intelligence quotient
LBW:	Low Birthweight
MCR:	Maternity Case Records
MMR:	Maternity Mortality Ratio
MOU:	Memorandum of Understanding
MSB:	Macerated Still Births

NDoH:	National Department of Health
NHRD:	National Health Research Database
NMR:	Neonatal Mortality Rate
NND:	Neo Natal death
NPR:	National Population Register
OCR:	Obstetrical Clinical Records
OPD:	Out-Patient’s Department
PHC:	Primary Health Care
PMTC:	Prevention of Mother to Child Transmission
RCR:	Retrospective Chart Review
SADHS:	South African Demographic Health Survey
SD:	Standard Deviation
SITA:	State Information Technology Agency
SLA:	Service level agreement
SOP:	Standard Operating Procedure
SRB:	Sex Ratio at Birth
Stats SA:	Statistics South Africa
TFR:	Total Fertility Rate
TOP:	Termination of Pregnancy
UK:	United Kingdom
UNICEF:	United Nations Children’s Fund

UN: United Nations

UNSP: Unspecified

US: United States

VA: Verbal Autopsies

VR: Vital Registration

VSPI: Vital Statistics Performance Index

WHO: World Health Organization

WIC: Women Infants and Children

CHAPTER 1

INTRODUCTION

1. Introduction

1.1 Background

There are two sources of nationally representative birth data currently utilised in South Africa, namely; data obtained from censuses and surveys based on questions asked from women in the child bearing ages about their birth histories. The second source is data based on birth registrations obtained from civil registration system maintained by the Department of Home Affairs (DHA). The other possible source of birth data available within public health facilities is data from District Health Information System (DHIS). This is a paper-based system of registers, tally sheets, and monthly data collation forms. The collated data are sent monthly from district or sub-district level to be captured onto computers using DHIS software (Mate *et al*, 2009). Monthly reports are generated and forwarded to the district, provincial and national health department (Garrib *et al*, 2008). One of the biggest shortcomings of the DHIS is that it produces aggregated data and thus not structured for estimation purposes.

The DHIS2 is an updated version of the DHIS. In countries where this system was introduced it provides disaggregated data, however this system is not yet available in South Africa (*based on conversation with officials from Department of Health*). In its current format, the system is more a management tool for health professionals. Researchers have noted a number of challenges related to quality and content of DHIS data (Garrib *et al*, 2008; Mate et al, 2009 Malherbe *et al,* 2016; Katuu, 2015).

Much of what is known about fertility patterns and trends in South Africa is based on evidence from censuses and surveys (Nhlapo, 2016). This notwithstanding, birth registration data remains an ideal source of data as it is continuous and once complete, requires no adjustment for estimation purposes. Impressive improvements in birth registration have been observed in

South Africa in recent years. Statistics South Africa (2018) estimated birth registration completeness level of 88.6% in the 2011 to 2016 intercensal period.

Extensive investments into increasing birth registration in recent years produced a number of indirect benefits including increasing timely registration of births. This uptake was partly driven by the desire by new mothers to access certain benefits including government social grants. Also important is that in South Africa, a birth certificate is required for registration in school. Research points to a number of quality issues within the data (Stats SA, 2007);

Firstly; there remains a proportion of births registered late, Nhlapo (2016) estimated that 10% of births were still registered one year after occurrence in 2008. Stats SA (2018) found that despite improving timeliness of birth registrations overtime, in 2016 only 78% of registrations occurred within the compulsory 30 days stipulated by the Births and Deaths Registration Amendment Act (Act No. 18 of 2010). Registrations within occurrence year (current registrations) increased to 89% by the end of the first year.

The data also show that 30 107 births registered in 2017 had missing age of mother or were indicated to have occurred to women outside the 10-54 age range (these includes births to those aged less than 10 years and 55 years and older). About 72,3% of these were late registrations (Stats SA, 2018). These were mainly births registered by persons other than biological parents hence the late registrations (Stats SA, 2018). Maternal age is an important variable in demographic analysis, in the estimation of age specific fertility rates it determines the accuracy of the denominator. The variable is also one of the main sources of errors affecting interpretation of data (Stats SA, 2007). Additionally, indirect estimation techniques used to estimate key births indicators, such as those used by Statistics South Africa (Stats SA) to estimate completeness of registration make assumptions about the distribution of missing data and general accuracy of age data.

Secondly, the data does not include socio-demographic variables such as marital status of parents, education and employment status. Although marital status is collected through the DHA-24 it is not part of the births data. Socio-demographic factors including age, education, marital and employment status of the mother etc., are important indicators of maternal and child health outcomes (Auger *et al*, 2013; Blumenshine *et al*, 2010; Bohensky, 2010). For instance, research indicates that child birth outside marriage is associated with increased risk of poverty, life in unstable relationships and welfare (Romero and Agénor, 2009; Joseph *et al* 2007; Guzzo and Furstenberg, 2007). Within developed countries, the rise in educational attainment and labour market participation has been associated with negative effect on higher-order birth rates and increasing mean age at first birth (Bhrolchain and Beaujouan, 2012; Mills *et al*, 2011; Kravdal and Rindfuss, 2007). In its current format and beyond computing total fertility rate (TFR) and fertility trends, not much information can be obtained from births data. TFR only provides tempo effect of fertility, it is not a sensitive measure of fertility behaviour in a population (Zumpe, 2012).

Another data item missing from birth register data is information on usual residence of the mother. Although the DHA-24 asks for address of the mother, this is not captured by the DHA. The data only include information on place of birth of both mother and child. In a mobile society such as South Africa, the place of birth of a child might not necessarily be the place of usual residence of the mother. Studies on migration have demonstrated that migration could be motivated by the need to access better services including healthcare (Murray and Pearson, 2006; Todes *et al*, 2010; Landau, 2010). Murray and Pearson (2006) found evidence across a number of countries of movement between the public and private sectors and geographical areas by pregnant women seeking better care. In United States, research has found persistent portrayal of Mexican immigrants as net-utilisers of government services contrary to empirical evidence (Frank and Hummer, 2002).

In South Africa, a study by DSD (2011) conducted in cross border districts of Vhembe, Mopani and Waterberg in Limpopo reported acknowledgement by health professionals and cross border travellers on the use of health and social resources in the province. In the Bushbuckridge district of Mpumalanga Province, Collinson (2010) found net population loss from villages to nearby towns, specifically for access to improved services. For purposes of this study, the usual place of residence of the mother will allow attribution of births by locality which is important, particularly for small areas analysis.

Furthermore, Stats SA publishes the number and trends in registered births annually based on information from the birth register. This information excludes births to non-citizens and South Africans without South African national identification numbers (ID). The births register only captures births to South African citizens and permanent residents with IDs. The DHA does not keep a register of births due to non-citizens, undocumented individuals and special groups such as refugees and asylum seekers. The usual practice is to issue a hand written certificate for births occurring to non-South Africans with the expectation that these will be registered at respective embassies or countries. This emanates from the provision of the Population

Registration Act Repeal Act 1991 (Act No. 114 of 1991) which stipulates entry into the NPR through registration of birth by South Africa ID holders and naturalised individuals.

In-migration into South Africa from mostly other African countries has increased in recent times; this immigration has been both documented and undocumented. Research has shown that immigrant women typically have lower fertility prior to migration followed by higher fertility immediately after arrival in destination country (Zumpe *et al*, 2012). Equally, other studies found the country of origin impacts on birth outcomes among migrant women (Malin and Gissler, 2009). It is currently unclear what contribution births due to undocumented migrants and other special groups make to total births in the country, including their birth outcomes. The estimated number of births due to individuals who reported migrating into South Africa between 2001 and 2011 is 47 206 based on Census 2011(*own computation*). Although quite low, this figure includes both documented and undocumented individuals.

An additional shortcoming of birth registrations data is lack of information on the health and birth characteristics of newborn babies and their mothers. Key health information such as birth weight, parity of the mother and gestational age are not part of the data. Health related questions are not asked in the DHA-24 and yet these were included in the BI-24 which was a predecessor to the current form (This is discussed in section 8.7). Information such as birth-weight, gestational age and other maternal conditions are critical for informing strategies in health services (Murray *et al*, 2012). For instance, studies on birthweight found significant effect on longer-run outcomes such as height, intelligence quotient (IQ), earnings, and education. Equally, low birth weight has been associated with infant mortality, congenital malformations, mental retardation and other neurological and physical impairments, it is also an indicator of risks newborns may face in the neonatal period (Lai *et al*, 2017; Black *et al*, 2007; Royer, 2009). Hoque *et al* (2011) found low birthweight of neonates accounted for 53% of hospitalisation and 85% deaths in a rural hospital in South Africa. Internationally, data items such as birthweight and gestational age are standard items included in the birth certificate by registration authorities (UN, 2014; Andrade *et al*, 2013; Murray *et al*, 2012).

A number of children also die before their births are registered. Hoque *et al* (2011) asserts that in most developing countries, nearly half of perinatal deaths occur during the antepartum or intrapartum period, and the rest during the first week of life. Pillay *et al* (2014) estimated that in South Africa 40% of child deaths occur during the neonatal period. The Births and Deaths

Registration Act, 1992 (Act No. 51 of 1992) precludes death registration of anybody that dies before their birth is registered (Republic of South Africa, 1992; Republic of South Africa, 2014). With most births occurring within health facilities, most of the deaths occurring just after births should at most be identified.

In South Africa, the notification and registration of a birth is still the primary responsibility of parents, which affect the occurrence and timing of registration. This also points to weaknesses in current legislation on notification and registration of vital events in the country which places the burden of both notification and registration of births and deaths on next of kin.

Lastly, in countries with efficient civil registration systems the onus of notification rest with those present at occurrence of an event, in case of births, this responsibility falls on health professionals present at the birth of a child (WHO, 2010). For instance, in the United Kingdom (UK), the US and Australia, responsibility for notification of births is placed on the hospital where birth occurred or the midwife or doctor in attendance at the birth, by the law. In the UK and US, the information is also shared with the Statistics office (McCandless, 2017; ONS, 2015; Wier *et al*, 2007; NSW, 2014). In Norway, legislation binds both midwives and physicians attending to any birth to notify the registry office (Romundstad *et al*, 2010). The Norwegian system also has a parallel system linked to the Central Bureau of Statistics for births notification (These includes stillbirths and early neonatal deaths data). The system also generates a registry and national identification numbers of the new-born and establishes a new record with the civil registration bureau (Romundstad *et al*, 2010).

Recording of events at source reduces data quality challenges and the risk of excluding children that die during or after discharge and before registration occurs. Hospital birth records contain data on all births that occur in health facilities. The proportion giving birth in health facilities have increased noticeably in South Africa over time. The proportion of women reporting occurrence of their last live birth in a health facility increased to 96 percent in 2016 from the 86 percent reported in the 2003 South African Demographic and Health Survey (DoH *et al*, 2017). This proportion was estimated at 83% in 1998. The percentage reporting birth occurrence in health facilities in Gauteng and Mpumalanga provinces were 97 and 95% respectively (DoH *et al*, 2017).

Hospital birth records have a potential to be an alternative source or to supplement of data on births. It is expected that hospital birth records will cover more births and that for research purposes these data can reduce the costs associated with data collection and deficiencies identified within vital registration data. No study has been done in South Africa to investigate the feasibility of using hospital birth records for estimation.

1.2 Research Problem

In the analysis of data on births and birth outcomes, few variables are of critical importance, among these are age of the mother at birth, date of birth of the child and place of usual residence of the mother for localisation of births. Additional indicators of birth outcomes such as birthweight, gestational age and where applicable date of death of the child are also critical. Typically, such information is obtained from a complete birth register. In South Africa, impressive strides have been made in improving of birth register completeness in recent years, making the register potential source of information on births in the country (Stats SA, 2007; Nhlapo, 2016; Garenne *et al*, 2016a). However, some of the variables critical for the estimation of births and analysis of health outcomes are either not collected or captured in this dataset. Documented evidence has shown some deficiencies in the data including both omission and content errors (Nhlapo, 2016). For births, the vital register data currently only give an indication of levels and trends of fertility. In its current format, the data fails to adequately convey the complexity of fertility behaviour and health outcomes of infants in the country.

The data currently omits some sectors of the population affecting its completeness. This includes, births due to undocumented individuals giving birth in South Africa as well as South Africans without national identity numbers (ID). This exclusion emanates from the provision of the Population Registration Act Repeal Act 1991 (Act No. 114 of 1991) which specifies entry into the National Population Register (NPR) through registration of births by South Africa ID holders only. Infants that die shortly after birth or in isolated areas without access to DHA services are also not included in these data. The completeness of birth registrations also impacts on the registration of child deaths.

It has also been shown that these data exclude some key data items, for instance only the place of birth of both the child and the mother are provided in the data. Inclusion of residential address of the mother is ideal as it allows for localisation of indicators. Identification of health differentials at smaller areas and within subgroups requires accurate information for localisation of indicators and effectively targeted interventions.

Data items on the health of mother and child at birth such as gestational age, birthweight and births defects are also not part of this data. Best practice internationally is for inclusion of key data items on the health of mother and child at birth as part of birth register data. Health information at the time of delivery is essential for monitoring child health, identifying priorities and planning health service delivery. In counties with advanced civil registration systems birth registration data collects information on every aspect of the event, enabling analysis of subpopulations, infant defects and infant deaths. Empirical evidence consistently points to better coverage and quality of data obtained in hospital records than is the case with register data and this source as a gold standard in data linking studies (Frohnert *et al*, 2005; Devlin *et al*, 2009; Murray *et al,* 2012; Martin *et al*, 2013; Boulet *et al*, 2011).

This study investigates usability of hospital birth records as source of data for estimation of births for the period 2014 to 2016. Hospital birth records contains data routinely collected and can be a rich source of information on births, the health status of individuals at birth, and for measuring quality of maternity care (Murray *et al*, 2012). Investigating these data will provide insight into their ability to enhance birth register data and to exist as an independent source for estimation purposes.

1.3 Purpose of the Study

The primary aim of the study is investigation of potential use of hospital birth records to estimate the number and characteristics of births from health facilities within the Germiston area in Ekurhuleni Metropolitan municipality and Nkomazi local municipality in Ehlanzeni district municipality located in Mpumalanga Province. The chosen areas are located in two different provinces, one more urban and the other largely rural.

Germiston (which incorporates Katlehong Township) municipality is located in the Gauteng Province, a highly urbanised region. Gaede and Versteeg (2011) estimated that only 4% of Gauteng province is rural. The urban nature of the province can provide adequate cases in facilities to achieve the main purposes of the study. The choice of the area was also motivated by the principle researcher’s local knowledge of the sites and contacts which helped facilitate access to data.

Nkomazi is mainly a rural municipality incorporating large parts of what was formally referred to as Homelands or Bantustans (These were ten territories formerly designated by the apartheid government as national homelands for the country's black African population during apartheid) areas. Research estimates that 60% of Mpumalanga province is rural (Gaede and Versteeg, 2011). The rural and cross border location of Nkomazi municipality will allow the study to test whether hospital records can contain adequate information to separate information by physical address of the mother and citizenship. The main urban centres within this municipality are Louw's Creek; Kaapmuiden; Malelane, Hectorspruit, Marloth Park, Komatipoort, KaMhlushwa, Tonga and KaMaqhekeza.

Nkomazi Municipality is 3240.42 km² in extent, which is 4.07% and 23% of the Mpumalanga Province and Ehlanzeni District Municipality land mass respectively.

Information from these two municipalities will enable comparison of quality of reporting between the two geographical areas. It also allows for assessment of consistency of data-collection methods and tools across time and space which is essential for policy utility (Rao *et al*, 2005). The study focuses on the period 2014 to 2016, representing a three-year period of adjustment after adoption of the new standardised maternity case record (MRC) within public health facilities (*discussed in detail later*).

1.4 Objectives of the Study

- **To assess content validity of hospital birth records data for the period 2014 to 2016.**

To achieve the first objective, the study draws from BORN Data Quality Framework (BORN-DQF) of the Ontario Agency for Health Protection and Promotion (2016) framework for evaluation of birth data. Content validity of hospital data is assessed through two dimensions of the framework. Firstly, it looks at the usability of hospital data or the ease with which data can be understood and accessed. Within this dimension; a) the documentation element is used to assess the layout of three types of records encountered in facilities; b) The second element looks at accessibility of hospital records for use beyond clinical and health purposes, looking at the presence and adherence to record management policies as well as record keeping practices within facilities.

Secondly, the *Relevan*ce dimension which is the degree to which the data meets users' needs is informed by adaptability element; this is the degree to which additional data items necessary for estimation of key indicators of birth, child and maternal health are included and usable in hospital records data is considered.

Lastly; the consistency element within the *Comparability* dimension is used to measures the consistency of reporting in the two locations by comparing the proportion of missing key data items cases between the two study areas by facility type and size to provide a rating of content validity of these data.

- **To assess the quality of hospital birth records data for the period 2014 to 2016.**

The reliability of hospital births data is assessed through the accuracy dimension from BORN-DQF which is the extent to which information in hospital birth records reflect reality. Precision element is used to achieve record linkage and to measure the level of agreement of key data items in the hospital births records data and birth registration data.

- **To establish the extent to which the health referral system affects localisation of birth indicators obtained from health facilities.**

The linkage element in the comparability dimension is used to establish the extent to which health referral system affects localisation of birth indicators.

The ability of hospital records to be used in the localisation of births indicators in the face of prevailing health referral system is assessed using three indicators of the linkage element; 1) the presence of identifiers of individual hospital records, which is measured by the percentage of records with unique identifiers; 2) The presence of unique identifiers of each patient within each record, measured by the percentage of hospital birth records with correct unique records identifiers and 3) the percentage of hospital birth records with correct residential addresses of the mother.

- **To help in developing a more systematic and comprehensive system to ultimately improve the coverage and accuracy of birth registration.**

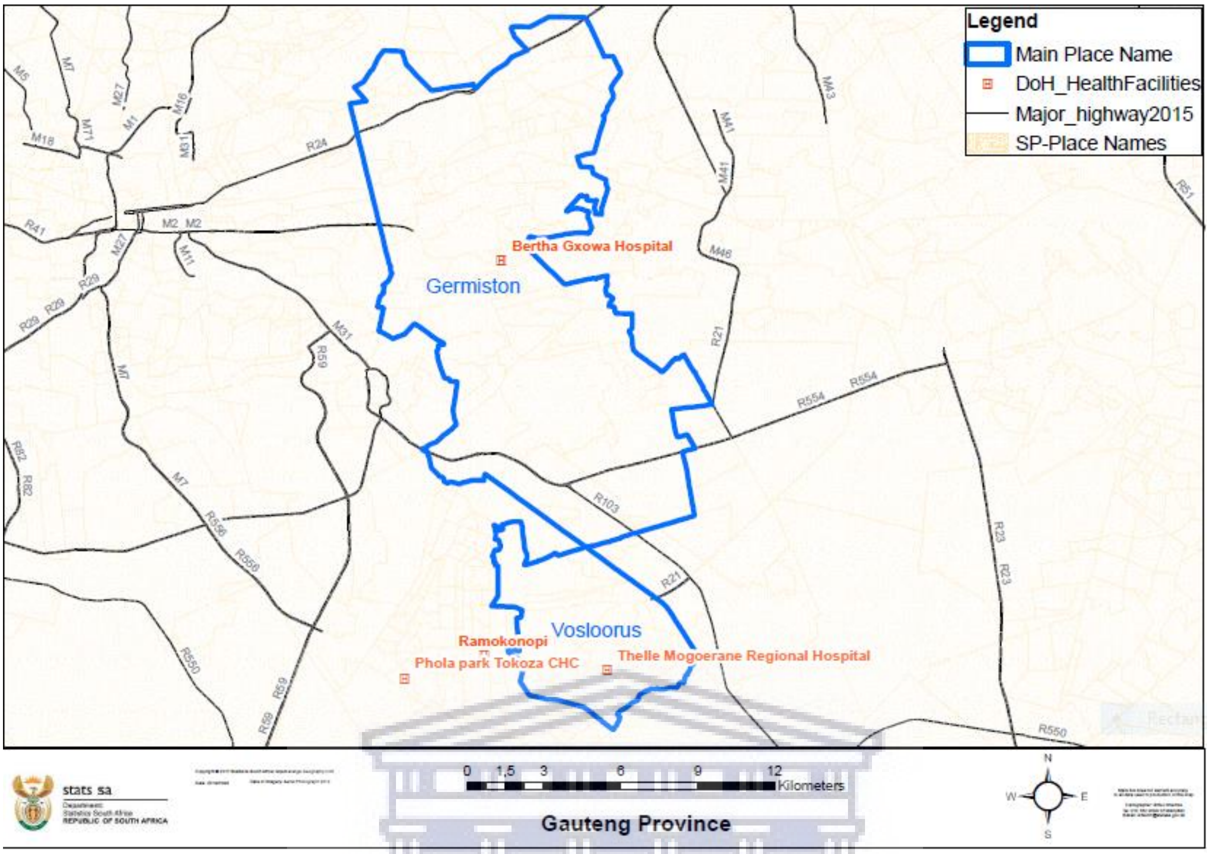
To accomplish this objective, the study looks at available sources that can be used to improve births data as well as recent intervention in improving births registrations in the country and recommends measures to improve the coverage and accuracy of birth registrations data.

1.5 The study areas

The previous section dealt with the aims and objectives of the study. This section provides an overview and background to Gauteng and Mpumalanga study sites, discussed in sections 1.5.1 and 1.5.2 respectively.

1.5.1 Germiston: demographic, socio-economic and health care background

Germiston is located within the Ekurhuleni Metropolitan Municipality in the Gauteng Province. The province is the smallest in the country accounting for only 18,176 square kilometres, but the most populated (population estimated at 14,278,700 in 2016). Ekurhuleni is one of the three metropolitan municipalities in Gauteng which was formed by the amalgamation of a number of smaller municipalities, including Germiston. Germiston was founded in 1886 and incorporates Katlehong Township, a black African location in the south. It became a municipality in 1903 and a city in 1950. Until recently Germiston was home to more than 700 factories, some of them the biggest in the country (EMM, 2010). Research has shown that manufacturing, previously the most important economic activity in this city, is on the decline (EMM, 2013). This history of high economic activity has created constant migration streams from other areas into the municipality.



Source: Statistics South Africa

Figure 1.1 The geographical map showing facilities in Germiston area

For public health care purposes Germiston falls within the Southern region which includes Alberton and Boksburg. The region consists of 32 public health care facilities, composed of five community health centres, twenty-four clinics and three hospitals. The Germiston area comprises of two hospitals, one regional hospital and a district hospital two community health centres and six municipal clinics. The hospitals take referrals from clinics, community health care centres from Katlehong, Vosloorus, Thokoza, Magugala heights, Zonkiziwe, Phola Park, Palm Ridge, Eden Park, Germiston, Leondale as well as far as Heidelberg and from other district hospitals. Referrals from private practices are also accommodated in these health facilities.

Based on information collected during the 2016 Community Survey the population of Ekurhuleni was estimated at 3 178 470. Stats SA (2016) reported that 61 721 births were registered in 2015 for Ekurhuleni, 52 455 of these occurred in 2015. Total fertility rate was estimated at an average of 2.4 children per woman.

Number of births occurring in health facilities is higher in Gauteng province (SADHS, 2016), this makes Ekurhuleni an ideal location to achieve the main aim of the paper; assessing feasibility of using hospital records to estimate births. The other assumption is that the region being urban, will provide a better setting to test the quality of reporting and establish the extent to which the referral system can affect the indicators obtained from the health facilities.

1.5.2 Nkomazi Local Municipality: Demographic, socio-economic and health care background

Nkomazi Local Municipality is located in the eastern part of Ehlanzeni District Municipality in Mpumalanga Province, a land locked province in the eastern part of South Africa. It is surrounded by four of the nine provinces: namely Limpopo, Gauteng, Free State and KwaZulu-Natal. It shares international borders with Mozambique and Swaziland. The province is made up of three district municipalities, namely Ehlanzeni, Nkangala and Gert Sibande (Dawson, 2013). Nkomazi Local Municipality is one of the five local municipalities within the Ehlanzeni District Municipality. The district is located in the eastern part of Mpumalanga Province. It is bordered to the north by the south-eastern section of the Sabie River in the Kruger National Park, Mozambique to the east, Swaziland to the south and Mbombela to the west and Umjindi Local Municipality to the south-west. It incorporates a number of small towns including Louw’s Creek; Kaapmuiden; Malelane, Hectorspruit, Marloth Park, Komatipoort, KaMhlushwa, Tonga and KaMaqhekeza (Mutuma, 2010).

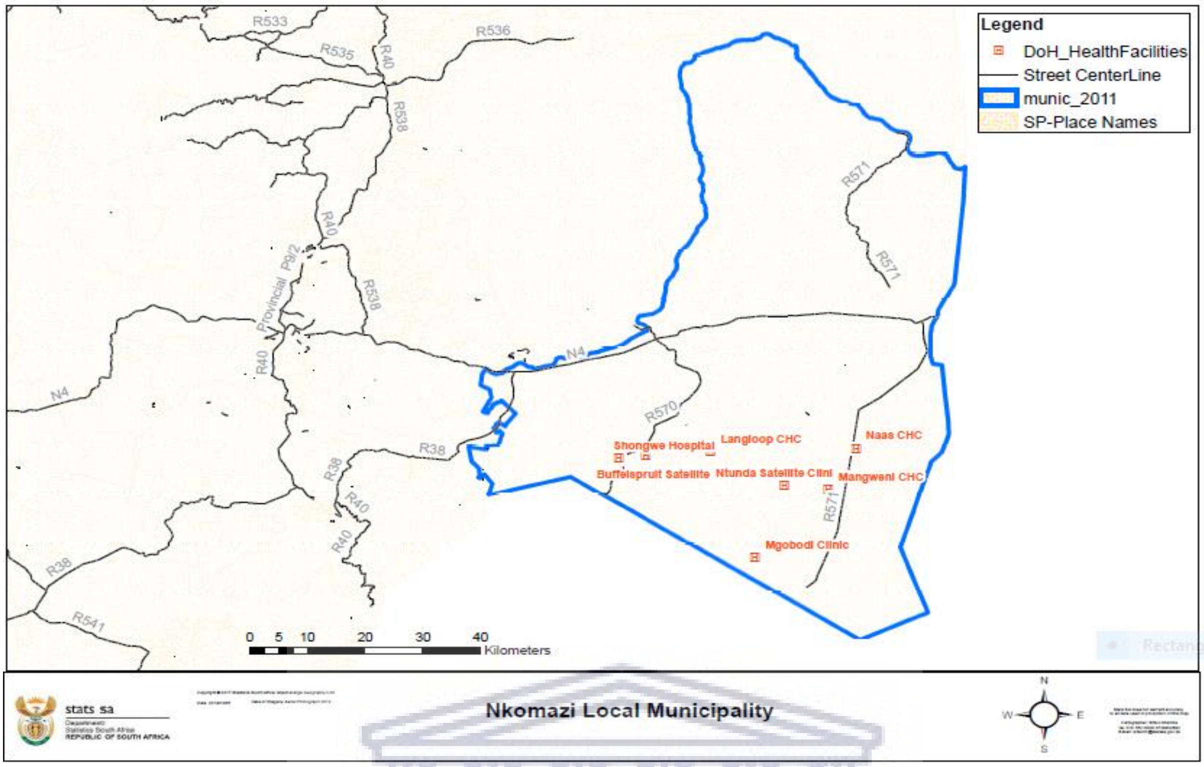


Figure 1.2. The geographical map showing facilities in Nkomazi municipality.

The municipality includes a number of smaller villages previously under the old KaNgwane homeland jurisdiction during apartheid years. Nkomazi is made up of many cross-border communities (such as Shangaans and Swazis) sharing a language, culture, kinship and traditional leadership structures (Mutuma, 2010).

Nkomazi municipality falls within the Lowveld health region which includes Sabie, Barberton and Nelspruit. The area has about 25 public health facilities; composed of 6 community health centres, 17 clinics and 2 hospitals. Two hospitals, six community health centres and 18 clinics are located in this study site.

Community Survey 2016 estimated the population of Nkomazi at 393 030 of which 97.7% were black African, 1.6% were white and other population groups making up the remaining 0.4 percent (Stats SA, 2016). More than a third (34.2%) of the 110 469 economically active population in the municipality are unemployed (Stats SA, 2016). A total of 41 646 births were registered with DHA for Ehlanzeni district in 2015, 37 227 of these occurred in 2015 (Stats SA, 2016).

The location of this municipality across border area makes it ideal to test if the ruralness of an area can affect quality of data in hospital records and the effect of referral system on localisation of birth indicators obtained from health facilities. With the assumption that women do cross the borders for delivery purposes, the study will establish if births by women from neighbouring countries can be identified and isolated to estimation purposes. Both migration dynamic and the higher birth rate make the area an ideal place to test one of the objectives of the study.

1.6 Research Questions

The fundamental questions this research aim to answer are the following;

- What is the content validity of births data from hospital records for the period 2014 – 2016
- What is the quality of births data from hospital records for the period 2014 – 2016
- Can the public health referral system affects localisation of birth indicators obtained from health facilities?
- Can a more systematic and comprehensive system be designed improve the coverage and accuracy of birth registration?

1.7 Significance of the study

Impressive birth registrations completeness improvements observed in recent years in South Africa failed to encourage the use of this data as the main source for estimation and monitoring maternal and infant health, in despite of the critical need for continuously available data in the country to inform policy particularly at subnational level. Structural deficiencies prohibiting utility of these data include continued late registrations and resultant uncertainty around the number of children lost to mortality; exclusion of some sectors of the population and limited and poor quality of variables characterised by omissions and content errors (Nhlapo, 2016).

With above 90% of births reported to occur in health facility (DoH *et al*, 2017), the utility and reliability of birth data produced from hospital records in health facilities is yet to be tested. Hospital records are the custodian of all vital events at facility level including births. Studies using hospital births records to evaluate other sources of data have accorded this source a “golden standard” status (Martin *et al*, 2013; Li *et al,* 2006). A few studies have used hospital records to evaluate accuracy of mortality and causes of deaths data from civil registration in

South Africa (Kahn *et al*, 2000; Khoza, *unpublished thesis)*. No study has considered the suitability of hospital births to improve and supplement births data from civil registrations in South Africa. Understanding hospital birth records as potential source of births data and the environment at facility level surrounding live births may fill critical knowledge gaps about circumstances of the children and the mother who give birth at facilities, encourage and expand the use to this source of data for monitoring key childhood and maternal health indicators and demographic patterns and trends. Moreover, investigating usefulness of this source has potential to enhance birth register data and add information on births outcome not currently available in the register. The work will enhance understanding of dynamics on births and birth characteristics in the country and recommend ways of strengthening current systems.

1.8 Definition of key term

Vital registrations - it is defined as the registration of births and deaths with the civil registration authority (DHA).

Civil registration - includes other aspects of civil status such as marriage, divorce and migration as well and births and deaths.

Maternity Case Record - A record of pregnancy and birth used in public health facilities in South Africa.

Birth Register – A register of all birth occurrences in health facilities.

BORN-DQF - The Better Outcome Registry and Network (BORN) data quality framework.

Key data items – Key data items in this study are the following:

- Age of the mother;
- Sex of the child;
- Date of birth of the child;
- Status of the birth;
- ID of the mother (the thirteen-digit national identity number assigned to South African citizens) and permanent residents.
- Address of the mother

Data dimension – Dimension describes a feature of data that can be measured or assessed against defined standards in order to determine the quality of data

Neonatal mortality rate – The probability of dying within the first 28 days of life, per 1,000 live births.

Perinatal deaths - A combination of fetuses of at least 26 weeks that are born dead (stillbirths) and infants that die within the first week after live birth (early neonatal deaths).

Stillbirths - Means a child that has at least 26 weeks of intra-uterine existence but showed no sign of life after complete birth.

1.9 Thesis Outline

This study on the assessment of the potential of hospital births records to estimates the number of births consist of nine chapters. The chapters are outlined as follows:

Chapter 1: Introduction

This chapter serves as an orientation to the study. The chapter covers the background to the study, and problem statement, furthermore purpose of the study and specific objectives that guides the research are outlined. The study area and research question are also provided.

Chapter 2: Literature Review

Chapter two explores existing literature relating to the history and development of vital registration globally and in South Africa as well as current status of the vital registrations in the country. Studies undertaken using administrative data globally and locally are also reviewed in this chapter. The South African health system, both public and private are discussed at length. Frameworks and methods used in the assessment of administrative data are reviewed last in this chapter.

Chapter 3: Research Methodology

This chapter covers the methodology followed in the study. It highlights methods followed during data collection, observations made and challenges encountered. The study design, data collection strategy, observations and challenges experienced in the field during data of records management within facilities and the data processing experiences are included in this section. Lastly, a brief discussion on challenges encountered during data collection and processing period is undertaken.

Chapter 4: Birth Registrations data

This chapter provide an overview of birth registrations data used in this assessment and presents the background characteristics of data for the period 2014 to 2016 which was used in the matching exercise with hospital data. Sections of the data covering parental information available in the data and information on the child and quality of this data are also covered. Challenges presented by the place of birth variables in the data are discussed as are the discrepancies between date of birth and date of registration.

Chapter 5: Hospital Births records data

The section on hospital data present background characteristics of hospital births data collected for this study. It presents the number of cases abstracted from each facility by years of births and the age of the mother variable. Methodological challenges of using hospital records data for research purposes are included, covering some deficiencies related to the types of records encountered during data collection and abstraction. Data collection experiences are discussed last.

Chapter 6: Hospital Births records data

The results of the implementation of the assessment framework adopted for this study are presented in this chapter.

Three of the four dimensions and their respective elements are implemented in response to the first and third objectives of this study on content validity of hospital births data and possibility of localisation of births. Dimensions applied are usability and applicable elements adopted for assessment of hospital births data in this study. Relevance of data items available in hospital records for improving quality and depth of information on births and the adaptability of these items are included in subsequent sections. Lastly comparability dimension is applied to check proportion of unspecified *key data items* while the linkage element within this dimension checks their ability to identify individuals, their records and their place of usual residence for purposes of localising number of births.

Chapter 7: The assessment framework

The last dimension adopted is used in this chapter assess reliability in response to the second objective of the study which is to assess data quality hospital data. This chapter implements the *accuracy* dimension of the framework using the *precision* element to assess quality of data across hospital records and birth registrations data through record matching. Matching rates and agreement levels are used to draw conclusion on quality of data.

Chapter 8: A proposal for a systematic and comprehensive birth registration system

This chapter responds to the fourth objective of the study which seeks to identify appropriate interventions towards building a more systematic and comprehensive system. Current legislative environment in relation to registrations of births, data collection instruments as well as processes and procedures are discussed. Equally, legislation applicable to production of statistics and loopholes in these legislations are covered. Proposal and recommendation for system based on appropriate legislative intervention, processes and data collection instruments to meet data needs of various stakeholders with interest in the birth register data are provided last.

Chapter 9: Summary and conclusions

This chapter provides a summary of conclusions reached based on the literature reviewed and empirical findings. Recommendations and suggestion for future research are also tabled.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The motivation for assessment of hospital birth records is to test the feasibility of their use for estimation of the number of births and potential to complement birth register data. In that regard, this chapter reviews literature related to subject of the study. Section 2.2 looks at the development of vital registration globally and within the region, lastly current status in South Africa. The South African health system covering historical development, the public and private health care sectors is reviewed in chapter 2.3. Studies undertaken using both hospital records and vital registration data are also discussed in section 2.4 of this chapter. Three types of studies are identified in this regard; Study dealing with direct methods of data assessment and studies that undertook assessment of content validity. The last category consists of studies using administration data for estimation purposes. Section 2.5 deals with methods and frameworks used to assess administrative data in literature.

2.2 Vital registration

The development of vital registration is discussed under three parts in this section, namely the history of vital registration in various regions of the world. The second and third parts of this section deal with development of vital registrations in Africa and South Africa respectively and current status in South Africa.

2.2.1 The History of vital registration

According to the UN (1955) recording of vital events was originally an uncoordinated concern of individual ecclesiastical authorities motivated by mandatory payment attached to performance of these events. The earliest evidence of registered vital events is thought to be the parish registers of deaths of the Franciscan monastery at Coburg in Germany with entries from 1250–1525 (Wilke, 2004). In France, the earliest evidence of vital records was the statutes of Henri Ie Barbu, Bishop of Nantes, in the main these records were kept to furnish proof of kinship, and provide a means of enforcing the rules of ecclesiastical law which forbade marriage between relatives (UN, 1955).

The origins of civil registration in Europe are thought to have been driven largely by juridical concerns and the desire by the state to monitor and control its subjects (Slack, 2004; Nissel, 1987). In England, the first legislation on vital events was the Registration and Marriage Act of 1836 (Blyth *et al*, 2009**)**, by 1850s the number of births and age-specific deaths for about 635 registration districts covering both England and Wales were already published by the General Register Office (Gregory, 2008). Research indicates that prior to this period, and since the middle decades of the sixteenth century only records of baptisms, marriage banns, burials and marriages conducted in the parish by the minister, instead of actual events of births, marriages and deaths existed (Wilke, 2004; Cameron, 2007; McCandless, 2017). Researchers agree that the real impetus behind the Registration Act in England was the need for an accurate record of lines of descent to facilitate property inheritance and for tax extortion in the case of men (Pullinger, 2013; Wilke, 2004; Blyth *et al*, 2009).

For Scotland as was the case in England, only a system of parochial registration carried out by officers of the established church predates the Registration Act of 1854 (Cameron, 2007; Davis, 2009). Various researchers found that parish records were incomplete (originally only performed for certain denominations) and costly which tended to exclude the poor as they were associated with ability to pay (UN, 1955; Higgs, 2001; Wilke, 2004; Lee, 2009; Cameron, 2007).

In Demark, civil registration can be traced back to 1500 when ecclesiastical events such as births, marriages, and deaths were registered within parishes in a system referred to as Church Books (Krogness, 2011). Denmark is one of a few countries that still maintain a functional parish register system (Church Books), which exist alongside the Danish civil registration system (CRS), the system is now electronic and feeds into the country’s CRS (Schmidt *et al*, 2014). In Russia, the development of a decentralised system of government at local level called Zemstvo around 1861 also included recording of births and deaths, the Russian civil registration system was considered near complete (above 90%) by 1926 (Garenne, 2017).

Registration of vital events in the United State (US) dates back to the early colonial years. The requirement by the Grand Assembly of Virginia in 1632 for ministers or wardens from every parish to provide a register of all burials, christenings and marriages annually at court represented the formalisation of collection of events in the US (Brumberg *et al,* 2012). The first colonial states to involve the state in the collection of vital events were colonies of Massachusetts, Bay and New Plymouth in the early seventeenth century (1639) where government clerks were made record keepers of births, deaths and marriages (UN, 1955). Shapiro & Schachter (1952) observed that prior to the 1900 two forces impeded the development of registration systems, the lack of unifying force across the country and the domination of immigration and internal migration as a source of population change.

The cholera epidemic which engulfed England and Wales in the early 1800s is noted as one of the key events that prompted the creation of the first American State registration law in 1842 (Brumberg *et al*, 2012). The NRC-US (2009) points to the introduction of the *Model Law*, which brought a number of important imperatives for the registration of births. These included the introduction of centrality of the authority of State boards of health over registration matters and the establishment of a strong local apparatus among others. The law also fixed responsibility for registering births on those present at birth (*physicians, midwives)*, called for rigid enforcement of the law, and listed a minimum set of items for inclusion on State certificates. For instance, data items such as maternal and infant variables have been part of birth certificate data in the US since 1939 (Northam and Knapp, 2006).

In Canada, Quebec province was the first province to enact the civil registration law in 1678 (Emery, 1990), while provinces such as Ontario only introduced the registration of births, marriages and deaths in July 1869, through the *Act to Provide for the Registration of Births, Marriages, and Deaths, of 1869* (Hallman, 2015). Other provinces subsequently passed legislation on civil registrations such that by 1916 all Canadian provinces had civil registration offices setup (Emery, 1990).

According to the UN (1955) civil registrations in Latin America developed at different stages, from the 19th century in countries such as Peru (1852) to as late as 1940 in Bolivia. Some countries achieved completeness of civil registration early (e.g. Argentina, Chile), while others like Paraguay took a while to achieve this milestone (UN, 1985).

In Asia most civil registration offices were established after 1850 (UN, 1985). For instance, in Japan, the registration of births and deaths was introduced after 1868 (during the Meiji era) and was considered near completed by 1872 (Garenne, 2017). In India, the registration of Births and Deaths Act was introduced in 1969. However, civil registrations are still limited in its application in India, hence the Office of the Registrar General introduced the sample registration system to measure fertility and mortality rates at national and state level in both urban and rural areas (Gupta *et al*, 2016)

2.2.2 The development of vital registrations in Africa

In Africa, save for fragmentary vital registration during the pre-Christian era in Egypt, used for revenue and military purposes, civil registration was introduced during the colonial period (UN, 1955). During this period different forms of parish birth registration were common in Christian areas on the continent differentiated by denominations largely based on colonial master present (Siiskonen *et al*, 2005). Much of the current civil registration and vital statistics systems are legacies of those colonial administrations. These systems were then discriminative and limited to registration of vital events occurring to specified groups mainly foreigners (Garenne *et al*, 2016; Jewkes and Wood, 1998). Researchers agree that under colonialism the system was used as an instrument of nasty exactions of taxes, rents, conscription and confession obscuring the benefits of civil registration for most African countries, while the mortality of children and mothers went unaccounted (Breckenridge, 2012; Siiskonen *et al*, 2001) In South Africa, Jewkes and Wood (1998) argued that as was the case in most colonised Africa, the introduction of vital events registration requirement largely reflected the colonial master’s selective concern about the vital events and health of their own people than those of indigenous people.

In contemporary Africa, Breckenridge, (2012) sums civil registration and its institutions as faulty and non-existent and attributes the uncertainty about population in Africa to this weakness. For instance, Tobin *et al* (2013) report that several decades after compulsory registration of births and deaths was established in Nigeria about 70% of the over 5 million births annually still went unregistered in 2008 Akesode (1980) wrote that even though compulsory registration of vital events came into effect in 1863 in Lagos Nigeria, the availability of vital statistics from this system has not developed at the same pace.

Most efforts into improving the systems on the African continent were largely statistically oriented with a view to obtaining improved vital statistics on a regular basis and promoting birth registration (Breckenridge, 2012). These were mainly led by international agencies. Garenne (2017) argue that civil registration systems in most European countries were established during periods when income per capita was still low, and literacy not universal, much like the current situation in Africa.

In South Africa, Bah (1999) concludes that the creation and development of a civil registration system was influenced by colonial arrangements and racial imperatives, with the former taking precedence prior to 1910. However, various researchers have pointed to evidence of preoccupation with racial categorisation prior to the formation of the Union of South Africa in 1910 (Breckenridge, 2012; Simkins and van Heynigen, 1989; Posel, 2001). Breckenridge (2012) indicates that scholars of apartheid system have argued that developments in South Africa have shown the state had '*an insatiable appetite'* for information about the population it managed. The author notes weakness in the development of the system of birth registration in South Africa stemming from the presence of a competing scheme for identity registration, a scheme advocating for compulsory universal finger-printing of all African men as an alternative to universal civil registration (Breckenridge, 2012).

The registration of vital events during colonial times started with the registration of marriages, subsequent to which births and deaths were registered. The two colonies (Cape and Natal) and two republics (Transvaal and Orange Free State) which merged into a unified state in 1910 all had their own litanies of legislation based on race (Posel, 2001).

In Natal the first legislation on registration of births and deaths was first passed in 1867, with the Births and deaths Law No. 16 of 1867 amended by Act 17 of 1894 and Act No. 5 of 1896 (Badassy, 2009). The author also notes that this law excluded Africans and Indians, who came under "Native Law" and Indian Immigration Law respectively. Three legislations were applicable for marriages in Natal, Ordinance No. 17 of 1846, made provisions for the registration of European marriages only. The Law No. 46 of 1887 only accounted for marriages of Africans who married under Christian rites (Badassy, 2009). Indian marriages were regulated through Law No. 25 of 1891.

The first Births and Death Registration Act (Act No 7 of 1894) was passed in 1895 in the Cape Colony (Simkins and van Heyningen, 1989). This Act made available for the first time relatively accurate records of the mortality in the Colony, but also the causes of death. The registration of marriages was governed by Marriage Order in Council of 1838 amended by Act No. 16 of 1860. (Posel, 2001)

In the Orange Free State, the registration of births and deaths was governed by Law No. 15 of 1902, while registration of marriages was under Law 26 of 1899. In the Transvaal, Ordinance No. 19 of 1906 governed the registration of births and deaths, while the registration of marriages was provided under Law No. 3 of 1871 as amended by Act No13 of 1909 and by Ordinance No. 19 of 1906, applicable only to Europeans (Posel, 2001). The registration of Coloured marriages was governed by Law No. 3 of 1897.

In 1910, when the Union of South Africa was founded, colonies became provinces within the state (Coovadia *et al*, 2009). The first uniform law on vital events in South Africa, the Births Marriages and Deaths Act No. 17 of 1923 (Act, No. 17 of 1923), did not bring unification or inclusivity to civil registration (Joubert *et al*, 2014).This Act was however, one of the most important legislations to the vital registration discourse, it consolidated classification by population group (Bah, 1999), and excluded 86% of the population by making registration of the three vital events voluntary in rural areas (Bourne, 1995). This law remained in place for seven decades.

The Births and Deaths Registration Act 81 of 1963, which repealed the 1923 Act provided for the registration of births and deaths of Africans/blacks at district level by the Bantu Affairs commissioner while for all other population groups it was to be handled by the district registrar (Joubert *et al*, 2014). This Act, as with the former, also included the provision for voluntary registration of vital event in rural areas (Bourne, 1995; Bah, 1999). The latter act was also amended several times through Act 17 of 1967, Act 18 of 1968, Act 58 of 1970, act 51 of 1974 and Act 35 of 1982 (Posel, 2001). The final amendment under apartheid was through the Births, Marriages and Deaths Amendment Act No.41 of 1986.

The implementation of the National Population Register (NPR) in 1950 through the Population Registration Act of 1950 further impeded the performance of the civil registration system in South Africa (Joubert *et al*, 2014). Originally this register only included Whites, Coloured and Natives (in urban areas only) and excluded Indians/Asians (Bah, 1999). For those included in the register, information on place and date of birth, date of death and date of departure from the Union was captured (Bah, 1999). As Joubert (2014) noted the impetus of the Act was to assign an identity number that included a population group identifier than enhancement of civil registration system

2.2.3 Current status of civil registration in South Africa

The Births and Deaths Registration Act of 1992 ended a century of geographic and population fragmentation (Joubert *et al*, 2013). The Act was amended in 1997 (Act No. 67 of 1997) and again in 1998 (Act No. 67 of 1997) with the last amendment in 2010 through the Births and Deaths Registration Amendment Act, 2010 (Act No. 18 of 2010) (Republic of South Africa, 1992; 2010). Joubert *et al* (2013) list three critical events that facilitated improvements in coverage and content of civil registration in South Africa namely; The implementation of the new Births and Deaths Registration Act of 1992, the adoption of the new Interim Constitution of South Africa in 1993 which consolidated the country into one geo-political unit enabling the centralisation of the civil registration and vital statistics system.

Lastly, the formation of a strategic collaboration among role players in CRVS in the country was one of the key interventions. Act 51 of 1992 also introduced new birth and deaths notification forms (BI-24 and BI-1663 respectively) which were later replaced by DHA-24 and DHA-1663 (*See the DHA-24 in Appendix A*). The DHA-24 is used to register children within 30 days after birth, and form DHA-24/LRB (late registration of birth) for persons registering 30 days after their birth date (Republic of South Africa, 1992). The DHA-1663 is used to register deaths and stillbirths occurring within the country.

The DHA-24 has three sections; section A asks information on the child including surname, names, date of birth, place of birth, (city, province and country) and marital status of the parents. Sections B and C ask information on the father and mother respectively. Data items asked includes ID number, surname names (and maiden names), date of birth, place of birth, (city and country) and citizenship. Age of the mother is not asked directly in the DHA-24, but the date of birth of the mother, which allows derivation of mother’s age at birth of her child. Although marital status of parents is asked in the DHA-24, this information is not available in the data accessed by Stats SA. However, DHA require a marriage certificate where the birth occurred to married parents and in cases of non-marital births, where the father wants to appear on a certificate, he must sign acknowledgement of paternity. The father’s information is part of the data.

In most countries with advanced civil registration systems, information related to birth and its outcome (death) is part of the birth certificate data collected at health facilities where the birth occurred. Such data are used extensively to track trends in demographic characteristics, health care utilisation, obstetric care, and maternal and infant health (Martin *et al*, 2013; Murray *et al*, 2012). Examples of studies using births certificate data to assess health related issues include those by Branum *et al* (2002) who used birth certificate data to compare primary risk factors associated with low birthweight and preterm births among children born to black and white women in the US. Kramer *et al* (2000) undertook a comparative study of the US and Canada using births certificate data to construct birth cohorts for the years 1985 to 1994 to assess the quantitative contribution of mild (defined as births at 34-36 gestational age) and moderate (births at 32-33 gestational age) preterm births to infant mortality.

Although the revision of the births and deaths registration forms in 1998 was aimed at bringing South African data in line with international standards, and to ensure additional information needed within the health information system is collected (Bradshaw *et al*, 1998), this has been true in the case of the DHA-1663. Changes made to this form have ensured improvement in the collection of a chain of events leading to death sufficient to derive the underlying causes of death (Bradshaw *et al*, 1998). Efforts were also made to ensure that information collected follow the convention proposed by the International Classification of Diseases (ICD) (Joubert, 2014). The review also ensured separation of information collected for statistical purpose and information for registration purpose.

Cause of death statistics are an essential data source for monitoring population health, identifying health priorities and planning (Bradshaw *et al*, 1998). Ideally such information is obtained from a well-established system of vital registrations. Currently in South Africa, the only national source of data on early childhood deaths from the vital registration system is based on information from the DHA-1663 that is processed at Stats SA.

The Perinatal report is an annual report on perinatal deaths that occur in South Africa based on data from the vital registration system. Although this information is derived from the DHA-1663, it still relates to deaths in the perinatal period. This data is also characterised by missing data and misclassification of causes of deaths. The report noted limited number of variables for in-depth analysis, particularly factors related to the mother (Stats SA, 2017). The 2015 report found that almost 40% of the total proportion of perinatal deaths was assigned to ill-defined causes. Information on maternal characteristics was missing for almost 60% of cases (Stats SA, 2017). The outcome of previous pregnancy and gestation period were missing in 75.4% and 16.4% of cases respectively (Stats SA, 2017).

Research has shown that historical developments have affected the completeness and quality of data on vital events of mainly Black Africans. Simkins and van Heyningen (1989) found that even after the scope of registration of vital events was extended nationally in the latter stages of the twenty first century, coverage was still below fifty percent. This limits the use and generalisability of civil registration data considerably (Nannan *et al,* 2015). The authors estimated completeness of Black African death registration to have ranged from about a quarter of all deaths during the late 1960s to about half in the mid-1980s.

Birth registration is therefore critical to maintaining accurate and complete NPR and issuing of all enabling documents (Giese and Smith, 2007).

Extensive resources invested into improvements of the vital registration system in the post-1994 period resulted in fruitful gains in the registration of vital events. Empirical evidence points to positive results of the intervention in South Africa. Hill (2009) estimated a completeness level of 84% using data from the South African Community Survey 2007. Nhlapo (2016) found completeness to be around 87% in 2008 for current registrations, while Stats SA (2013) estimated 89.2% based on the 2007- 2011 intercensal period. Provincially, an earlier study by Stats SA (2007) established variation between provinces. Western Cape, Northern Cape and Gauteng provinces had the highest completeness estimates in the country, at 96.7%; 82.2% and 81.4% respectively. Kwa-Zulu Natal and Eastern Cape provinces were found to have the lowest completeness estimates at 56% and 58% respectively, while Mpumalanga was estimated at 66.2%. Nannan *et al* (2015) found that provinces previously found to have lower completeness estimates made progress in subsequent years. There exists a likelihood that discrepancies observed provincially might be even more pronounced at lower levels even for provinces such as Gauteng which appear to be performing well. No attempt has been made to estimate completeness at sub-provincial level.

2.3 The health care system in South Africa

2.3.1 Historical development

Historically, the South African's health care policy as observed with other colonialised countries, was driven by political imperatives meant to benefit a small elite group of colonials and their workers (McIntyre *et al*, 2007). This created service delivery gaps across regions and population groups, which persist to the present (Delobelle, 2013).

Delobelle (2013) identifies two key eras in the development of South African health system; the pre-apartheid era which he locates as the period between 1652 and 1910, centred around the development of a hospital based system, and the apartheid era health system which introduced fragmentation and deregulation. Van Rensburg and Harrison (1995) on the other hand delineates six different periods in the policy and legislative development within health sector in South Africa:

- The first period was characterised by British influence in institutionalisation and professionalisation of health care. This period also saw the development of first health infrastructure under British rule.
- The first health legislation with national jurisdiction, was the Public Health Act of 1919 which was introduced during the second phase represented by the period between 1919 and 1940.
- The third phase was between 1940 and 1950 was a period characterised by cultivation of the vision of a unified, comprehensive and state-funded national health service, based on primary care within the health sector.
- The fourth period coincided with the victory of National Party and the introduction of legislated racial discrimination and segregation. This is represented by the period between 1950 and 1990, which had a profound effect on both health services and health outcomes of the population that lasted for decades.
- The fifth and sixth period, between 1990 and 1994 and beyond, was the transitional periods characterised by ambitious and radical change to the health system, mainly to improve coverage of total population.

Katuu (2015) extended these developments to include the seventh period representing the period up to the promulgation of the National Health Act from 2003 and beyond.

Kautzky and Tollman (2008) identified two developments during the apartheid period that were particularly damaging to South Africa's health care, namely; the racial fragmentation of health services; and the deregulation of the health sector. Katuu (2015) submits that in principle, transition from one health Act to the next in South Africa was usually triggered by the need to address identified weakness in existing legislative instruments. The author further notes numerous advances in health policy, legislative instruments and health system that have accompanied the historical evolution of South Africa's health sector, dating back to the 17th century. There is also general admission of the role of political and socio-economic imperatives in the numerous transitions observed over time in South Africa (Delobelle, 2013; Van Rensburg and Harrison, 1995; Katuu, 2015).

The first attempt at health regulation was around 1807 with the establishment of the Supreme Medical Committee under British colonial rule (Jaques and Fehrsen, 2007). The first Public Health Act was promulgated in 1883, this Act made the notification and inoculation of smallpox compulsory (Delobelle, 2013). The first national legislation during the apartheid era was introduced through the Public Health Act of 1919, it established the first public health department in the Union and introduced the new three tier health system. Under this new system, preventive, environmental, antenatal, and child care were provided at municipal clinics (Delobelle, 2013).

Post-Apartheid South Africa inherited one of the least equitable health care systems in the world. Pre-independence, South Africa consisted of 14 separate health departments based on race, ethnicity and geographical area emanating from the separate development policies (Cavoodia *et al*, 2009). The new government faced a daunting task of merging these fragmented entities administratively. The National Health Act (Act 2003) was largely promulgated to address inherited fragmentation and to give effect to the right of everyone to have access to health care services (Katuu, 2015). The Act, subsequent amendments and associated regulations also strived to address emerging health challenges faced by the country in the post-apartheid era. The 4th edition of the Guidelines for Maternity Care in South Africa published by the National Department of Health in 2015 is among such interventions. The guidelines were meant among other things, to provide practical approaches for management of pregnancy, labour and delivery in South African health sector in an era where the advent of HIV/AIDS epidemic saw quadrupling maternal mortality ratio (MMR) in the country (Malherbe *et al*, 2016).

Katuu (2015) submits that the extent of fragmentation and inequality observed at the dawn of South Africa's new democracy in 1994, indicated a health sector in dire need of transformation. Key among the challenges was large inequalities in the distribution of infrastructure, financial and human resources and between geographical areas and sectors (Cavoodia *et al*, 2009; Delobelle, 2013). It is also within the historical context that the two tiered system consisting of the private and public sectors emerged in South Africa (Thomas, 2016). Research locates the historical development of private hospitals to non-profit mission hospitals, mainly in rural areas, and within industry facilities large mines (Komape, 2013; McIntyre *et al*, 2007; Coovadia *et al*, 2009). The rapid growth of profit hospitals occurred in the late 1990's (Komape, 2013).

2.3.2 Public health care in South Africa

South Africa adopted a healthcare delivery model called the District Health System (DHS); a system centred on districts as main focus of health care delivery and implementation of primary health care services. For purposes of this model, the country was divided into 39 health regions and 174 health districts (DoH, 2015) and provision of health services subdivided into four levels of care comprising of hospitals, community centres and clinics;

Community level - This level consists of clinics and community health centres and represent entry into the health care system. Antenatal care and family planning services, chronic diseases and child health services such as immunisation are provided in these facilities (DoH, 2015).

The second layer on this level consists of community health centres (CHC) which provide 24-hours comprehensive health service and include an obstetric unit run by midwives, providing delivery of low risk pregnancies (DoH, 2015; Chopra *et al* ,2009).

The district level – The health district is the main locus of the primary health care model (DoH, 2015). Each health district has a district (Level 1) hospital, expected to handle patients within the surrounding geographical area. (Ncana, 2010). For maternity purposes, district hospitals handle trauma, emergency care and obstetric care (DoH, 2015). These hospitals are staffed by specialist family physicians, obstetricians/gynaecologists and pediatricians who attend to high risk pregnancies and caesarean section deliveries (DoH, 2015).

Regional level - The health region consists of one or more regional or level 2 hospitals serving a number of districts. Hospitals at this level also provide 24-hour service for acute gynaecological and obstetric problems and deliveries of most high-risk pregnancies (DoH, 2002).

Tertiary/Central Hospitals: - Also referred to as Level 3 and Level 4 hospitals, these hospitals render specialist care and accept referrals from a number of regional hospitals and provide facilities for training of health care workers and research. In relation to maternity cases these facilities provide the management of extreme illnesses or difficult obstetric cases (DoH, 2015).

Provincial level: According to the National Health Act, (Act 61 of 2003), provincial health authorities have a mandate to monitor and evaluate health services at district level (Ncana, 2010).

National level - The national level is responsible for developing guidelines and strategies for all health care in the country (Ncana, 2010).

Public health care in South Africa follows a hierarchical referral system. In this system, patients are referred from lower to higher level of care (Murray and Pearson, 2006). The WHO (2003) defines referral as a process in which health workers at one level of the health system, having insufficient resources (drugs, equipment, skills) to manage a clinical condition, seeks the assistance of a better or differently resourced facility at the same or higher level to assist in, or take over the management of a client's case. In the case of South Africa this is from clinic or community health centre (CHC) to a district or regional hospital and higher.

Ncana (2010) notes that the fundamental principle of primary health care is the close relationship between all levels of care in the system; starting at community level extending upwards to district health hospital and beyond. An efficient referral system also has cost reduction benefits for hospitals and primary health care services (WHO, 2003).

2.3.2.1 Referral of pregnant women in the public sector

Maternity care provision and referral criteria in the public sector are set out in the Guidelines for Maternity Care in South Africa (DoH, 2000). The guidelines provide a practical approach for primary healthcare to manage pregnancy, labour and delivery in public facilities (Malherbe et al, 2016). For maternal care and pregnancy management purposes clinics should provide antenatal care and management of child health. Community health centres are expected to provide maternity service from an obstetric unit run by midwives. All other complicated pregnancies are referred to higher levels of care (DoH, 2015). The CSIR and NDoH (2013) described the South African maternity care as a complete paper-based system using standardised forms and stationery.

Women who present at clinics upon pregnancy are issued with Maternity Case Record (MCR) at the first visit. The MCR was introduced by the South African Department of Health (DoH) in 2007 as one of the key interventions to improve the care of pregnant women (DoH, 2015). It is a standardised record used within public health facilities in South Africa and issued to pregnant women who attend antenatal care (DoH, 2015; Cele, 2014. During pregnancy the record is used to monitor the mother’s health and once the child is born their information is capture in the record. The MCR is retained by mothers until delivery, after which it is kept at the place of final referral, which is mostly where birth occurred (DoH, 2015). The contents of the MCR will be discussed in section 6.2.1.1.

Only limited research has been conducted using MCR in South Africa. Mugerwa–Sekawabe (2007) used the records to determine the extent to which pregnant women are appropriately referred from district to regional hospitals in the Eastern Cape Province according to the criteria described in the Guidelines. A study by Cele (2014) assessed the extent to which the implementation of the new maternity case record has impacted quality of care for pregnant women. The author found that although recording was done fairly well, a number of activities and interventions were poorly recorded or not recorded at all in some primary health care clinic. Sibiya *et al* (2015) found that mid-wives in EThekwini in Kwa-Zulu Natal made photocopies of the MCR due to delivery challenges experienced in primary health care facilities. Patience *et al* (2016) analysed MCR for evidence of adequate application of basic antenatal principles of good care and guidelines in primary health care clinics in eThekwini district, KwaZulu-Natal.

The above notwithstanding, the adoption of a district centred system has been heralded as one of the biggest post-1994 innovations in South Africa. However, research points to a number of challenges within the system (Harrison, 2009). Rispel (2016) notes persistent inequalities between the public and private health sectors, between urban and rural areas and even within provinces almost twenty-two years into the new dispensation in South Africa. Harris *et al* (2011) found marked disparities between the type of care accessed, both between private and public sectors, and within the public sector itself. They note the concentration of better resourced tertiary hospitals in largely urban, wealthier provinces of Gauteng and Western Cape which advantaged richer, urban, and insured population.

According to Chopra *et al* (2009) the paradox in South Africa is that although the health sector has both supportive policies and extensive funding, high rates of maternal and child health services use, yet poor and in many cases worsening health outcomes are still the norm. Covaadia *et al* (2009) identified several factors constraining the complete implementation of the DHS including; inadequate human resource capacity and planning, poor stewardship, leadership, and management as well the impact of AIDS epidemic.

Although a large section of the South African population uses public health services, empirical evidence has shown that towards the end of the 1990's close to 60% of resources were used by the private sector, serving about 20% of the population (Braa and Hedberg, 2002; Garenne et al, 2001). Mayosi *et al* (2014) note the extensive disparity in annual per capita expenditure on health between private and public sector, estimated at approximately $1,400 and $140 respectively in 2005. Benatar (2004) notes the replacement of economic affordability as grounds for access to better health care to racial discrimination of the past in post-apartheid South Africa.

In 2005 Cavoodia *et al* (2009) found that although less than 15% of South Africans belonged to private medical schemes, 46% of all health-care expenditure was attributable to these schemes. The study also revealed that a further 21% of the population used the private sector on an out-of-pocket basis mainly for primary level care, while dependent on the public sector for hospital care. Stats SA (2019) reported while a largest proportion of households use public sector at first consultation (65%), the proportion using private doctors at first consultation has remained in the 24% and 27% range between 2004 and 2018. Coovadia *et al*, (2009) also found that 64% of the population is entirely dependent on the public sector for all their health-care needs. In the rural areas, SAHR (2011) found the private sector comprised mostly of General Practitioners (GPs) who run cash practices and either use local public sector hospitals or private facilities in larger towns and cities as referral centres. The study also reported that provincially, Northern Cape had the lowest number of private hospitals (3) and Gauteng the highest at 95, however when the proportion of rural population is brought into focus, Limpopo fared badly at only 0.11/per 100 000 rural populations. Katuu (2015) found that in rural areas, patients circumventing primary care institutions, in order to access doctor's appointment. This inequality was part of the motivation for the adoption of the new health system by the new government (Braa and Hedberg, 2002).

Chopra *et al* (2009) points to the suboptimum nature of referral systems, and the tendency for patients to bypass lower levels of care. The SAHR (2011) reported that in most rural areas specialist services are rarely available at regional hospitals, in such cases patients are referred to tertiary services, usually even further removed geographically. A study by Mugerwa–Sekawabe (2007) found that about 65% of women who should be managed at district hospitals were inappropriately referred to a regional hospital because of shortage of maternity care providers. In the Free State Mojaki *et al* (2011) found that most patients seen in out-patients' department (OPD) and casualty in a district hospital in Thaba-Nchu could have been consulted at PHC facilities. Murray and Pearson (2006) concluded that most acts of by-passing levels of care by pregnant women reflect justifiable lack of confidence in the quality of care available or in the efficiency of subsequent referral-on processes.

Above challenges notwithstanding, research indicates high rates of use for primary health care in South Africa; 94% of women attend at least one antenatal visit in 2016 (DoH *et al*, 2017; Silal *et al*, 2012).

2.3.3 Private health care in South Africa

The South African private healthcare sector consists of generalist and specialist practitioners, pharmacies and a large number of private hospitals or clinics (Gilson and McIntyre, 2007). It is standard practice in South Africa for private specialists to be located within private hospitals and women are admitted in facilities at the onset of labour (Komape, 2013), the same is the case with private pharmacies. Stuckler *et al* (2011) points to acceleration in the number of private hospitals in the post 1994 period as a reaction to inclusivity, pressure to reduce the budget deficit by government and an international climate favouring private-sector provision of health care. The authors note that in Gauteng Province alone, between 1998 and 2004, twenty new private hospitals were built and by the end of this period 128 of 157 hospitals in this province were private (Stucker *et al,* 2011). The HST (2006) reported that 16 of the private hospitals in Gauteng were located in Ekurhuleni, while in the case of Mpumalanga, although the province had eight private hospitals in 2008, only two were within Ehlanzeni district and none within Nkomazi municipality.

The study by Naidoo and Moodley (2009) found evidence that majority of those attending private practice were on medical aid scheme and belonged to the middle and high socio-economic groups. According to Delobelle (2013) private sector spending on health care exceeds public sector expenditure, which mainly serves the black African majority through free primary health care services (PHC) to secondary and tertiary care offered at state owned hospitals, while the private sector offers world-class facilities for the insured minority, or for those who can afford care on an out-of-pocket basis.

Nkundla (2004) noted that about R3, 5bn is spent on healthcare in SA, while the HST (2010) found that only about 17% of the population used private health facilities for deliveries. The SADHS (1998) reported that about 82.1% of White women used private doctors for both antenatal care and births, while only 22.8% of African women were attended by private doctors (DoH, 2002), population group was not considered in the 2016 SADHS. The GHS 2015 reported that roughly one fifth of those in the poorest quintile use private providers (private doctors) on out of pocket basis (Stats SA, 2016). The same observation on the use of private insurance and out-of-pocket payments for antenatal care and births was made by Victoria *et al* (2010) in Brazil.

The 2016 SADHS reported that 87.4% of women gave birth in public health facilities while only 8.5% enjoy high-quality private medical care. A study by Montagu *et al* (2011) based in 48 developing countries show that while 56% of home births in the poorest wealth quintile were unattended by a trained professional over the period 2003 to the 2011, among wealthy women about one in four home births were attended by a doctor, clinical officer, or nurse and these were elective.

2.3.4 Births in health facilities in South Africa

The South African Demographic Health Survey (SADHS, 2016) found that 96% of women reported giving birth in a health facility in the three years preceding the survey (DoH *et al,* 2017). Although there was slight provincial variation, with provinces such as Eastern Cape showing lower proportions (91.3%), generally the estimates were high. These figures represented great improvement from 1998 where nationally 14% of births occurred at home and higher proportions were reported from Mpumalanga and Eastern Cape at 23 percent and 25 percent respectively (DoH, 2002).

Notwithstanding the above achievements, maternal care is still faced with a number of challenges within health system in South Africa. A study by Thomas *et al* (2007) based at a Gauteng sub-district found preference for hospital deliveries instead of Midwife Obstetric units at community health centers among patients. Perceptions of better quality of care and proximity to the hospital were cited as reasons for preference. Chopra, (2009) found that of the total number of birth that occurred in public health facilities, 17% took place in clinics, 42% in district hospitals, 30% in regional hospitals, and 11% in tertiary hospitals. Mashishi (2012) found that both pregnant women and paramedics tended to by-pass the midwifery obstetric unit and go directly to hospital for delivery.

The 2012-2013 Saving mother and babies report found that most births and infant deaths occur at district hospitals (DoH, 2014). The report also found that at lower levels of care, defined as Community Health Centres, District Hospitals and Regional Hospitals, major causes of infant and maternal deaths were; unexplained stillbirths, spontaneous preterm labour and intrapartum asphyxia. Whereas in the higher levels of care (Tertiary Hospitals and National Central hospitals) complications of hypertension, antepartum haemorrhage and spontaneous preterm labour were the major causes of death (DoH, 2014). Rhoda *et al* (2018) note that the 6th perinatal care survey attributed 46% and 39% of early neonatal deaths to district and regional hospitals, respectively.

Childhood mortality is a good indicator of the effectiveness of a country's health care system and socio-economic development (Stiegler, 2008). Understanding the causes of child mortality provide important public health insights, helps identify health priorities and planning for health service delivery (UNICEF, 2015).

Continued underreporting of births and deaths renders the South African health system inadequate for monitoring purposes (Nannan *et al* 2012). While there is often lack of consensus on infant and under-five mortality rates, data indicates that although steady declines have been observed recently, rates are still high (DoH, 2014, Nannan *et al,* 2012). For example, data on under-five mortality rate improved from 56 per 1000 to 42 per 1000 live births, from 2009 to 2011. Mayosi et al (2014) estimated that NMR declined from 19 to 15 per thousand and infant mortality rate from 46% to 15% between 1995 and 2012.

Notwithstanding differing estimates of childhood health indicators, there is general consensus by researchers that for South Africa, these figures are still too high given the level of expenditure on health care and economic development of the country (Chopra *et al*, 2009; Covaadia *et al*, 2009).

2.4 Studies on the use of administrative data

Studies conducted using administrative data sources such as hospital records and vital registration data can be categorised into three types. There are studies which used direct methods such as linkage of births and deaths registration data with other data sources to assess completeness of reporting.

Record linkage studies include those by Vinikoor (2010) who evaluated the reliability of birth certificate data by comparing them with data from the Pregnancy, Infection, and Nutrition cohort study. The author found high agreement between the two data sources, especially for maternal demographic and birth outcome variables. Park *et al* (2011) linked Florida birth certificate data with first trimester Women, Infants, and Children (WIC) Program data for women with a live birth during the last quarter of 2005. Martin *et al* (2013) evaluated the quality of selected medical and health data from the 2003 revision of the US birth certificate by comparing birth certificate data with information abstracted from hospital medical records.

Zollinger *et al* (2006) assessed the accuracy and completeness of birth data reported on the electronic birth certificates in Indiana State Department of Health on a random sample of hospital birth records related to the 1996 calendar year.

Shapiro *et al* (2016) linked birth and death registration data based on a cohort of births that occurred from 2004 to 2006 with the 2006 Canadian census to estimate relative risks and risk differences for preterm birth, small-for-gestational-age birth, stillbirth and infant mortality associated with the absence of paternal information. They concluded that missing paternal information was a marker for increased risk of adverse birth outcomes, over and above maternal characteristics. Black *et al* (2007) linked the Norwegian birth registry data with other administrative data including education register, family register, and the tax and earnings register covering a population aged 16 to 74 to examine the effects of birthweight on both short-run (such as mortality) and long-run outcomes. The authors found significant effect of birthweight on longer-run outcomes such as adult height, IQ, earnings, and education. A study by McKinnon *et al* (2016) used a combined Canadian Live Birth, Infant Death and Stillbirth database linked with 2006 Canadian census data to compare differences in preterm birth between non-Hispanic black and white women in Canada and the US. Disparities were found to be less extreme in Canada largely attributed to different historical experiences of black populations in the two countries and impact of Canada's universal health care system on health outcomes. Bushnik *et al* (2016) used deterministic techniques to match the 2006 Canadian Census records to the database from live birth, infant death and stillbirth records to create Canadian birth cohorts.

The second group of studies focused on assessment of content validity, looking at consistency of data items reported between different sources. Studies in this group includes those by Frohnert *et al* (2005) who used hospital discharge data to assess if ICD-9-CM codes used in discharge data correctly identified infants with birth defects than birth certificate data. The study found additional defects included in discharge data but not in birth certificates, that ICD-9-CM codes from hospital discharge data identified most infants with cardiac defects and some false positive diagnoses. Boulet *et al* (2011) evaluated variation in birth defects reporting on birth certificates based on maternal and infant characteristics and hospital size. The study found socio-demographic and hospital characteristics had an effect on birth defects reporting on birth certificates. A study by Roseman (2010) compared maternal characteristics, maternal co-morbidities and complications of pregnancy, and adverse infant outcomes among live births from assisted reproductive technology (ART), and non-ART live births in Texas using birth certificate data. Nojilana *et al* (2009) used information recorded on death notification forms in a hospital in Cape Town to investigate the quality of cause of death certification and level of under-reporting of HIV/ AIDS as a cause of death

In England, Murray *et al* (2012) examined completeness of recording for baby tail fields over a period of five years (2005/06–2009/10). They compared hospitals with highly complete data with the others in terms of hospital characteristics focusing on levels of recording of key birth variables such as gestational age and birth weight. They classified hospitals into two groups; those with birth records containing complete recording of the two key variables and those with low or incomplete recording of these variables. Harper *et al* (2011) used Missouri linked birth, fetal, and infant death certificate data of singleton pregnancies of primiparous women less than 20 years' old who delivered between 24 and 44 weeks of gestation from 1989 to 2005. They examined the Institute of Medicine (IOM) recommendations for gestational weight gain in adolescents by investigating the relationship of weight gain less than, within, or greater than the IOM recommendations with pregnancy outcomes and infant birthweight.

The last group consists of studies which used administrative records for estimation purposes or to study some aspect of data contents. A study by Kreyenfeld *et al* (2010) used the German birth order register and hospital birth statistics to generate birth order-specific fertility rates for the period 2001 to 2008. A study by Varghese *et al* (2005) used hospital records to identify emerging pattern of sex ratio at birth [SRB] of hospitalised deliveries in the state of Delhi and various demographic and socioeconomic factors based on a number of variables. Lampi *et al* (2012) used the Finnish Hospital Discharge Register to identify cases with ICD-diagnoses of childhood autism, Asperger syndrome, to assess whether after controlling for maternal age, parity, smoking during pregnancy, birth weight and gestational age information predicted ASD.

Zumpe *et al* (2012) investigated childbearing among UK born and non-UK born women living in the UK during the period 2007 -2011 and the fertility patterns of the two groups. A study by Margett *et al* (2002) assessed differences and trends in birth weight between first and second generation South Asian babies born in Southampton, since 1957 through birth records of women of South Asian origin who gave birth in Southampton from 1957 to 1996. El-Sayed and Galea (2009) used birth records in the US state of Michigan to assess if factors such as maternal age, parity, education, marital status, tobacco use, and maternal birthplace may contribute to the association between ethnicity and preterm birth risk in Michigan.

Klemetti *et al* (2013) compared the use of maternity care and birth outcomes by maternal age between 1991 and 2008 to establish whether older maternal age at first birth was still an obstetric risk in 2008 using the Finland national birth register data. A study by Ekert-Jaffe *et al* (2002) linked birth registration and data from three censuses carried out between 1968 and 1991 to compare fertility in France and Britain by birth order according to the age and socio-economic characteristics of women and of their partner. Li *et al* (2013) used hospital based Chinese Birth Defects register to investigate the epidemiological patterns of neural tube defects and urban–rural disparities in prevalence of neural tube defects at any weeks of gestational age in China during 2006–2008.

2.4.1 Studies using administrative data in South Africa

A few studies have been conducted using administrative data within the health sector in South Africa and most of these focused on assessment of deaths and causes of death data and even fewer on births from the vital register. A study by Joubert *et al* (2014) compared civil registration and demographic and health surveillance site (DHSS) mortality data for the same individuals to estimate the level of completeness of death registration in the CRVS system. The author also assessed the level of agreement between vital register and verbal autopsy cause-of-death data. A study by Kahn *et al* (2000) validated the results of verbal autopsies (VAs) conducted on all deaths recorded during annual demographic and health surveillance over a 3-year period, 1992-1995 in the Agincourt surveillance site in Bushbuckridge by comparing them with hospital reference diagnoses obtained for those who died in a district hospital. They found that frequency distribution of causes of death based on VAs closely approximated that of the hospital records used for validation. A validity study by Burger *et al* (2012) compared causes of death recorded on hospital records and death notification of patients that died in Cape Town during 2003 and 2004 period and found poor agreement. Khoza [*unpublished PHD Thesis*] investigated the reliability of death and causes of death data from Emalahleni Municipality in Mpumalanga Province by linking the death registration data with hospital and other administrative data sources. Naidoo and Moodley (2009) used patient records within a specialist private practice to audit all caesarean sections done in private practice over a period of one year in 2004.

Kabudula *et al* (2014) applied deterministic and probabilistic record linkage approaches to mortality records from 2006 to 2009 from the Agincourt HDSS and those in the CR system to evaluate the quality of record linkage between the two data sources. They found that a total of 2264 out of 3726 (60.8%) mortality records from the two sources could be linked through the combined deterministic and probabilistic record linkage approaches, while 87.0% of the records were successfully linked through the probabilistic approach independently. Joubert *et al* (2014) linked the same data to examine the quality of Bushbuckridge municipality civil registration data, a rural municipality in Mpumalanga province in South Africa.

Hoque *et al* (2011) used neonatal admission records and discharge registers to identify the probable, primary and final causes of admissions and deaths in a rural hospital in KwaZulu-Natal. Ellison *et al* (2009) examined the reliability of hand-written birth files and computerised birth records at (Chris Hani) Baragwanath Hospital in Soweto. They found that for 539 of the 2120 births that occurred at Baragwanath Hospital, it was possible to locate the original records with maternal age, gravidity, and infant sex, date of birth, birth weight and gestational age at birth, contained in obstetric and neonatal hospital files. Ntuli and Mahlangu (2012) used hospital records of women who gave birth in a Limpopo Tertiary hospital to determine the level of stillbirths.

2.5 Methods and frameworks for assessing administrative data

Direct and indirect methods are often employed by researches in the evaluation of data quality, largely related to evaluation of administrative data. Direct methods match individual records with records in other data source containing some or all of the same information from an independent source such as hospital records or other administrative data (UN, 2014). These methods are ideal for estimating coverage and accuracy (UN, 2014). Indirect methods involve examination of internal consistency of data and validation of the same data overtime.

2.5.1 Frame works for evaluating CRVS data

Complete civil registrations data is regarded as gold standard for measurement of demographic and health outcomes (Joubert *et al*, 2012). Understandably due to the importance of mortality and causes death data to health outcomes, some of the most successful data assessment frameworks were designed for the assessment of mortality and causes of death data.

The comprehensive assessment criteria for evaluation of quality of cause-of-death statistics was first introduced by Ruzicka and Lopez (1990) for purposes of assessing mortality data submitted by countries to WHO. Subsequent studies expanded on the original method by these authors including one by Mahapatra *et al* (2007) which introduced an assessment framework for vital statistics derived from civil registration systems that is consistent with quality dimensions for official statistics. The five dimensions covered in the Mahapatra *et al* framework are; ***Accuracy, Relevance, Comparability, Timeliness and Accessibility.***

The first dimension; *Accuracy* consist of six elements encompassing; *a) Coverage – which is the p*ercentage of population living in areas where civil registration is functional*; b) Completeness* - the percentage of events contributing to mortality or fertility statistics*; c) Missing data* – Proportion of key variables with response not stated. The last three elements within this dimension relate to quality of causes of death, these are; *d) Use of ill-defined categories; e) Improbable classifications; f) Consistency between cause of death and general mortality.*

The second dimension is *Relevance* which is defined through two elements which measures data quality, namely; *a) Routine tabulations* – This deals with existence of tabulation *b*y sex and 5-year age groups, based on place of usual residence*; b) Small area statistics* - Number of general vital statistics tabulation areas per million populations.

The *Comparability* dimension encompass two elements that of; *a) Over time* - Stability of key definitions over time*; b) Across space* - Uniformity of definitions across areas.

The fifth dimension of the framework is *Timeliness* which defines two elements namely;

a) Production time – This indicates the *m*ean time from end of reference period to publication and*; b) Regularity* – which is an indicator of Standard Deviation (SD) of production time.

The last dimension is *Accessibility* which defined by three elements, namely; *a) Media* – Which denotes the number of formats in which data are released*; b) Metadata* – Deals with availability and quality of documentation*; c) User services* – covers the *a*vailability and responsiveness of user service.

Rao *et al* (2005) proposed a framework with four elements which was successfully applied to civil registrations data from China and subsequently used by Franca (2008) to assess mortality and causes of death data from Brazil. Elements of the framework include; ***Generalisability, Reliability, Validity*** and ***Policy relevance.***

The *Generalisability* aspect of the framework consists of two sub-criteria namely; *Coverage* and *Completeness*. *Coverage* refers to the population covered by the data, or to which the data relate for instance rural/urban, geographical location or even socio-economic group. *Completeness* indicates; for a given event, the percentage registered in a given population. Two aspects are considered under *Reliability* criterion; namely the consistency of cause-specific patterns with general mortality and consistency of cause-specific mortality rates over time (e.g. over 5 years). *Validity* criterion consist of three sub-criteria namely; a) *Content validity – b) Use of ill-defined categories and codes lastly; c) Improbable age or sex dependency*. The last element of the framework is *Policy Relevance***,** which consist of two sub-criteria; a) *Timeliness* and*; b) Geographic disaggregation.*

Rao *et al* (2005) also proposed a three-tiered measure for evaluating data quality as part of the model. Using this measure, the authors classified mortality data quality as either *satisfactor*y or *unsatisfactory* and, for cases where information is unavailable or inadequate, the option *unknown quality* was proposed. These measures were accompanied by suggested thresholds measures. For instance, for content validity, a proportion of ill-defined cause of deaths greater than 10%, implies inadequate medical certification process, is assigned *unsatisfactory* rating, based on the model.

Both Rao *et al* and Mahapatra frameworks have been used in South African studies evaluating quality of mortality data. This includes studies by Joubert *et al* (2013), who used the criterion developed by Rao *et al* (2005) to evaluate the country mortality data from vital registrations for the period 1997 to 2007. Khoza (*unpublished thesis*) adopted modified versions of both frameworks to assess death data from Mpumalanga Province for the period 1999 to 2005.

Other frameworks include the Vital Statistics Performance Index (VSPI) developed by Phillips *et al* (2014). The VSPI assesses CRVS performance using quality mortality data as proxy for quality and utility of all vital statistics produced by the civil registration system. Mikkelsen *et al* (2015) applied the VSPI to data from 148 countries or territories during 1980 to 2012 period to assess the performance of CRVS systems. They classified CRVS systems into five distinct performance categories, ranging from rudimentary (*with scores close to zero*) to satisfactory (*with scores close to one*).

2.5.2 Frameworks used in the assessment of hospital records

In a number of frameworks proposed and applied to assess hospital records data, the criterion typically used are consistent with those used in the assessment of vital registration data with occasional adjustment. Direct and indirect methods also apply to hospital records. For instance, Sørensen *et al* (1996) suggested seven elements for assessment of quality of hospital data. The dimensions identified include;

a) For *Completeness of registration;* three sub-categories are identified under methods of valuating completeness of data; i) comparing the data source with one or more independent reference sources, ii) Comprehensive records' review methods and iii) Using aggregated methods in which the total number of cases in the data source is compared with the total number in other sources.

b) *The accuracy and degree of completeness of variables*- Two types of errors in the data are identified namely*;* 1) random errors and 2) systematic errors.

c) *The size of the data sources* - The size of a data source affects the statistical output. For instance, large data source will give statistically significant results, and vice versa.

d) *Data accessibility, availability and cost.* - Relates to the importance of clarifying data ownership and approval protocols prior to undertaking research.

e) *Data format* – Whether data is in the form of paper records from hospitals or computerised should be established in advance, to allow proper planning.

f) *Record linkage* – Record linkage techniques can help identify the same individuals in different files from various data sources (Sorensen *et al*; 1996).

In a study aimed at assessment of usability of hospital birth records data to create birth cohorts, Murray *et al* (2012) used the completeness element to assess information captured in hospital birth records of the English Hospital Episode Statistics (HES) in England. Based on their assessment, only birth records from hospitals with over 90% recording of birth weight and gestational age variables were used. The authors also identified methodological issues to be address when using administrative data, including the structure of data, definition of concepts used and data collection methods.

The Canadian Institute for Health Information (CIHI) developed one of the most comprehensive frameworks for evaluation of health databases (Long and Seko, 2001). The CIHI Data Quality Framework (CIHI-DQF) was designed to facilitate evaluation of databases based on five common and widely used quality dimensions i.e. *accuracy, timeliness, comparability, usability,* and *relevance.* To quantify and enable measurement of quality, the five dimensions were further divided into a second level of 24 characteristics referred to as the foundation of the model. These second level characteristics were further sub-divided into 86 basic unit items known as *criteria*. Detailed particulars of the framework and its application are explained elsewhere (Long *et al*, 2001; Long and Seko, 2001).

The Better Outcome Registry and Network (BORN) Data Quality Framework (BORN-DQF) of the Canadian Ontario Agency for Health Protection and Promotion (2016) is based on the five CIHI-DQF data quality dimensions. However, BORN-DQF consists of only 19 elements and sub-elements, instead of the 24 characteristics and 86 basic criteria of the former framework. The five BORN-DQF (2013) data dimensions and their interpretation are;

- *Timeliness* - How current or up to date data is at the time of release and whether the data is available for user needs within a reasonable time period.
- *Accuracy (validity)* - How well information within or derived from the database reflects the reality it was designed to measure.

- *Comparability (reliability)* - The extent to which data are consistent over time and entered using standard conventions making it comparable to other databases.
- *Usability*- The ease with which the data is understood and accessed.
- *Relevance* – The degree to which the data meets the current and potential future needs of users.

Empirical evidence points to differentiated interpretation of the criterion in various assessment frameworks developed over time, mostly for practical purposes (Weiskopf and Weng, 2012; Chan *et al*, 2009). For instance, in the frameworks proposed by Mahapatra (2007) for assessment of mortality data from civil registration and the BORN-DQF (2013) applied on hospital births data, four of the five dimensions are similar. However, as can be expected, interpretation varies. The four similar dimensions are; Accuracy (*validity*), Comparability (*reliability*), Timeliness, and Relevance. The *Accessibility* dimension is applied differently in the two frameworks, in the Mahapatra framework *Accessibility* is the fifth dimension, while in the BORN-DQF *Accessibility* forms one of three elements within the Usability dimension.

The DAMA-UK (2013) study notes the lack of universal agreement on what constitute key data quality dimensions amongst data quality professionals. In a systematic literature review of studies undertaken on assessment of electronic hospital records Weiskopf and Weng (2013) found five consistently utilised dimensions of data quality from literature with variable interpretation. These dimensions included:

a) *Completeness:* which relates to presence of true information about a patient in the electronic hospital record?

b) *Correctness:* Is an element that is present in the electronic hospital record true?

c) *Concordance:* Agreement between elements in the electronic hospital record, or between the electronic hospital record and another data source.

d) *Plausibility:* Does an element in the electronic hospital record makes sense in light of other knowledge about what that element is measuring?

e) *Currency:* Is an element in the electronic hospital record a relevant representation of the patient state at a given point in time.

The Better Outcome Registry and Network -Data Quality Framework BORN-DQF (2013) used four of the five dimensions developed by the Canadian Institute for Health Information to assess the BORN data. In this assessment, the organisation excluded the comparability dimension as they observed that this was better captured by other data quality indicators including accuracy and relevance.

Dimensions covered in the framework included:

a) *Data relevance* – Which relates to the alignment of indicators and data definitions to the reproductive health core indicators as defined by the Core Indicators for Public Health in Ontario;

b) *Timeliness* – Calculated and examined weekly changes in the number of births in a given month based on time to extraction (i.e. the time between the birth occurrence and appearance of the event in the BORN database);

c) *Accuracy* – Three elements were captured under this dimension:

   i. Level of data *missingness* - this is the percentage of missing data.

   ii. *Comparability* to other databases - This compared core indicators found in the BORN data and those from other reproductive health databases within the country and

   iii. Population *under-coverage* – In this case the BORN documents and metadata were used to check for potential under coverage of sub-population groups;

(d) *Usability* – This element assessed the ease of performing tasks while conducting analysis using BORN data (Public Health Ontario Corporation, 2016).

Rao *et al* (2005) emphasised the importance of ease of application in the success of any evaluation framework. The study by Weiskopf and Weng (2012) reiterates the importance of meeting user needs in the adoption of the dimension of any framework which further dictate conceptualisation. The DAMA-UK (2013) acknowledges that assessment criteria used in any setting can never be prescriptive and that quality dimensions used will vary depending on business requirements and industry involved. Above challenges notwithstanding, all frameworks were developed with aim of ensuring data quality and completeness. Weiskopf (2015) demonstrated that data quality is task-dependent, indicating that appropriate data quality measures must be selected, applied, and interpreted within the context of a specific study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter discusses methods used to investigate the feasibility of using hospital birth records from health facilities for estimation purposes. It highlights methods followed during data collection, observations made and challenges encountered. In section 3.2 the research design documents process followed during applications for access to health facilities and ethical clearance and design of data abstraction tools are discussed. Section 3.3 describes data collection strategy including processes followed and challenges experienced during pilot study, training of data abstractors and main data collection. Observations of records management within facilities and the data processing experiences are included in this section. Methods used for data processing are included in sub-section 3.3.4. The framework adopted for assessing hospital birth records data and its modifications are introduced in section 3.4. Data matching method and assessment of matched hospital records data and register data are discussed in section 3.5. Lastly section 3.6, is a response to the fourth objective of the study; which introduces a review of current processes, procedures and interventions in order to assist in building a more systematic and comprehensive system.

3.2 Research Design

Methods of collecting data using hospital records as a primary data source are well established (Weiskopf et al, 2013; Flood & Small, 2007; Murray *et al*, 2012). The design and validation of data abstraction tools and methods used in research involving hospital records as a data source are some of the critical aspects of the data collection strategy. Research design deals with the process followed in application for access to health facilities, ethics application and the design of the data collection tools and manual.

3.2.1 Application for access to facilities and ethics approval

Data sources used in this study were hospital birth records obtained from health facilities in identified study areas. To access such records, it was necessary to apply for permission from the National Department of Health (DoH) in the case of Maternity Case Records (MCR) and private health facilities for their records.

The National Health Research Database (NHRD) is a centralised online application tool created by the DoH to facilitate and coordinate all applications to conduct research within public health facilities in the country. For purposes of this study, applications to the NHRD were first launched in November 2017. As part of the application process the system required several documents to be uploaded, including ethics clearance letter from the university and letters of approval from provincial health research committees in the study provinces among others.

The Mpumalanga and Gauteng provincial health departments had additional requirements for research undertaken in facilities within their provinces. The Mpumalanga Health Department's Research and Ethics Committee required ethics clearance approval from the university and completion of their internal application forms. A letter of support for the research was issued upon approval of the application in June 2018 and uploaded onto the NHRD system to complete the process. As an additional requirement for accessing community health centres (CHC) for research purposes, the district health office in Nkomazi required researchers to notify them of their presence in such facilities prior to commencing with data collection, this process was done in July 2018.

Two applications were launched in Gauteng province. The first application was launched with the Ekurhuleni District Health Committee (EHDRC). This committee meets once a month to consider applications to district hospitals and CHCs within the district. Application to this committee was launched in November 2017 and approval was obtained in May 2018. A permission letter was issued through the NHRD system, this letter (*approval letter is attached*) was used to approach health facilities in the district.

The second level of application was to the Gauteng Provincial Health Research Unit which deals with applications for access to higher-level facilities, including regional and higher level health facilities. There was only one regional level facility in this study. Through subsequent communication with the Gauteng Provincial Health Research unit it emerged that approval for access to conduct research at regional and higher level facilities, have been devolved to hospital CEOs within these facilities. A letter of permission to access the hospital signed by the CEO was obtained on the 12 August 2018 (*the approval letter is attached*).

Application for ethical clearance to conduct the study was obtained in May 2018 from the University of the Western Cape's Humanities and Social Sciences Research Ethics Committee (HSSREC). Ethical clearance was needed for a number of reasons; Firstly, ethical clearance from the university was one of the requirements in the process to apply for access through the NHRD. Secondly, the study proposed to use identity numbers (ID) as proxy for births by South African mothers. The ID number was used to link hospital records and birth register data. Final approval was obtained and reference numbers issued for both Gauteng and Mpumalanga (*See attached approval letters- Appendix B*).

3.2.2 The data abstraction tools

A data abstraction form (DAF) based on the format of MCR was designed for data collection purposes (*See appendix C for the DAF*). The adoption of the MCR format for data abstraction was based on the high proportion of births occurring within public health facilities. The 2016 SADHS found that 87% of births occurred in public health facilities in South Africa in the five years preceding the survey; with only 8.5% delivering in private facilities. Additionally, lack of access to private health facilities at the time of the pilot study prevented the incorporation of the private hospitals records layout in the design of the DAF.

The initial layout of the DAF was based on the Gauteng MCR, however, it subsequently became clear that there are no material differences between records used in the two provinces save for the additional residential address of the mother on the second page in the Gauteng MCR (*Copies of MCRs are attached in appendix D*). Each page of the DAF was designed to be identical to the page of interest in MCR and the corresponding page number was indicated on the form. In the main, the form was design to capture what is referred in the study as key data items. These key data items are:

- ***Age and date of birth of the mother,***
- ***Sex of the baby,***
- ***Date of birth of the child,***
- ***Status of the birth,***
- ***ID, of the mother, and***
- ***Residential address of the mother***.

Key data items were selected because of their importance to birth estimation. The first five data items are also consistent with those available in the birth registration data. In the rest of the study, the term key data items refer to the above mentioned data items.

To ensure adequate coverage of these data items, they were repeated a number of times in the DAF. For instance, information on the mother's date of birth (DoB) was captured three times in the form. This is because the MCR is completed in two (sometimes three) different facilities, the first two pages of the MCR are completed at the antenatal clinic at which the pregnant woman first makes contact with the health facility. The remainder of the form is completed at the facility where birth occurs, this could be a CHC or a hospital, depending on the final referral. For instance, the mother's DoB is captured on the first two pages, which are completed at the antenatal clinic. The last mother's DoB appears under the section called Discharge Summary which is completed at the facility where the birth occurred. The same observation was made about the data item called mother's name, which is captured in three different sections. Repetition of data items was also done to check consistency of recording by different facilities in the referral system. Indeed, the level of consistency was found to be quite low. Other data items included in the DAF were included in order to answer other objectives of the study.

Information was transcribed from hospital records onto the DAF. Each DAF was allocated a Record Identifier (Record ID). A record ID is a derived eight-digit alphanumeric unique identifier for each DAF and each facility. The first two numbers of the Record ID represent the province and municipality respectively and were p*re-populated*. The remainder of the codes are facility identifier, which is based on the size of the facility (*allocated based on the number of births per year*) and type within the hierarchy i.e. either a hospital (H) or a Community Health Centre (C) OR private clinic and the record number. The latter three codes were completed in the field by data abstractors. DAF numbers started at 001 to the last record abstracted at a given facility. For instance, a typical DAF will have an ID; 812H0071 (this indicates Mpumalanga (8), Nkomazi (1), second hospital (2H) and record number 0071). Record IDs also enabled the lead researcher to monitor daily performance of individual data abstractors and the number of records abstracted each day.

A comprehensive data abstraction manual was designed to facilitate training, standardise data collection and to provide guidance for abstractors during data collection. The manual explained the purpose of each question, codes used in the form and medical concepts and abbreviations found in records. Each section in the manual defined data items in the corresponding sections of the DAF. The manual also covered instructions for abstracting information from records to DAF with appropriate examples. It explained the layout of MCR and data abstraction form, location of data items of interest in the MCR. Abstractors were instructed to carry the manual with them daily during abstraction for reference purposes.

3.3 Data collection strategy

Guidelines for data abstraction from medical records developed by Jansen *et al* (2005) were adopted in this study. The guidelines set out critical factors to consider when abstracting data from medical records. Key considerations noted by the study include prior testing of data abstraction tool and methodology, training of data abstraction team and quality assurance measures during data abstraction. These are discussed below.

3.3.1 The Pilot study

One of the key recommendations from literature is for a pilot study to be undertaken prior to the main data collection (Jansen *et al*, 2005; Flood & Small, 2007). The importance of a pilot study is emphasised in order to achieve three goals 1) To confirm availability of information, 2) the viability of the project plan, and 3) assess the relevance of the data collection tool.

Initially the pilot study was planned for Mpumalanga. This plan was motivated by unfamiliarity of format of the MCR in Mpumalanga. However, owing to delays in securing clearance and permission to access facilities, the pilot study was conducted in Gauteng.

A pilot study was conducted over two days in a Gauteng hospital. Two data abstractors were trained for this purpose; one of the two abstractors had a nursing background (the third abstractor was the lead researcher). Initially, twenty records were allocated per day for each abstractor, however, between ten and fifteen were abstracted per day by each individual during this phase of the study. The following changes were made to the study design based on pilot results:

- The DAF was reduced from eight to five pages. Some of the fields initially included were excluded as they seemed difficult to transcribe, while others did not yield what was envisaged during project planning.
- A decision was made to derive Record ID for each DAF, after observing the poor quality of hospital records identifiers during pilot study.
- Estimated time for completing each DAF was increased to twenty minutes. Estimated time for completing each record was initially set at eleven minutes as part of fieldwork planning and monitoring.
- Most importantly, the number of data abstractors recruited was increased from four to ten owing to workload.

3.3.2 Training

Training was conducted in each province for two days a few days prior to the start of data collection. In both Mpumalanga and Gauteng training occurred from 6 to 7 July and 10 to 11 August 2018 respectively. An additional one-day training session was arranged on the 2 December 2018, prior to data collection at the regional hospital to train additional abstractors recruited and as a refresher for the other abstractors. This was also to introduce abstractors to the Computer-Assisted Personal Interview (CAPI) system, which was used for data collection in that hospital in the place of manual data abstraction. A capturing system based on the layout of the DAF was uploaded onto tablets for both training and data collection purposes. A number of additional training sessions were conducted during data collection based on assessment of quality of abstraction and due to dropouts.

Training focused on a number of aspects, namely;

- Concepts and definition, inclusions and exclusions.
- Ensuring adequate knowledge and understanding of the study subject matter.
- Understanding the layout and contents of the MCR, data abstraction form and manual.
- Using the data abstraction manual for reference during field work.
- Completing various sections of the DAF.
- Ethical behaviour during data abstraction.
- For the second training in Germiston, navigating the capturing system was part of the training.
- The capturing system was also updated based on training outcomes to close loopholes and include additional controls prior to data collection.

Mock data abstraction sessions were conducted at each training and trainees were given feedback on their performance. Training on some sections of the DAF were repeated based on the results of mock exercises. Data abstractors were also offered a demonstration on how to use the manual for reference when completing every item and encouraged to familiarise themselves with the contents. One of the key briefs to data abstractors was to transcribe information as presented in the records, this means that where information was missing or even plainly wrong they were expected to complete as observed.

3.3.3 Data collection

Data collection started in Nkomazi after the recruitment of eleven data abstractors from surrounding areas. Based on data collection experience in Nkomazi, where it became clear that a team of ten abstractors was not adequate, the number of data abstractors recruited was increased to seventeen in Germiston. This adjustment was also done as contingency for dropouts (which eventually occurred). The cost of including two data abstractors with medical background as originally planned, proved to be prohibitive, thus only one individual with nursing background was secured for the entire project.

Data collection took five days in hospitals and between one to three days in CHCs depending on the size of the facility (size was based on the number of births from DHIS). Data abstractors were issued with staff identity cards, which reflected their names and staff ID numbers. These cards were visibly worn for the duration of data collection to clearly identify the team. Abstractors also signed a contract setting out conditions of employment, the duration of employment and remuneration. A data confidentiality form was also designed which was signed by all abstractors.

In all facilities visited during this phase in both study areas, the team was allocated a working area and a contact person (mostly an administrative personnel, a few facilities allocated the maternity ward nurse for this function). Working space was generally a challenge in most CHCs, this was largely because these facilities were small and overcrowded daily. As a result, work typically started an hour later than scheduled due to meetings or other facility activities.

During data collection and mainly in Germiston based facilities, a different type of record called Obstetrical Clinical Records (OCR) was encountered mainly for births that occurred in 2014. Information derived from such records were allocated a final code 400 during data collection for ease of identification at capturing and analysis phase.

Another data source encountered during data collection is the Birth Register (BR). The register was in a form of a book which registers births by month of birth for each year. Most facilities had this book readily available to use and when there were enquiries related to entries in the records. In most facilities where the BR was forwarded, it had more births than those reported in the DHIS. Forms abstracted from the BR were allocated a code 400 for purposes of analysis.

To facilitate work and to ensure no duplication, each data abstractor was allocated a new series number on the first day of data collection in each facility based on Records ID. For instance, on the first day of data collection at the second hospital, the first three data abstractors were allocated numbers 812H0001, 812H1000 and 812H2000 this sequence was followed until the end of abstraction in that facility. These were used as unique record ID for data abstraction forms (DAF) for data capturing purposes. The system was also used to monitor individual performance.

3.3.3.1 Data collection in Nkomazi

Data collection started on 09 to 27 July 2018 in Nkomazi. Eight facilities were part of the study in Nkomazi, however, data was only collected from six of these, which were two hospitals and four CHCs. Two facilities were excluded from data collection. One was under renovation at the time of data collection, while the other facility had water problems, patients from this facility were referred to nearby facilities. Under normal circumstances pregnant women give birth in the six CHC in the area, referral to the two district facilities occurs in case of complications or in cases where a woman is booked due to pre-existing conditions and emergencies.

Data collection started at the first hospital on 9 July 2018. A recreation centre on the edge of the hospital was allocated to the team for work purposes. Work at the second hospital started on the week of the 16th July 2018. Secondly, part of the team had to be released from abstraction work to assist with retrieving and refiling of records, this was the case in most hospitals.

Data collection at the first CHC in Nkomazi occurred on the 23 and 24 July 2018, while in the week of 25 and 26 July 2018 the team moved to the second CHC. For the two remaining CHC, data collection was allocated one day (27 July 2018) based on the number of births recorded in the DHIS. The team was divided into two teams, six abstractors worked at the third facility with lead researcher and the rest of the team were stationed as the fourth CHC. The third CHC was the smallest facility and was located in the most rural part of Nkomazi, the facility also did not have space for the team to work. For a number of facilities, the larger part of the morning of the first day was spent trying to locate the records in storages pointed to the team and identification of relevant records, with work mostly starting late.

3.3.3.2 Data collection in Germiston

In Germiston, data was collected from two hospitals and two CHCs over two periods. The first phase was between the 13 to 24 August 2018 in a number of facilities and resumed again at the last hospital on 03 to 07 December 2018. Data collection at the last hospital was delayed because a week prior to commencing data collection at this facility (data collection was planned to start on

27 August 2018), notification of the suspension of hospital CEO and closure of the maternity unit was received. The acting CEO recommended postponement of data collection in the facility pending the appointment of a substantive CEO.

Data collection started on the 13 August 2018 at the first hospital and lasted for five days. Based on experiences from Nkomazi, a proactive decision was made at this facility to allocate six of the seventeen team members to assist with retrieval of records. Records were collected daily from storage, which was a driving distance and returned to filing room by 14h00.

Data collection at the first CHC in Germiston started on 20 August 2018 and lasted three days. Working space was the main challenge in this facility.

Data collection at the second CHC in Germiston was allocated two days on 23 to 24 August 2018. This facility allocated a boardroom and the senior maternity nurse to work with the team, this proved to be a big advantage for data collection.

Data collection at the last hospital started on the 03 December 2018. The team comprised of 12 data abstractors for this facilities (due to dropouts). A boardroom inside the maternity ward was allocated to the team and the hospital's research coordinator as a contact person. Data was collected through CAPI, this saved time and costs for capturing the information later. In this facility, as was the case in other facilities a team of six was dispatched to assist with retrieval of records.

Quality assurance was conducted at the end of each day by the lead researcher and feedback was given to abstractors each morning and corrections effected. Feedback covered previous day performance and quality issues observed by the lead researcher. Weaker data abstractors were paired with stronger ones to provide assistance and daily rotation of abstractors was effected to increase efficiency. Data abstractors were also encouraged to forward records that were either unclear due to bad hand writing or unusual contents to the lead researcher to resolve. Data abstractors were able to focus on the work instead of resolving problems. Additionally, due to the high number of records available in facilities, one data abstractor was responsible for quality assurance of completed DAF as wells as marking completed records in order to avoid duplication of work. This abstractor was also tasked with ensuring that records are refiled back into the boxes in the order received from storage.

3.3.4 Data Processing

Data capturing started in October 2018 while waiting for permission to access the last hospital and lasted for a period of four weeks. A capturing system based on the CSPro software was used for data capturing and implementation of data edits. Six data capturers were recruited and trained for this purpose, each capturer was allocated a four digits Data Capturer ID number, which was also captured. For quality monitoring purposes, each data-capturer was allocated one facility to capture. Completed forms were colour coded to avoid duplication (different colours were used for completed, for duplicates and those needing attention of the programmer and lead researcher). Each day, data capturers flagged issues and errors for attention of the lead researcher and the programmer. Notes were made daily for capturers in cases where changes were made to the capturing system. The number of DAF captured were checked against the forms allocated daily for completeness by the lead researcher and the programmer.

For DAF abstracted from records with complete information (i.e. all pages of the MCR were completed), a final capturing code of 100 was allocated at capturing phase. In case of DAFs marked 002 during fieldwork (only pages 2 and 3 were completed) a final code 300 was allocated. Forms based on records allocated code 004 (abstracted from OCR) during data collection were captured with final code 400. Most DAF abstracted from BR were also allocated a code 400 (indicating information obtained from another form) at capturing phase. A number of empty records were found during the abstraction phase. Empty records were those where only the first page of the MCR was completed. Such DAF were coded HE (Hospital Empty) or CE (Clinic Empty) during capturing, for instance 812HE0071 referred to a DAF abstracted from an empty hospital record, while a record 812CE0071 is a DAF based on an empty CHC record. A total of 550 duplicate DAF were found during capturing phase. These were duplicate DAFs created during data abstraction, largely in Germiston (*this is discussed under fieldwork challenges*). Such forms were coded HD (Hospital Duplicate) or CD (Clinic Duplicate) during capturing. Additional fields were added to the capturing system to check consistency of capturing, these were largely to check consistency of mother DoB completed from different facilities and the new born DoB which is completed on different pages. Codes were derived for sub-places within the two areas of study, based on information obtained from Stats SA.

To protect the identity of facilities in the study, they are labelled HGP_1, (Hospital Gauteng Province) HGP_2, for two hospitals in Germiston and HMP_1 (Hospital Mpumalanga Province) and HMP_2 for hospitals in Nkomazi. The CHCs in the study are labelled CHC_1 and CHC_2 for those in Germiston, those in Nkomazi are labelled CHC_3 to CHC_6.

3.4 The assessment framework

This section introduces the proposed data validation methods. To this end, both direct and indirect methods of data quality assessment are considered. It is also critical to narrow the focus on frameworks that can be successfully applied to assessment of paper based hospital birth records data while responding to key objectives of this study, this is achieved in sub-section 3.4.1.

The focus in this thesis is assessment of '*fitness for use'* of hospital birth records *i.e*. if hospital birth records data can be used both to supplement and improve civil registration data in the country. Two key considerations arise; Firstly, in case of hospital records data, most frameworks were largely applied to electronic hospital records within more developed health systems settings (Long and Seko, 2001; BORN-DQF, 2013; Murray *et al* ,2012; Kreyenfeld *et al*, 2010). Secondly, in light of the relative modesty of literature on the application of data assessment frameworks on paper-based hospital birth records data, developing a framework that can be credibly applied to paper based hospital records is important.

3.4.1 The framework

The BORN-DQF (2013) framework is adopted with modification to account for aspects relevant to the study. The criterion proposed by Rao *et al* (2005), of rating data quality using a three-tiered scale of Satisfactory 2) unsatisfactory or 3) unknown/unavailable in case of insufficient information is used to operationalise the proposed framework.

Four dimensions are considered for this assessment, within each of these, only a few elements are considered. *Usability* dimension is used to assess the ease of access to hospital birth records data. *Relevance* dimension considers the ability of hospital data to meet current and future user needs. Reliability is assessed through the *Comparability* dimension. Quality in this study is assessed through the *Accuracy,* dimension. Timeliness dimension from this framework becomes redundant largely because hospital birth records in South Africa are seldom used beyond clinical and health monitoring purposes.

Table 3.1 relates to dimensions used, how these are defined in the original model, and elements chosen to respond to objectives in the study. In the original framework *Accuracy* is defined through comprehensiveness, completeness and precision. *Usability* comprises of three elements; interpretability, accessibility and documentation. *Relevance* dimension has two elements; adaptability and value. Lastly, *Comparability* covers consistency, linkages, equivalency and historical comparability.

Table: 3.1 Data dimension from the BORN-DQF, the elements and their application.

Data Quality dimensions	**BORN-DQF Definition**	**Study Objective**	**Elements applied in the hospital births records data quality assessment focus**
Usability	Ease with which data can be understood and accessed.	To assess the content of hospital birth records data.	*a) Documentation* *b) Accessibility*
Relevance	The degree to which the data meets the users' needs.		*a) Adaptability*
Comparability-a	Consistency of data over time making it comparable with other datasets.		*Consistency:* *a) Facility (size)* *b) Across space*
Comparability-b	Consistency of data over time making it comparable with other datasets.	To establish the extent to which the health referral system affects localisation of birth indicators obtained from health facilities.	*Linkages:* *a) Physical addresses* *b) Record identifiers* *c) Patient identifiers*
Accuracy	Whether information reflects the reality it was designed to measure.	To assess the quality of hospital birth records data.	*Consistency:* *a) Completeness* *b) Precision*

For current purposes ***Usability*** measures the ease with which data can be understood and accessed. Within this dimension, two elements are considered, firstly; the documentation element, which is used to assess the structure (layout of sections) of three types of records encountered in facilities. Secondly, accessibility of hospital birth records for use beyond clinical and health purposes is assessed through the ***Accessibility*** element, looking at the presence and adherence to record management policies as well as record keeping practices within facilities.

Relevance; the degree to which hospital births data can meet user needs is included in the framework. In more developed countries, fields of information included in a birth certificate incorporate infant, maternal and other socio-economic information over and above basic fields such as the mother's name, age, the child's birthplace. In this case, the presence of data items which provide more information of socio-demographic background of mothers and children and those necessary for estimation of key indicators of birth, child and maternal health typically included in birth register data in countries with complete registers are considered.

Availability of records in a facility is not necessarily an indicator of sufficiency and relevance of information contained, the content validity of such indicators was also important. To that end, the adaptability element within the relevance dimension was considered to test if some of the additional fields collected in hospital records can be adopted to birth registrations data.

Accuracy or the extent to which information in hospital birth records reflect the reality is measured. One method for assessing validity and reliability of data is matching such data with other data sources, using common variables across the two sources. Record linkage is the process whereby an entry in one dataset is linked to an entry in another dataset using a common identifier (Fair, 2004). For this purpose, *Precision* element is used to measure quality of data across the two datasets through record linkage.

Comparability is used to respond to two objectives of the study; firstly, establish the extent to which the health referral system affects localisation of birth indicators, the linkage element of comparability dimension is applied to achieve the third objective of the study. It refers to possible attribution of births to catchment areas in the context of referral system applicable to public health in South Africa. Additionally, it is used to assess the extent to which individuals, individual hospital records and individual's usual place of residence can be identified. Although this study does not estimate coverage, an assessment of presence of proper identifiers, such as residential addresses in hospital records is used to indicate feasibility of estimation.

The benchmark proposed and used by Rao *et al*. (2005) of judging performance as ‘satisfactory’ or ‘unsatisfactory’, or if insufficient information is available, ‘unknown’ is adopted for the assessment. In that regard the proportion of cases above 20% for unspecified cases is used to denote quality of data items assessed as low quality or otherwise.

3.5 Data Matching

Record matching is the process whereby records from two different data sources are linked using a common identifier, in an effort to identify and select data items belonging to the same person or entity (Bohensky *et al*, 2010). In countries with unique common national identifiers, this is used to achieve the matching process. Names in combination with other details such as date of birth and residential place are also used to increase the chances of achieving accurate match.

Data matching is used to generate more complete and informative datasets allowing for diverse data sources with limited information on an event occurring at a point to be matched to generate additional information (Fair, 2004; Murray *et al*, 2012; Bushnik et al, 2016). Introduction of new data linkage techniques have potential to reduced methodological challenges relating to recall (in surveys), loss to follow-up (in clinical trials), selection, and other reporting bias (Fair, 2004). Data linkage also provide a wide platform for research opportunities and generation of new knowledge (Martin *et al*, 2003).

The matching process typically produce successful matches while a proportion remains unmatched (Bohensky *et al*, 2010). A number of issues can compromise the matching process; including missing or inaccurate data or false matches i.e. where non related records are mistakenly linked. Incomplete matching might lead to systematic bias in the results (Bohensky *et al*, 2010). Fair (2004) argued that identifying variables such as names, birth dates, addresses are sometimes reported with no consistency and may vary making it difficult to standardise.

3.5.1 Data items available for matching process

Most data matching techniques use common demographic, social and even economic characteristics of individuals in each data source to effect the match. These data items are ideal to supplement matching process where some variables fail to match using the common unique identifier and where unique identifiers for linking datasets do not exist. Items that are typically critical in establishing a match in the absence of unique identifiers include individual's name (and surname), date of birth, age, sex, population group and residential address.

Six variables common to both data sources were available to be used in the match: the ID number of the mother, age of the mother, Date of birth (*DoB*) of the mother, the child' sex date of birth of the child, name and surname of the mother, these are shown in Table 3.2. The ID number was the main variable used in the linking process. Records with missing or invalid ID number were incorporated back into the data for the next stage of matching using other variables common to the two datasets. The challenge with using the name variable is the possibility of misspelled names or use of initials instead of full names.

Additionally, although both datasets included a data item on birth outcomes (called *status* in birth register and *neonatal outcomes* in hospital records data), the merged datasets showed inconsistency in the reporting of status of birth, including instances reported as dead in hospital data while registered as alive in the register. This was excluded from the matching process. Analyses of the birth register data in chapter 4 will show that residential address of the mother is not asked in this data, although it is available and relatively well captured in hospital records, this could not be included in the linking process.

Table: 3.2 Data items used in the matching process

Data Item	**Register**	**Hospital data**
ID number of the mother.	ID number_mother	Identity number
Age of the mother	Mother_Age	Age
Sex of the child	Sex	Gender
Date of birth of the mother	DoB_Mother	Day, Month and Year of birth

Date of birth of the child	DoB_Mother	Day, Month and Year of birth
Surname (and name) of the mother	Mother_Surname & Mother_Names	Name & Surname

Data items; ID number, name and surname of the mother, are made available as part of births data to Stats SA, these are not published by Stats SA in the annual publication as they are protected in terms of the Statistics Act (Act No. 6 of 1999). Permission was obtained for these variables to be used in the linking process.

3.5.2 Data matching process

Births registrations data consisted of 954 385 cases relating to births that occurred in 2014 and were registered within that year. A total of 919 561 births related to 2015 births and 876 435 cases for 2016 births.

Data on registrations show that a total of 954 385 births which occurred and were registered in with Department of Home Affairs (DHA), 30 772 of these were registered within the six most frequently used offices in the two study areas; for Germiston area, data from the following offices were included Alberton, Boksburg and Germiston and for Nkomazi, the following offices were considered Malelane, Komatipoort and Nkomazi. These births were attributed to the two study sites for purposes of analysis and subsequent matching to hospital births records (This is discussed in section 4.1). Equally, for 2015, 30 539 births linked to the two study areas were used for analysis. A slightly lower number of births that occurred and were registered in 2016 (876 435), about 29 679 of these were linked to the two study sites. A total of 90 990 births for the three years and recorded in offices mentioned above were used to match with hospital records data in this study.

Hospital birth data collected for this study consisted of 10 394 cases (this is discussed in detail in section 5.2). For data matching purposes, about 460 cases with missing information on births were excluded. These were records where only the first two pages of the Maternity Case Record (MCR) were completed. Also excluded were 136 cases based on what was referred to as empty records at processing phase. The total number of cases eligible for inclusion in the matching process from hospital data were 9798.

Data matching was undertaken in two phases between registrations data and hospital records. The first phase involved direct matching based on identity number of the mother (ID) from the two datasets. Once correct match was obtained, records with positive matches were set aside.

The second phase involved a two steps matching using additional common variables;

The first step included matching on age of the mother date of birth of mother and child and sex of the child. Records with positive matches from the first step were further included in the second step, matching by name and surname of the mother using the Levenshtein's algorithm method. The Levenshtein algorithm calculates iteratively similarity between two words by converting one of the two words given to the other one (Levenshtein, 1966). The formula is given by;

$$Lev_{a,b}(i,j) = \begin{cases} \max(i,j) & If\ min\ (i,j) = 0, \\ min \begin{cases} Lev_{a,b}(i-1,j) + 1 \\ Lev_{a,b}(i,j-1) + 1 \\ Lev_{a,b}(i-1,j-1) + 1_{(a_i \neq b_j)} \end{cases} & Otherwise, \end{cases}$$

Where,

1(*ai≠bi*) is the indicator function equal to 0 when *ai≠bi* and equal to 1 otherwise, and b *(i,j*) is the distance between the first *i* characters of *a* and the first *j* characters of *b.*

The first element in the minimum corresponds to deletion (from a to b), the second relates to insertion and the third to match or mismatch, based on the respective symbols. Application of Levenshtein algorithm returned three values from the matching process, where the higher the number, the more different the two matched words and vice versa. The value 0 (zero) reflected true match i.e. (*name matched more reliably from hospital and birth register data*) the two words compared were accepted as representing the same individual. A value 1 (one) was assigned to cases of partial match, i.e. (*indicating typographical error in matched surname/name*), thus, requiring further confirmation of the matched cases. These cases were further subjected to 100% manual investigation. Cases with consistent match based on step 1 but inconsistent names/ surnames, were assigned a value 2. A complete non-match between two cases compared was allocated a value of 3 (*name matches less reliably from the two records*).

The results of successful data matching produced matching rate. Matching rate is the percentage of all births for which values reported in one source (the register) agree with values in another source (hospital records). Furthermore, for successfully matched records, agreement levels of data items in the two data sources were computed and analysed for consistency.

Additionally, ‘‘Cohen’s kappa’’ (kappa) was used to test the strength of the agreement between hospital births data and birth register data. Kappa measures the percentage of agreement of the number of births with data items indicated by the birth register and hospital births records, adjusted for the percentage of agreement expected by chance. In essence this statistic measures the difference by which the observed agreement on the number of births by a given data item is beyond chance agreement. This measure is recommended for cases where neither merged data sources are viewed as “the gold standard” (Northam and Knapp, 2006). For any datasets to be considered “gold standard” it must not only be accepted as the most accurate and reliable but must be most often used to measure quality of other datasets. The birth register has potential to be the gold standard, however in its current state the data is beset with a number of structural challenges, most of which were discussed elsewhere (Nhlapo, 2016; Stats SA, 2007).

To evaluate linkage quality, sensitivity of results is measured to assess the strength of agreement. Sensitivity is the percentage of births with particular cases for a given data item indicated on the register and also on hospital record data (Martin, 2003).

Inconsistency in matched data is assessed through the false discovery rate (FDR), which represents the percentage of births with a given data item appearing in the register data and not in the hospital data.

3.6 Building a more systematic and comprehensive births registrations system

The fourth objective of the study seeks to propose a more systematic and comprehensive system to ultimately improve the coverage and accuracy of birth registration. To that end, a review of global registration systems and data transfer processes and procedures is under taken. Current challenges in the registrations of births related to policies, processes and procedures are highlighted and proposals for appropriate interventions at policy and operational level in order to assist in building a more systematic and comprehensive system are provided.

3.7 Limitation of the study

This research study did not explore births in the private sector even though the sector continues to perform a critical role in the provision of health service in the country. Applications for access to the two private health clinics that were part of the study in Germiston were launched during the same period as applications for public facilities. However, no responses were received from management of both facilities until the end of data collection phase, this notwithstanding numerous enquiries. Private health facilities are therefore not included in this study. However, enough evidence was obtained from other facilities to enable to the study to continue.

Given logistical challenges experienced during data collection, the week allocated to data collection at hospitals proved insufficient in relation to the number of records available, however the cost of extending data collection period was prohibitive.

The study should have conducted interviews with facilities to obtain information not reflected in the records, for instance;

- It was not established formally if facilities had mechanism to encourage mothers to register births as well as stillbirths and neonatal deaths.
- Where a baby developed complications soon after birth, they are transferred to the neonatal ward, and the MCR failed to capture the final outcome of that birth, this issue was not established formally during data collection.

CHAPTER 4

BIRTH REGISTRATION DATA

4.1 Introduction

In countries with complete and efficient CRVS system, birth certificate data, beyond the basic legal function of recording a birth, is used to monitor demographic trends as well as maternal and infant health. In South Africa, births registrations data is currently collected to facilitate registration of a birth and issuance of births certificate by the Department of Home Affairs (DHA). Information recorded on the birth certificate is obtained, usually from one or both parents, by the DHA registrar at the point of registration. The birth notification form DHA-24, which is used in the registration of births, does not include data items beyond basic items needed for registrations.

Challenges besetting birth registrations data were analysed and discussed extensively elsewhere (Nhlapo, 2016; Stats SA, 2007). For purposes of this thesis only issues likely to impact on the use of these data to identify births pertaining to the study areas and potential for linking with administrative data collected are addressed. Discussion in this chapter also highlight potential bias inherent in current structure of birth registrations data and seeks to serve as a base for assessment of data collected administratively in this study.

To this end, section 4.2 provide background characteristics of birth registrations data; Parental and child information are covered in section 4.3 covering quality of data on age, date of birth and ID of the parents. The discrepancies between date of birth and date of registration is addressed in section 4.4. Lastly, Section 4.5 deals with the challenge with place of birth in the data.

4.2 Background characteristics of birth registrations data

The current process in relation to acquisition and processing of births data are death with in section 8.3. As indicated in section 3.5.2 a total of 954 385 births occurred in 2014 and were registered at the Department of Home Affairs (DHA), while 919 562 occurred in 2015 and 876 435 in 2016. To facilitate analysis and prepare registrations data for linking with hospital births records, 90 990 births potentially attributable to the two study areas were identified. In 2014, of the total number of births that occurred and were registered, 30 772 were linked to Nkomazi and Germiston. About 30 539 births could be linked to the two study sites for 2015 births. A slightly lower number of births were registered in 2016 (29 679) were linked to the two study sites.

Data obtained by Stats SA consist of the following variables; Information on parents (or informant), the child and particulars of the registration office. Information on the mother includes: Date of birth of the mother, ID number of the mother, Age (derived variable), name and surname of the mother. For the father: Date of birth of the father, ID number of the father, Age (derived from the date of birth at Stats SA) Name and surname of the father. In relation to the child, data includes: Date of birth and date of registration, ID number, sex and status of birth (alive or dead), name of the child. On the birth: Office (Office where the birth was registered), Province, district municipality and local municipality name.

Until 2016, births registrations data did not include place of births of the child (and mother) only province, district and municipality variables reflected in the data. According to DHA, these referred to place of registrations (*based on conversation with DHA official*). However, this new variable was found to be rather of poor data quality. The 2016 data and subsequent years also include variable called hospital, referring to the hospital where birth was registered. Although the DHA-24 includes an item on marital status, this is not included in the data provided to Stats SA.

4.3 Parental information

Parental information includes name and surnames of parents, age, date of births and ID numbers of both. Data are edited (which is referred to as data cleaning in Stats SA) mainly to confirm expected patterns and ensure quality. The ID number is also used to edit information on age and date of birth of the parents. The final product consists of extensively edited data; thus it is impossible to identify data errors in the original data as obtained from DHA. The ID number is also not included in the data publicised by Stats SA. Data on age and ID of parents are dealt with in the next sections.

4.3.1 Age of the mother

Age of the mother at birth of the child is a key variable in analysis of births data. It has implication for the health of the mother and child and has been associated with certain social-demographic and economic outcomes for both mother and child. Various methods used in estimation of demographic indices make assumption about patterns of reporting in relation to this variable which have implications for estimates derived. Accurate reporting of age is thus critical to conclusion drawn in any analysis. Figure 4.1 present information on age of the mother from the register.

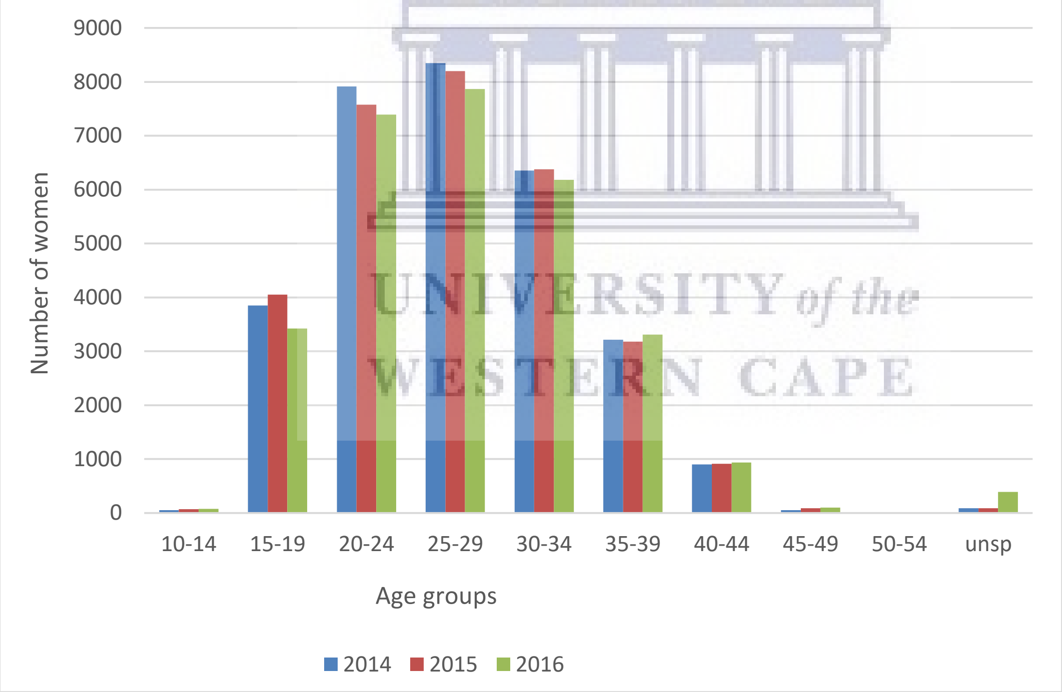


Figure: 4.1 Age of the mother at birth 2014 to 2016

For all three years the highest number of births occurred to women aged 25-29, followed by those age 20-24. Data also show births occur much earlier for mothers, with youngest mothers aged 10 years and the oldest mother was shown to be aged 54 years. Almost 13% of births across the three years occurred to teenagers between the ages of 10 and 19 years. It is observed that data on age still consist of unspecified cases even after editing done at Stats SA, with the highest proportion of unspecified indicated in 2016 with just above 1% cases. As shown in the next section over 50 % of births to women aged 50 and above were characterised by late registrations.

4.3.2 Age of the father

Information collected in the DHA-24 notification form on the father is based on two scenarios; where birth occurs within marriage and cases where birth occurs out of wedlock and the father requests his information to be included in the certificate of the child. Where the marriage was registered, the father's details are automatically included in the births certificate; while in the latter case, the biological father must sign acknowledgement of paternity and both parents consent to the registration in writing in the presence of a Department of Home Affairs (DHA) official. Table 4.1 shows information on age of father at birth by birth year.

Table 4.1 Age of the father at birth 2014 to 2016

Age	2014	2015	2016
15-19	314	10	273
20-24	1859	11	1857
25-29	3273	3	3332
30-34	3633	3	3781
35-39	2602	3	2641
40-44	1528	4	1553
45-49	605	2	626
50-54	233	1	236
55-59	82	0	82
60+	41	0	55
Unspecified	16602	30502	15243
Total	30772	30539	29679

The age of the father variable is poorly recorded in birth registrations data. Almost all 2015 births (99%) did not contain information on age of the father. About 46% of cases in 2014 had valid entries for age of the father, this figure was almost 49% in 2016. The 2015 data had the least number of valid cases with only 37 cases. Unspecified age of father for 2014 and 2016 were about 54% and 51% respectively. This is largely because variables usually used to edit age data i.e. ID and date of birth were also poorly recorded. In instances where age was provided, age at birth started at 15 years for fathers and continues above 60 years. The 2014 data included two cases where the age at birth for some father was 80 years, while the oldest father in 2016 was aged 72 years. Further analysis shows that above 30 years, fathers tend to be five years older than mothers. Data also show cases where for teenage mothers (those in the 15 to 19 age group), the age difference of the father was ten or more years. This conclusion could not be made with the 2015 data, for reasons stated earlier.

4.3.3 ID of the mother

Possession of a valid ID, facilitates entry into the birth register and by extension into the Population Register. In the case of this study, the presence of (mainly) a valid ID number of the mother will facilitate data linking.

Table 4.2 Information on the ID of the mother

	2014		2015		2016	
	Number	%	Number	%	Number	%
Invalid	44	0,14	151	0,49	412	1,39
Date of birth	537	1,75	472	1,55	522	1,76
Valid	30120	97,88	29877	97,78	28725	96,79
Missing	71	0,23	56	0,18	20	0,06
	30772	100	30556	100	29679	100

Results in Table 4.2 indicate that recording of ID of the mother is almost complete in the birth register. For all three years, over 90% of mothers' information contained valid ID numbers. Just above one percent of cases were instances where mother's date of birth was recorded instead of the ID number. This could be cases where one of the parents (The mother in this case) was not a South African. Across the three years, less than 1% of cases had missing and invalid ID numbers (this is with exception for 2016). Invalid ID numbers were cases where between ten and twelve digits were captured instead of the expected 13-digit ID numbers.

4.3.4 ID number of the father

Information on the ID number of the father also appears in the birth register. Figure 4.2 show recording on ID number of the father across the three years.

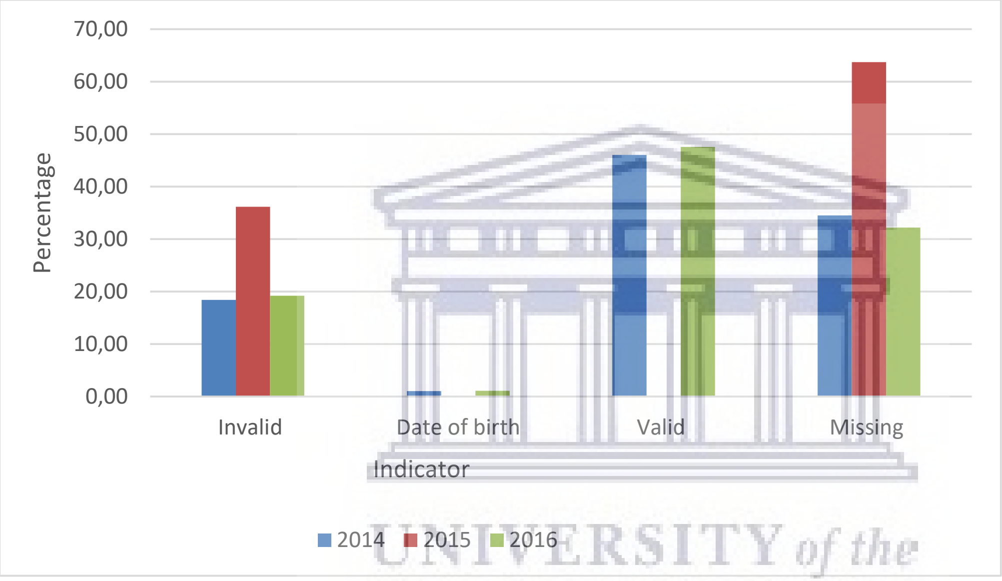


Figure 4.2 Information on ID of the father

As was observed with information on age of the father, the 2015 data on ID number of the father deviated from trends seen in the other two years. The 2015 data had the highest proportion of missing and invalid cases, with almost all of information on ID number (99%) unusable. For 2014 and 2016, the proportion of cases with valid ID number was above 45% for both years, while invalid cases (which includes cases with between 10 to twelve digits, instead of the required 13 digits) were just below 20% for both years.

4.3.5 Information on the child

Information on the child in the births register data, include; ID number of the child. The ID number of the child is derived at the time of birth; this information is linked to mother on the NPR. Also included are the name, surnames, date of birth and date of death for those that subsequently died. Additional information on sex of the child, status (Alive or dead/ Neonatal). Sex of the child is used to measure sex differentials in health outcomes and is input into population estimation. The 2016 data also included a variable called ChildAge, which reflected the age at which the birth was registered. Table 4.3 shows two key variables pertaining to the child; status of birth and sex of the child.

Table 4.3 Status of birth and sex of the child

	2014	**2015**	**2016**
	Status of birth		
Alive	30354	30213	29581
Dead	297	236	26
N	121	90	72
	Sex of the child		
Male	15550	15259	14911
Female	15222	15280	14768

Table 4.3 shows that of the total number of births that occurred were registered, about 98% were indicated as alive, while less than one percent births had fatal outcomes (child deaths and Neonatal death). Around 50% of births registered were split between the two sexes over the three years. Stats SA (2016) has also indicated that data on registrations by sex does not indicate sex preference in registration of child births in South Africa.

4.4 Year of birth and registration year

Legislation on births (Births and Deaths Registration Act of 1992: Act No. 51, as amended) requires births to be registered within 30 days with DHA. Registration outside this prescribed period is deemed late by the department. However, for purposes of its annual publication, Stats

SA considers late registration as those occurring a year after occurrence, known as current registrations. Birth registrations data published annually by Stats SA includes both current and late registrations, this includes births which could have occurred any time from two to fifteen years prior to registration as well as birth registered for individuals who are naturalised in the country. Table 4.4 shows births that occurred in 2014 to 2016 and were registered during occurrence year and subsequent years.

Table 4.4 Year of birth by registration year.

	2014	2015	2016	2017	Total
2014	**28669**	3386	206	45	32306
2015		**27397**	2559	65	30021
2016			**26846**	1744	28590
Total	28669	30783	29611	1854	90917

The total number of birth registrations for each year consisted of both current registrations and late registrations (horizontal axis), while current registrations are shown in bold. The largest number of births are registered within the occurrence year, while the highest number of late registrations occur one year after occurrence, with a decline over subsequent years. In 2014, 88% of birth registrations were current, this increased to 93% in 2016. Equally, the proportion of births registered one year later declined from 10% for births occurring in 2014 to just 6% of births attributed to 2016 being registered a year later. Observations made above have been a general trend in births registrations data for over a decade, although the proportions late have declined further.

4.5 Place of birth

Information on places in birth registrations data is primarily based on office of birth registration. During data editing at Stats SA this information is re-classified into district councils and metropolitan areas and re-aligned to the latest municipal boundaries.

Table 4.5 shows data on registrations for the two study sites based on registration office and municipality of registration. Evidence from merged hospital births and registrations data show the most commonly used registration offices for each of the two locality and the assumption that people will likely register in the office nearest to the usual place of residence. In the absence of usual address of the mother in the registration data, this is the best method used to give indication of births attributable to the two study sites. Although this method of identifying births attributed to the two study sites is not perfect, it proved useful and most practical for this purpose. Additionally, Ekurhuleni is a metropolitan municipality which incorporates a number of municipalities and large cities, identifying births for Germiston area was problematic, given the limitation of this data, the office of registration proved to be the only plausible profiler.

Table 4.5. Place information in registrations data.

	2014	**2015**	**2016**
Registrations	30772	30539	29679
Municipality of registration			
Ekurhuleni	22312	21858	21446
Nkomazi	8460	8681	8233
Registration office			
Alberton	9184	6183	4998
Boksburg	7405	9401	10665
Germiston	5723	6274	5783
Komatipoort	1880	1925	1833
Malelane	2383	2063	2538
Nkomazi	4197	4693	3862

Data on registrations show that a total of 954 385 births occurred in 2014 and were registered at the Department of Home Affairs (DHA), of these 30 772 could potentially be attributed to the two study areas. In 2015, 919 562 births that occurred within that year were registered, with 30 539 births linked to the Nkomazi and Germiston. A slightly lower number of births occurred and were registered in 2016 (876 435), about 29 679 were linked to the two study sites. Table 4.5 also show the most commonly used offices for registering births attributable to the two study area. For Nkomazi, most births are registered in Malelane, Komatipoort and Nkomazi offices. In the case of Germiston, the most frequently used offices were Alberton, Boksburg and Germiston.

4.6 Conclusion

Efforts made to improve the quality of annual births registrations report saw more data items made available for analysis from the DHA. Information on status of births was included in the data in 2017, additional parental information such as ID numbers, names and surnames were only added in 2016. The introduction of the DHA-24P/B allowed the inclusion of data on place of birth in the 2016 data, while this variable only points to the place where a birth occurred based on the hospital of birth, it is a step in the right direction.

There are a number of potential biases with birth registrations data. Firstly, the continued absence of information on usual residence is a challenge for births data. Since in South Africa, registration of vital events is captured into a live system, this enables people to register at any office in the country regardless of place of residence. Although this is good for enabling efficient registration of events, it is a challenge for statistical estimation. Thus, isolating births attributable to the two study areas in the registrations data was a challenge (this is one of the objectives of the study). Stats SA has noted high number of missing father information, which resulted in exclusion of such data from annual publications over a number of years (Stats SA. 2017). In the *User Guide to the 2018 Natality,* CDC (2018) notes that information on age of father is often missing for children born to unmarried mothers.

The continued presence of late birth registrations is an additional problem for registration data. For instance, observations made about late registrations for 2014 and 2015 and lower numbers for 2016 birth show that these births will still be registered in subsequent years. This numbers include children potentially lost to mortality. However, with extremely low number of deaths (and neonatal deaths) in the births register data, concluding about status of health of children born in the country is a challenge. Researchers have previously made assumptions that there is a proportion of these continued late registrations that might be lost to mortality, the true proportion however remains unknown (Nannan *et al,* 2012). Additionally, inclusion of all registrations in birth data every year also needs careful management of such data prior to analysis, since it also includes data on naturalised individuals.

Above 50% of cases on age of the father did not have information on the father, this is unlike age of the mother where the proportion of unspecified was below one percent. Information on age is not collected directly from individuals in the DHA-24, it is derived from date of birth and ID number variables for both parents. The quality of the age variable for any given year depends on the quality of the two variables. This fact if observed in relation to the 2015 data.

Data on parental age also provided information about age difference between parents. It was observed that on average fathers tend to be five years and older than mothers, particularly below the age of 30 years. Also that men father children until much older age than mothers, while parenting starts very early for women (the youngest mothers were aged 10 years).

CHAPTER 5

HOSPITAL BIRTHS DATA

5.1 Introduction

In countries with universal health coverage, hospital records play a significant role beyond recording patient quality of care and clinical outcomes, they also serve a secondary function as source of data for research and estimation (HMN, 2007). This chapter examines the potential for usability of administrative data collected for this study. Potential bias and strength of these data observed during collection and processing are also highlighted.

Section 5.2 provide the background characteristics of hospital births data; including the number of cases abstracted from each facility by years of births. Section 5.3 present methodological challenges of using hospital records for research purposes. Deficiencies related to the instrument are covered in sub-section 5.3.1 while sub-section 5.3.2 addresses challenges observed during data collection.

5.2 Background characteristics of hospital births data

A total of 10 394 birth records were abstracted from hospital birth records in health facilities. Slightly more records were collected from facilities in Germiston, 5563 (53.5%) than Nkomazi, 4831 (46.5%). About 3934 and 4554 records were based on 2015 and 2016 births respectively. A considerably lower number of records pertaining to 2014 births (1906) were abstracted relative to the other two years, this issues is discussed extensively in section 5.3.1. Of the 5563 forms abstracted from facilities in Germiston, 1155 cases were obtained from the first hospital (HGP_1), 1656 from second hospital (HGP_2) while from the two Community Health Centres 1551 and 1201 records were abstracted from first (CHC_1) and second (CHC_2) respectively.

In Nkomazi, from the 4831 forms obtained from facilities, 2456 were abstracted from the first hospital (HMP_1) and 1157 from the second hospital (HMP_2). From the four CHCs visited in this area, 526 were abstracted from the first (CHC_3), and 445 records from second CHC (CHC_4). The thirds (CHC_5) and fourth CHCs (CHC_6) contributed 136 and 111 respectively to the total. Just above 500 records were based on births that occurred before arrival at facilities (BBA). Above 80% of these pertained to births in Nkomazi facilities and in particular CHC_6.

Table 5.1 below provides a detailed breakdown of records abstracted from each study site and facility.

Table: 5.1 Background characteristics of hospital birth records data.

	Number	**%**	**Total**
Data Collection area			
Nkomazi	4831	46.48	
Germiston	5563	53.52	10394
Facilities -Germiston			
HGP_1	1155	20.76	
HGP_2	1656	29.77	
CHC_1	1551	27.88	
CHC_2	1201	21.59	5563
Facilities –Nkomazi			
HMP_1	2461	50,94	
HMP_2	1164	24.09	
CHC_3	529	10.95	
CHC_4	430	8.90	
CHC_5	136	2.82	
CHC_6	111	2.30	4831
Year of Birth			
2014	1906	18.34	
2015	3934	37.85	
2016	4554	43.81	10394
BBA			
Germiston	98	18.39	
Nkomazi	435	81.61	533

The issue of inconsistency between the three years is more pronounced when observed at facility level. More records were abstracted from HMP_1 followed by HGP_2. The number of records abstracted was largely affected by the record storage systems in facilities (discussed in section 6.2.2.2). For instance, in most hospitals it was easier to access 2015 and 2016 records than for 2014. In HMP_1 facility the 2014 was already in storage and retrieval was a challenge and CHC_1 had a more accessible storage system. In some facilities e.g. CHC_4, 5 and 6 where record storage system was nonexistent, it was not possible to assess levels of consistency for the three years.

5.3 Methodological challenges of using hospital birth records

The Maternity Case Record (MCR) was created as a communication tool between different levels of care and health facilities during pregnancy and to ensure recording of pregnant women information in a standardised way. Sibiya *et al* (2015) note specifically that this instrument was an intervention to fill gaps evident in previously documents used to monitor pregnancy and child birth. This aspect makes using the MCR for research a challenge as was observed during data collection. This section covers inherent challenges associated with using this data source for research purposes.

5.3.1 Deficiencies emanating from records

The MCR is created at pregnancy stage for women who present at public health facilities. The first two pages of the MCR are completed at the antenatal clinic at which the mother first presents. The rest of the record is completed at the facility where birth occurs, this could be a community health centre (CHC) or hospital, depending on the final referral (this is discussed in detail in section 6.2.1.1). For instance, key data items such as age and date of birth of the mother are recorded at two and sometimes three different facilities, this presents opportunities for inconsistency in the quality of data.

The second challenge was caused by the design of the data collection instrument. The Data Abstraction Form (DAF) was designed based on the MCR, abstracting information from the Birth register (BR) and the Obstetric Care Record (OCR) during data collection created a challenge for data abstraction. This contributed to inconsistencies and higher proportion of missing data in some fields which do not appear in the latter records. Furthermore, during the design of DAF, record ID (*the unique identifier for each DAF used in this study*) on the front page of the DAF was envisioned to be based on the hospital or patient record number on the MCR, however, observations during pilot revealed that this was not consistently recorded in the MCR. During the main data collection, a new variable called record ID was derived for purposes of unique identification of each DAF.

A number of records had incomplete information, and even inconsistent or contradictory information about the same data item, this was the case for such data items as date of birth and name of the mother. This included cases where the date of birth of the child was written instead of date of birth of the mother. Ineligible hand writing was also a major challenge for abstractors which necessitated subjective judgement to be made on interpretation based on what was documented. Additionally, unfamiliar medical terminology and ineligible abbreviation were also encountered a number of times, which delayed abstraction.

Recording of mother's name was also inconsistent across the three section of the MCR where it was captured. In few instances, the name entered in the background pages were inconsistent with those recorded at the facility where birth occurred; in other sections the nickname of the same mother was captured. There were also cases of misspelled names or surnames and where two different surnames were recorded for one person. In case of the BR, quality of mother's name was poorest, in most instances nicknames were recorded while in some instances only the first name was recorded and not the surname.

Figure 5.1 shows characteristics of records used in this study. It shows that a total of 6971 (67%) records had all pages, these were all abstracted from the MCR, 13% (1350) forms were abstracted from alternative records, these being those obtained from Birth Register (BR) and Obstetric Case Record (OCR). Just above four percent (460) of records had only the first two pages completed, these were pages where only the demographic and antenatal information of the mother was recorded, in few instances observed, these were births ending in miscarriage, Macerated Still Births (MSB) or Fresh Still Births (FSB). This information was not documented in the designated section of the MCR which was the *Summary of labour* section, instead notes were mostly written in the clinical sections while the dedicated section of the record was left blank. In a few instances the status of such records could not be resolved during abstraction. Narratives on clinical notes pages were intended as communication between personnel in different shifts, patient care or in case of patient transfer to another level of care. This is also a requirement in terms of the Guidelines for Maternity Care in South Africa (DoH, 2000).

About 137 (1.4%) data abstraction forms (DAF) were based on what is referred to as empty records. Empty records were those where only the first page of the MCR (the page with demographic information) was completed. Majority of these forms were abstracted from empty MCR records from CHCs in Nkomazi.

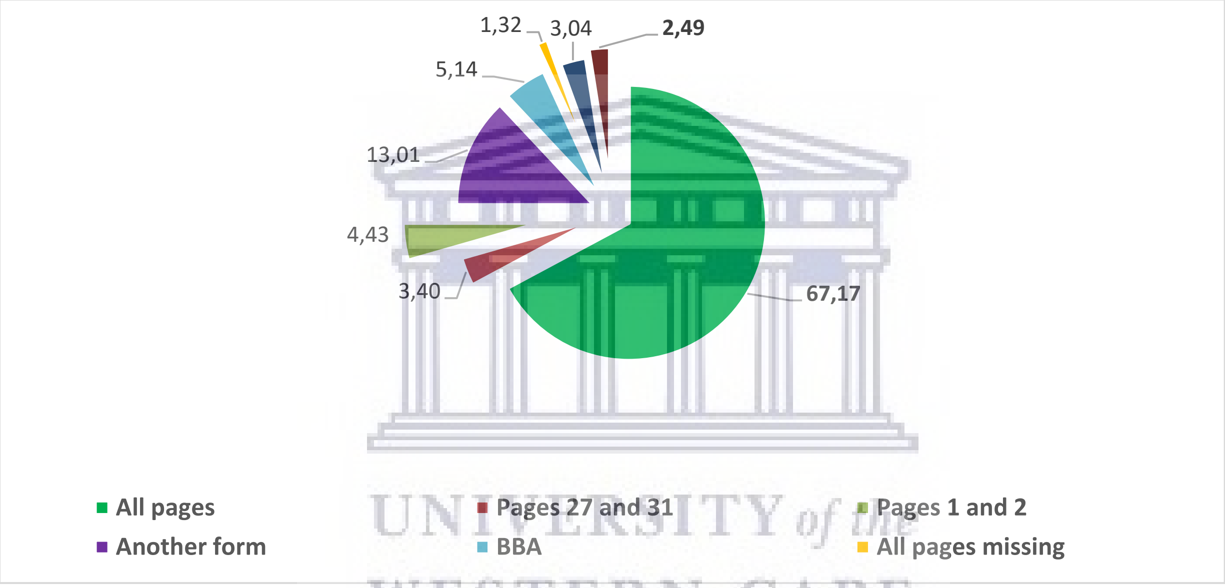


Figure: 5.1 Status of records and record types

A total of 669 (6.8%) forms were based on information abstracted from records containing only the last three pages of the MCR, these were mostly records marked "*Unbooked*" on the first two pages of records, indicating that the mother did not attend antenatal care and was thus not booked to give birth in the facility. About 279 (2.7%) records had only one page completed, this consisted of only the discharge page, which is the last page of the MCR. These records were actual instances of birth, however, no further information was provided on these births. Around 5% was for children born prior to arrival at the facility (BBA).

5.3.2 Data collection challenges

The abstraction process was impacted by a number of challenges emanating from the situation at facility level and how different facilities stored their records.

Most facilities (where we enquired) did not have knowledge of the number records in storage for each year. In number of facilities we were requested to count the number of entries in the BR as confirmation of number of births for each year, in larger institutions it was impossible to use the BR for this purpose, but also not all facilities had the BR available. The only estimate of number of births in each facility was based on the DHIS, this number did not always tally with what was observed in facilities. Inconsistency was also confirmed in cases of facilities where the Birth Register (BR) was forwarded to the team during data abstraction. This notwithstanding, during the first two days of data collection in the first facility visited it became clear that it will be impossible to cover all records for identified study years 2014 to 2016. A decision was made to cover 10% of records for each year based on the number of births reflected in the DHIS. The achievement of the planned sampled was also affected by other issue discussed below.

Firstly, although most facilities allocated space for the team to work (in five of the 10 facilities a boardroom was allocated), on a number of occasions the team was asked to relocate or alternative to stop temporarily to make way for other facility activities. Typical example was CHC_5 in Nkomazi which did not have space to accommodate the team. The team pitched a small tent outside to work, this impacted the pace of work. CHC_3 allocated a maternity ward where mothers were giving births throughout the period, which presented unique challenges, work stopped a number of times to allow mothers to give birth. The distance between the team's location and record storage also impacted the effectiveness of abstraction, some distance was even a driving distance between the two points.

Retrieval and refiling of records was a problem in most hospitals, given the number of records available in these facilities. Notwithstanding that most hospitals allocated administrative personnel to assist the team, records made available each day depended on the number the allocated hospital personnel were able and willing to retrieve. Additionally, regardless of daily targets, the administrative personnel tended to decide which year to retrieve from storage. This was mostly motivated by convenience, the extent of this varied by facility. For example, in hospitals where filing was based on delivery year, 2016 and 2015 records were easier to retrieve than for instance 2014 records. The result was inconsistencies in coverage for the three years in some facilities.

Additionally, part of the abstracting team had to be released from abstraction work to assist the allocated personnel with retrieval and refiling of records in a number of instances. It became a challenge for the team to continue abstracting records at the same pace, or even to achieve the target set for each day for the sample. Identifying records falling within the study period was also time consuming due to various storage systems in facilities.

The first and last day of data collection in facilities also proved to be a challenge as mostly fewer records were abstracted. Delays on first days were largely due to logistics of securing working space for the team and finding methods to retrieve records from storage. In instances where the last day of data abstraction fell on a Friday, administrative personnel allocated to assist mostly were reluctant to retrieve too many records.

Increased number of data abstractors in Germiston and the duel work of retrieval and refiling records created a new challenge of duplicate data abstraction forms (DAF). Most duplicates seemed to emanate from those abstractors who did both duties. A total of 550 duplicate DAF were found during capturing phase.

5.4 Conclusion

Generally, more records were abstracted in Germiston CHCs, this was largely because in a number of Nkomazi CHCs MCRs could not be located, even for cases where they were located fewer were complete. This will be discussed in detail in the coming chapters. Challenges encountered during data collection affected the number cases abstracted for the study, but also the structure and layout of other forms of records encountered and had an effect on the quality of data collected.

Data collection experience also provided evidence of inadequacies of the DHIS, the DHIS recorded considerably lower numbers of births in few facilities than what was observed from the BR.

Although the potential for usability of hospital births data in estimating number of births was confirmed, the inability of facilities to maintain proper records, not separating empty records from records of real events and a number of incomplete records included in the records cast some doubt on the validity of contents of these records. But also the lack of awareness about the importance of proper documentation of events of births in facilities. The recording of adverse birth outcome in undesignated spaces on the MCR might give an indication that events such as stillbirths will likely continue to be missed from official statistics. Equally, these records might point to inadequate adherence to referral system by pregnant women.

Five percent of births were children who were born before arriving at the facility, one facility was specifically responsible for over 80% of BBA cases. The facility was located in predominantly rural part of the country. Although the 533 mothers presented at the facility, there might be a proportion of those born at home that do not make it to facilities and to registrations offices, this proportion remains unknown and is beyond the scope of this study.

CHAPTER 6

ASSESSMENT OF HOSPITAL BIRTHS DATA

6.1 Introduction

Approaches typically adopted for assessment of vital registrations data tend to focus on two aspects of completeness and coverage. In the case of hospital records data, this evaluation has centred on content validity and reliability of births certificate data, where hospital data are considered golden standard. In countries with well-developed systems this assumption is true. In the case of South Africa, this must still be established.

Some of the frameworks for assessing administrative data discussed in chapter 2 may not be fully applicable in the assessment of births data from hospital birth records for reasons stated previously. This also applies to dimensions and elements employed in this study, some were further reconfigured to examine issues relevant to hospital birth records data in the South African context.

The BORN-DQF framework adopted in this study was introduced in Chapter 3, that discussion covered the original dimensions of this framework including dimensions and elements proposed for this assessment. Results based on application of the assessment framework are provided in this chapter and chapter 7, giving an indication of the potential for usability of administrative data in the estimate of number of births.

When assessing births data derived from hospital records, there were a number of features unique to this source, either because they described their utility (i.e. usability, relevance and accessibility of records) or the context within which records are created (i.e. the referral system), which determines comparability of records were also important to this analysis. Indicators such as the proportion of data with useable information and missing cases were employed to assess content validity of hospital births data.

Dimensions and elements adopted in this chapter respond to the first and third objectives of this study on content validity of hospital births data and possibility of localisation of births, in that regard four dimensions were considered. Section 6.2 introduces the usability dimension of the framework and applicable elements adopted for assessment of hospital births data in this study. Relevance of data items available in hospital records for improving quality and depth of information on births is discussed through the adaptability element within this dimension in section 6.3. Comparability, which is used to assess consistency of data items captured within the records and to their ability to identify individuals, their records and their place of usual residence, though the linkage element is discussed in section 6.4 and 6.5 respectively.

6.2 Usability of hospital birth records

Usability of any dataset for research purposes hinges on accessibility of such data and how it is documented. Two elements included to test usability of hospital records are documentation of these records and their accessibility for research purposes. Documentation looks at the three types of records encountered during data collection, focusing on contents of each. For accessibility, existence of and adherence to record keeping policies and presence of proper record filing system within each facility are assessed.

6.2.1 Documentation

Documentation examines the structure (layout of sections) of records found in facilities, namely; maternity case records (MCR) and the Birth Register (BR), the last record type; Obstetrical Clinical Records (OCR) is discussed briefly since it was only encountered in Germiston facilities and has since become obsolete. The layout of the MCR and BR are discussed in detail, focusing on data items important to the study. The presence of all the *key data items* in the three records is also assessed.

6.2.1.1 The Maternity Case Record

The MCR (introduced in section 2.3.2.1) is in the form of a booklet containing a wide range of information on the mother and the birth and documents what transpired throughout the pregnancy period until the birth of a child. Sections of the record and data items contained are shown in Box 1. Data items included in the record contains the following sections; the first section of the MCR provides demographic and social information of the mother and information about the facility and previous admissions during the current pregnancy. *Antenatal* Record section is the second section of the record and provides information on the pregnancy, past obstetric, neonatal and gynecological history as well as other medical information of the mother.

The section on *labour initial assessment* documents progress of labour and record maternal and fetal condition during labour (DoH, 2015). *Summary of labour records* information on the outcome of labour/delivery. There is a subsection on *Neonatal* which details early stages of the baby's life, including sex of the baby, status of baby at birth (alive or dead), birth defects and birthweight. Section on *assessment of new born* records vital information of the baby and covers, birthweight, gestation age and Apgar scores. Status at birth was obtained from four data items in the MCR Alive, FSB (Fresh stillbirth), MSB (macerated stillbirth) and NND (Neo Natal Death). The four data items appear three times, to accommodate instances where there were twin births and deaths and more. The *discharge summary* provides information on date of birth and discharge, type of delivery and place of delivery.

6.2.1.2 The Birth Register

The birth register (BR), records daily birth occurrence within facilities, each page in the register represent a year and births are recorded by month and day. Although sections of the BR are mostly not consistent with those of the MCR, the two have a number of common data items. A number of data items in the BR are in a summarised format. The BR had the following data items;

Name and surname; ID number (*this field required ID number or date of birth*); address; age; gravida and parity; *antenatal information*, including the clinic attended, the number visits, HIV status and treatment during pregnancy. The register does not have an item called date of birth, but a data item on date of delivery was included Additional item called mode of delivery was included. Information on the labour; Post labour information including family planning, labour outcomes; infant outcomes; which covers maternal outcomes (mother alive or dead or transferred to higher level) gestational age, birth status (as Yes/No variable), sex, birthweight, Apgar score (This is a simple test of the health of new born done at one minute and five minutes after birth, on a scale of 0 to 10, a score below 7 is regarded as low) and birth defects. The last section is the *Discharge information* including status at discharge, and date of discharge.

As shown in Table 6.1 all key data items were included in the BR, however, in most cases a number of these items were not completed. In facilities where only the BR was used, in the space for the *Date of delivery/Time of delivery* data item, only time was mostly specified. Although the data item called address was included, this was largely not completed. This observation was mainly made in CHC_6 in Nkomazi where most of address entries were missing. In the CHC_2 in Germiston area, where all cases for the years 2014 and 2015 were abstracted from the BR, only a small proportion of these had a valid address of the mother. Although the BR had a data item requiring the ID number of the mother or date of birth of the mothers, in most instances time of delivery was completed.

Table: 6.1 Data Items in the MCR and BR

	Maternity Case Record	**Birth Register**
Background:	Province	
	District	
	Facility	
	Name	Name and surname
	Hospital record number	
	Date of birth (Mother)	
	Identity Number	ID number
	Residential Address	Address
	Postal Address	
	Age	Age
	Marital status	
	Occupation	
	Race	

Antenatal:	Name	
	Folder Number	
	Date of birth (Mother)	
	Address (Only in Gauteng)	
	Clinic (Name)	Clinic (& number of antenatal visits)
	Age	
	Gravida	Gravida
	Parity	Parity
	Miscarriages	Miscarriages
	Obstetric and Neonatal History	Obstetric and Neonatal History
	Medical and general history of the mother	Medical and general history of the mother
Summary of Labour:	Method of delivery	Mode of delivery
	Fetal Distress: (Whether fetal heart could be detected)	
	Complications	Maternal outcomes
Neonatal details:	Resuscitation done: (& Description)	
	Birth injuries: (& Description)	
Neonate	Male	Sex of child
	Female	
	Alive	Birth status
	FSB	
	MSB	

	NND	
	Birthweight	Birthweight
Assessment of New Born	Infant name	
	Birth time	
	Hospital number	
	Birth date (Day, month, year)	Date of entry (Proxy for DoB)
	Gender	
	Birthweight	
	Head Circumference	
	Gestation	
	Apgar score	Apgar score
Discharge Summary	Date of delivery (day, month, year)	
	Date of discharge (day, month, year)	
	HIV status	HIV status

The Obstetrical Clinical Records (OCR) - The OCR was only observed from facilities in Gauteng. A total of 109 forms were abstracted from the OCR in Gauteng, all key data items were available in the ORC. Although there were more similarities between the OCR and MCR, including that both had data items on age, date of birth, marital status and Apgar scores among others, there were a number of differences;

- The OCR did not have information on population group but rather asked about nationality.
- The OCR did not capture HIV status of the mother, but captured other aspects of the mother’s health which appear to have been pertinent at the time of its creation.
- It did not have the Antenatal record page (which is page 2 in MCR), but in most cases the old Antenatal card (Green card) was attached to the record. Although this did not occur in all instances.

The ORC is no longer used in health facilities in the country, its importance is limited to cases found in this study.

Table: 6.2 Availability of key variables by type of record

	MCR	BR	OCR
Age of the mother	Yes	Yes	Yes
Sex of the baby	Yes	Yes	Yes
Date of birth of the child	Yes	Yes	Yes
Status of the birth	Yes	Yes	Yes
ID of the mother.	Yes	Yes	Yes
Address of the mother.	Yes	Yes	Yes

Overall, it was encouraging that all key data items required for births estimation were included in the three types of records as well as additional data items for enhancing the content of the birth register data. The next sub-section looks at accessibility of hospital records which include how they are stored and the various legislative requirement applicable to these records.

6.2.2 Accessibility

Two aspects are included to test accessibility of hospital birth records for research purposes. In this case the existence and adherence to record keeping policies and presence of proper record filing system within each facility, these are discussed below;

6.2.2.1 Record management and policies in public health facilities

Records management refers to management or control of different formats of records, including but not limited to hard-copy files, correspondence, papers, photographs, recordings, reports and tapes (Marutha, 2011). Efficient records management system is essential for the support core functions, which in case of health is patient care and compliance with legal and regulatory requirements. Records provide evidence of interaction between individuals and institutions for the protection of rights (Katuu, 2015). Good record management must include well documented provisions for archiving and disposal of dormant records to preserve records and make space for new records, particularly in the case of paper records (South Africa, 1996).

The National Archives and Records Service of South Africa Act (Act No. 43 of 1996) stipulates that all records created in the course of normal business activity of a government institution are the property of that institution until they are either destroyed or transferred for archiving (South Africa, 1996).

Katuu (2015) notes two significant Acts critical to management of records within the National Health Act, namely; the National Archives and Records Service of South Africa Act (Act No. 43 of 1996) (The National Archives Act) and the Promotion of Access to Information Act (Act No. 2, 2000). Section 2 of the former Act provides for establishment of the National Archives and Records Service of South Africa. The Act has jurisdiction over governmental bodies at the national level, and allows provincial governments to enact their own legislation within the Constitutional framework (South Africa 1996). The National Archives Act governs access to archival records older than 20 years. The Promotion of Access to Information Act (No 2 of 2000) on the other hand is applicable to the National Archives and Records Service as a public body, particularly in respect to its internal records systems and archival of records less than 20 years in storage.

Until the publication of the National Guideline for Filing, Archiving and Disposal of Patient Records in Primary Health Care Facilities, 2015 (Guidelines) in 2017 (NDoH, 2017), South Africa lacked adequate legislative and regulatory certainty regarding the management of health records. The Guidelines were created to provide directives for healthcare employees at all levels of care on their records management obligations in terms of The National Archives Act. The guidelines also closed existing loopholes in the National Health Act on record management in the health sector. A number of areas are covered in the guidelines including:

- Definition of roles, responsibilities and obligations of public entities and managers;
- Guidance to employees on archiving and disposal of patient records to ensure sufficient space exist for filing new patient records;
- Adherence to regulations on record disposal; and
- Directive for creation of standardised record registration system and record storage.

According to the National Archives Act records retention is the length of time set for retaining records before disposal by a government entity (South Africa, 1996). Part of the guidelines deal with rights given to health facilities to generate unique record registration number for each patient record using any of the following; surname, identity document number or date of birth of patient and to incorporate any unique numbers generated manually or electronically (NDoH, 2017).

The National Archives Act also accords provincial and district offices the scope to develop provincial or district specific guideline for filing, archiving and disposal of patient records. Most importantly, where provincial legislation exists, it is given priority on procedures for the filing, archiving and disposal of patient records (Ngoepe and Keakopa, 2011). Both the Gauteng province and Mpumalanga have existing provincial legislation on filing, archiving and disposal of patient records. The Mpumalanga Archives Act, 1998 (Act 14 of 1998) and the Gauteng Provincial Archives and Records Service Act, 2013 (Act No 5 of 2013) are the guiding frameworks within the two provinces with regard to management of records.

The existence of legislative instruments notwithstanding, research indicates persistent challenges in most governmental institutions in relation to records management. Nkundla, *et al*. (2004) conducted a study at a public health facility in Eastern Cape on the availability, accessibility and usability of patient information. The authors identified loss of records leading to creation of duplicate information, the absence of appropriate knowledge and skills amongst health professionals and administrative staff in order to harness technology appropriately among challenges in the facility. Marutha (2011) looked at records management in support of service delivery in the Limpopo public health sector. The author concluded that records created by the hospital were not considered a priority in planning and thus not properly managed. Luthuli and Kalusopa (2007) found lack of adherence to records management policy and with compliance with records management tools and procedures in a public hospital in Kwa-Zulu Natal.

The Gauteng Provincial Art and Culture department (2015) found a number of challenges within provincial institutions. Chief among challenges identified was that, most records managers were designated and not appointed; for most facilities the records manager was the same as the registry head; facilities were likely to appoint junior staff in these positions. Generally, most incumbents in records management lacked formal qualifications, with most having only undergone in-service training.

The National Guideline (NDoH, 2017) prescribes that records dormant or inactive for a period of two years must be archived in a separate lockable storage space at the facility if storage space is available. Where storage space is unavailable, records must be stored at provincial or district archives, alternatively these can be scanned and stored electronically to save space. The guidelines also prescribe patient records to be stored for a period of six (6) years from the date they became dormant. Exceptions exist in the case of Obstetric records, these must be kept until the child reached 21 years of age and the record has been dormant for six years (NDoH, 2015). However, Katuu (2015) argues that this provision in the guidelines lack clarity on definition of dormant period.

The next sub sections deal with record management practices observed at facilities in the two study areas.

6.2.2.2 Record management within facilities

The range of record management practices encountered during data collection and associated challenges give an indication of data problems likely to be confronted during analysis. Record management across facilities visited ranged from facilities with clear record management systems to those where records were kept in boxes and trunks or not kept at all. These are discussed in detail below;

- **Records management in Nkomazi facilities**

The first hospital (HMP_1) in Nkomazi kept birth records (MCR) for 2015 and 2016 in a storeroom inside the maternity unit filed in boxes based on year of birth. The records management responsibility was allocated to a senior maternity nurse. For instance, all records for February 2016 were in the same box, and flowed to subsequent boxes once full. All boxes in the maternity unit contained records for two recent years while earlier years were moved to Out Patient Department (OPD) storeroom for archiving. During our visit to this facility, 2014 records were already moved to OPD.

HMP_2 stored birth records in the OPD along with other medical files. The facility had a records manager who was supported by two deputies. Patient's records were stored in one folder with each folder containing records of all medical consultations alongside MCR. There were instances where a folder contained more than one MCR due to births pertaining to different years by the same woman. For instance, where a woman gave birth in 2015 and 2017, two MCRs for 2015 and 2017 were stored in the existing folder reflecting the two births along with medical records related to other ailments. Given the filing system, hospital filing personnel often contacted the team to check if a particular folder was among those in the team's possession when required for a patient.

All the four Community Health Centres (CHC) in Nkomazi had no records storage and filing system. The first CHC (CHC_3) stored records in boxes and trunks in a locked storeroom, while a few records were discovered on shelves in the maternity unit with no discernible filing system. According to the DHIS, about 764 births were reported to have occurred in the three years under review in this facility, however, the BR forwarded to the team reflected 854 births over this period. Records in the BR for 2016 were only until September, according to the facility manager, some records and registers were destroyed in recent flooding.

Same observations were made with regard to record storage in CHC_4. Records in this facility were located in three areas; in a box in the utility room, the second batch were in a cupboard in the maternity ward. The third batch were in the storeroom. During data collection the large part of the morning was spent going through each MCR individually to identify those relevant to the study period.

The situation observed in the last two CHCs in Nkomazi was the case in CHC_5. This facility also did not have a record keeping system, a handful of records were stored in a trunk at the facility. Most records in this facility were incomplete with only the first two pages completed.

Records could not be located at CHC_6, save for 12 MCRs located in the storeroom. The BR was forwarded to the team, hence almost all information at this facility was based on the BR. A total number of 210 births were recorded on the BR for the three years relevant to the study, of these, 111 forms were abstracted. The DHIS recorded only 47 births over the three years in this facility.

- **Record management in Germiston facilities**

Record management in Germiston facilities was relatively more organised, both hospitals in this area had dedicated records managers, while in the two CHCs this function was allocated to administrative personnel.

Births records at HGP_1 were stored in unmarked boxes in the hospital reception area along with other medical records (it subsequently became clear that only 2015 records were available in this part of the hospital). The hospital had moved to new premises in 2014 and was also in the process of transitioning to electronic record system. Part of the process, involved scanning old records, as a result most MCR booklets were torn in the middle to allow scanning, these were then folded into bundles and returned to boxes.

The 2014 records were not available at this facility; records were moved to a private storage company in August 2014 when the hospital relocated to the new building. The hospital was in the process of obtaining the records back (based on discussions with records manager. The 2016 records were kept in boxes in a storeroom inside the CEO's office and proved a challenge to access during data collection. Even these records were mixed with files from other units.

Boxes forwarded also contained records from other sections such as the mental health unit, ICU and Neonatal units etc. mixed with MCRs, in a number of instances, more than half a box contained such records. It was unclear if this was the result of scanning project underway or the original filling practices. A few boxes included Casualty unit cases involving incomplete abortions, miscarriages and TOP (termination of pregnancy) which occurred and seems to have been resolved and recorded in that section of the hospital [It can be assumed that MCR were not completed for these pregnancies]. The hospital used an automatic system to generate unique hospital record numbers. Derived hospital record numbers started with GT (indicating no ID produced during admission) GP (ID document was presented during admission).

HGP_2 stored records in a dedicated record storage room in the old part of the hospital. The hospital also used folders to store records, but unlike the HMP_2 in Nkomazi, folders did not include all of the patient's medical records. Each MCR had its own folder, thus a woman giving birth a couple of times in this hospital had a number of folders.

The two CHC visited had proper storage and well organised filing system. Records in CHC_1 were stored in the reception area in a specially designed records filing cabinet. The facility also had a dedicated records clerk.

Records in CHC_2 were stored in a lockable safe with records storage shelves inside the maternity ward. A senior maternity nurse was designated as manager for MRC records in this facility. However only 2016 records were available in storage, it was indicated that due to space constraints records for 2014 and 2015 were moved to the district office in Germiston for storage. Births for 2014 and 2015 years were abstracted from the BR. Three data abstractors were allocated this work and these DAFs were allocated a code 004 for ease of identification and analysis purpose.

The Medical Protection Society (2011) prescribes that health professionals dealing with large quantity of paper records must ensure systems are in place to protect them in case of fire, flood or other circumstances that could damage the records. For those cases where records could be found, a number of MCRs were found in storage that did not meet such criteria. Additionally, most facilities (save for HMP_2, CHC_1 and the two hospitals in Germiston area) didn't have dedicated staff members to maintain records and this was left for nurses (although in both cases it was senior nurses) who were too busy with medical responsibilities to make records management a priority. Adherence to prescripts, guidelines and associated legislations was mainly observed in Germiston facilities, in Nkomazi this was the case in the two hospitals only. Managers in Nkomazi CHCs were indiscriminately disposing of MCR thus unaware of records retention policies but also of records as valuable for longer-term research goals.

Nkomazi also had number of facilities where locating records and sometimes identifying records that met inclusion criteria and dealing with a number of folders unrelated to births were additional challenge attributable to lack of appropriate records storage system that supports research. Even for those facilities with storage system, presence of dedicated personnel varied.

In relation to availability of key data items in the three types of records found at facilities, the rating of 'satisfactory' is proposed however, lack of adequate documentation of records and varied adherence to legal requirement is a challenge for accessibility of records for research purpose and thus attracts 'unsatisfactory' rating.

6.3 Relevance

The ability of hospital birth records data to complement and improve quality and depth of information on births is crucial for health information system in the country. Data items on demographic, socio-economic background and health of mothers giving birth in health facilities and children are important indicators of health outcomes. For purpose of evaluating relevance and quality of the data items included in hospital data, the adaptability element is utilised in the assessment.

6.3.1 Adaptability of hospital birth records

The adaptability element relates to presence of data items able to supplement birth register data and make it more functional. This element requires the t three record types encountered during data collection to include other information on the mother and child beyond the six key data items identified. A number of these data items were available in the three sources and few were common across the three. These included, for the child; birthweight, gestational age, Apgar score, birth defects, head circumference and length. Mother's information included age, date of birth, gravida, parity, method of delivery and HIV status (HIV status not in OCR). Additional socio-demographic data items of the mother such as marital status, population group and occupation were included. The maternity case record (MCR) covered additional information on medical history of the mother (Which captured any pre-existing conditions of the mother), while the Birth Register (BR) captured status of life of the mother after birth (either alive, dead or transferred to higher care).

Availability of additional variables is not sufficient; the quality of recorded information also needs to be assessed. For instance, with the exception of HIV status, information on medical history of the mother and birth defects included in the MCR, these were mostly not completed in the appropriate place in the MCR. Data on Apgar scores consisted of 78% unspecified cases. The BR had items on HIV status of the mother and birth defects, and these were most not completed. This sub-section identifies the availability and content validity of these data items.

6.3.2 Key data items

First part of the analysis deals with *key data items* identified for this study, as indicated in section 3.2.2, these are items selected because of their importance to birth estimation. They are also consistent with data items available in the birth registration data. This section covers age, sex and year of birth of the child, the ID number and address of the mother are assessed under the Comparability dimension in section 6. 3.

6.3.2.1 Age of the mother

Precise data on age of the mother at birth is essential in demographic estimation including understanding any maternal health outcomes. Inferences are often made based on maternal age in the interpretation of trends and level of fertility and other health related outcomes. Due to the importance of age of the mother to estimation of a number of key indicators, analysis of this items is undertaken. Date of the birth of the mother is used to verify or even derive age in cases where both are collected

While the MCR and the OCR captured both the age of the mother and date of birth, in the MCR the two data items are captured several times throughout the record, this is because they are captured at different facilities. Table 6.3 shows age captured in the *Background* and *Antenatal* sections of the MCR respectively and calculated age. As indicated earlier, information recorded in the Background and Antenatal sections of MCR was recorded at the antenatal clinic. Calculated age was derived from mother’s date of birth.

Table 6.3 Age and calculated age data in the MCR

	Background Age	Antenatal Age	Calculated Age
10-14	34	40	30
15-19	1513	1587	1349
20-24	2676	2730	2176
25-29	2482	2506	1961
30-34	1569	1644	1310
35-39	693	740	577
40-44	151	163	160
45-49	12	12	13
Invalid_Age	4	10	654
Missing	1260	829	2164
Total	10394	10261	10394

The number of women aged 10-14 were inconsistent across the three data items. For each age range the number of women derived from calculated age is lower than age captured in the other two data items, save for age 40 and above and at lower age ranges. Invalid cases were highest for calculated age. Invalid values for calculated age included 632 cases where the date of birth of the child was captured instead of mother's date of birth, such cases yielded calculated age of zero. Calculated age also included 20% of cases with unspecified age this occurred where because both date of birth of the mother and child were missing. Just above 12% of background age data item had unstated age, less than 10% of age in Antenatal section had unspecified age. The above withstanding, the three data items show births peaks at age 20 to 24 and decline with increasing age.

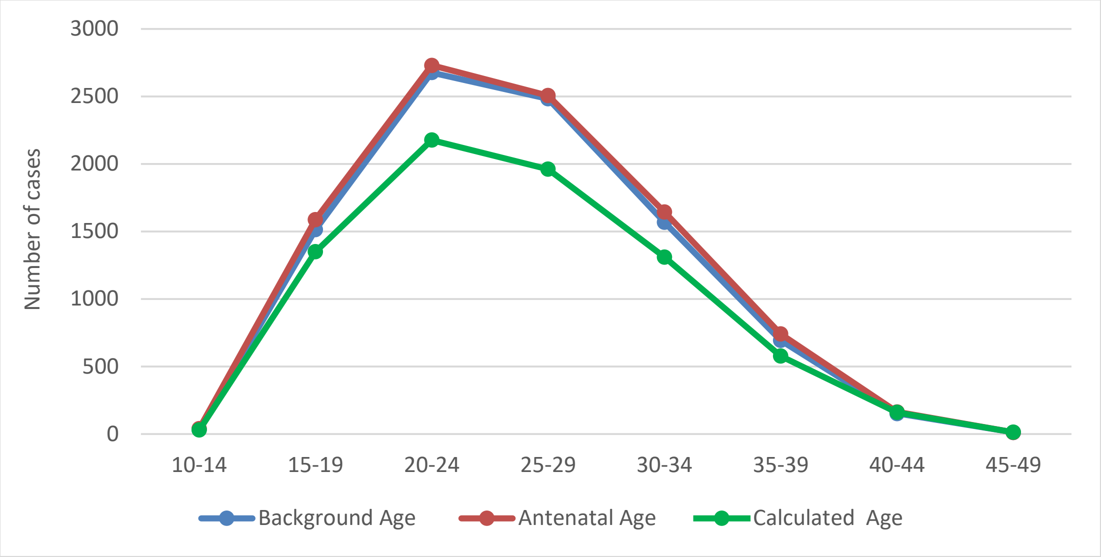


Figure 6.1 Background age, antenatal age and calculated age

Figure 6.1 shows slight differences between age captured in the background section of the MCR and the Antenatal section. However, there is a marked difference between age based on the last two sources and derived age. This indicate challenges with the date of birth variable used in the derivation of calculated age and also throw some light on the quality of date of birth information in the records. The differences observed notwithstanding, from Figure 6.1 the three variables show the same peaks and most difference at ages 20-24, the difference decline at a lower and higher age ranges.

6.3.2.2 Status of birth

The status of birth data item in the MCR has four possible outcomes; a birth might result in a live birth of a singleton, twins or triplet births; there are also data items capturing adverse outcomes covering fresh stillbirths (FSB), macerated stillbirths (MSB) and Neonatal deaths (NND), the latter options also provides for recording singletons, twins and triplets births;

Table 6.4 The number of births by status of births

	Single	Twins	Triplets
Alive	9224	75	1
FSB	21	1	1
MSB	40	1	-
NND	7	1	-
Unspecified	1102	5	1
Total	**10 394**	**83**	**3**

Table 6.4 shows the number of births by status of birth, about 98% of birth were live singleton births. It is observed that less than one percent of single births results in adverse outcomes, a higher number of these being MSB. Only seven NNDs were recorded, this might be attributed to the fact that children who experience complication after birth are transferred to neonatal unit and new record is open (*based on conversations with health personnel during data collection*), the final outcome for such births are recorded elsewhere. Additionally, there were a number of instances encountered during data abstraction where the outcomes of births were recorded under clinical notes section in the MCR, while the data item created for recording outcome of birth is left blank.

Just above 13% of cases had unspecified status of birth, these included twins and triplets. The BR does not have space for recording twin births, it might also be that twin pregnancies are regarded as high risk and referred to higher care (hospital).

6.3.2.3 Year of birth of the child

The highest number of records abstracted were for 2016 births and the least was 2014 (see Table 6.5). The year of birth of the child is recorded in three sections of the MCR, there were inconsistency in recording across the three sections on this variable. Less than 1% (28) of records represented cases where the year of birth of the mother was captured instead of the year of birth of the child and for 57 cases invalid year was captured. These were mainly data entry mistakes; either during recording in the facility or during data abstraction. About 8% of cases had missing year of birth.

Table 6.5 Number and percentage distribution of births by year of birth.

	Year of birth of the child	
2014	1906	18.34
2015	3662	35.23
2016	3888	37.41
Mother date of birth	28	0.27
Invalid year	57	0.55
Missing year of birth	853	8.20
Total	10394	100%

Inconsistencies in the year of birth of the child was complicated by instances where values were obtained from the BR and OCR. Where information was obtained from the latter two types of records, this appears as missing values in this data item, since they were only captured once.

6.3.2.4 Sex of the child

Table 6.6 show the number of births by sex. The sex of the child is also captured in two sections. Inconsistencies observed in previous analysis where an item is captured a number of time is evident for this item as well. There are more female recorded in the Neonate section that under the Discharge section of the MRC, this might because of capturing of sex from the BR which is likely to increase cases for one data item on sex while increasing incidents of unspecified sex in the other. Sex recorded in the Discharge section also had higher proportion unspecified (20%).

Table 6.6 Number and percentage distribution of births by sex.

Male			Female		Gender		
Yes	4565	43.92	4542	43.70	Male	4123	39.67
No	5063	48.71	5173	49.77	Female	4092	39.37
Missing	766	7.37	679	6.53	Missing	2179	20.96
Total	**10394**	**100**	**10394**	**100**		**10394**	**100**

6.3.3 Additional variables to complement and improve birth register data

Any improvements to births data from vital register must enable utilisation beyond estimation. It must provide information to monitor maternal and infant health, provide planning authorities with information for targeted intervention even for data at a lowest level of geography. Additional data items which can contribute to envisaged improvements were identified in hospital records. The assessment of the adaptability of hospital records is extended to these data items, which are typical part of births certificate data in more developed systems.

6.3.3.1 Birthweight

Birthweight is an important indicator of health of the child, low birth weight is often associated with increased risk of mortality and early morbidity. Birthweight was also found to be a predictor of later health, associated development of chronic degenerative diseases in later life (Weir, *et al*, 2007). The WHO defines low birth weight as weight below 2500g. Low birth weight is further classified into very low birth weight <1500g and extremely low birth weight which is weight below1000 g (Cutland *et al*, 2017).

Birthweight information is captured under two sections in the MCR namely; in *Summary of labour* and *Assessment of new born sections*, the BR and OCR also had birthweight data item, although it appeared only once in both. Recording of birthweight data item across the three records types appeared not to be standard and varied between weight in grams or Kg and instances where just numbers e.g. 2.6 are recorded. The birthweight value is required in grams (g) in the MCR, however, in about 165 cases this value was given in kilograms or just numbers such as 2.5. The challenge with the birthweight item was values which seem improbably to be classified as valid low birthweight. The classification of birthweight described by WHO is adopted for presentation of birthweights. Table 6.7 shows the birthweight variable as recorded in the two sections of MCR, the Summary of labour section(left) and Assessment of new born section (middle) and birthweight reported through the BR on the right. The BR values are based on data from two facilities where BR was exclusively used as source of data.

The quality of birthweight variable was better captured in the BR than MCR, for instance there were no invalid weight values recorded in the BR. Additionally, only 6% of birthweight information was missing in the BR compared to 20% in MCR data. Inconsistencies between the two birthweight data items captured in different section of the MCR were observed throughout the grouped categories, although captured in the same facility.

Table 6.7 Birth weight data in the MCR and BR

	Birth weight in the MCR		**Birth weight in BR**
	Summary of labour	Assessment of new born	
Extremely low birthweight	10	43	1
Very low birthweight	65	62	5
Low birthweight	628	652	35
Normal birthweight	6989	7087	379
Macrosomia birthweight	160	177	9
Unspecified birthweight	2011	1832	27
Invalid	22	71	1
Total	**9885**	**9924**	**457**

Above 70% of cases in the three sections had normal birthweight. Just about 7% of children were born with low birthweight, while just above 2 percent had macrosomia birthweight. Less than one percent of children was born with very low and extremely low birthweight, across the three data items. Between 18 and 20% of cases had unspecified birth birthweight. The highest cases of missing, invalid cases (less than 100g) and those with values between 200 and 499 grams were observed in the *Summary of Labour* section.

More birthweights values below 1000 grams (500-999g) were recorded in the *Assessment of new* born section than the *Summary of Labour* section. Birthweight was missing in about 20 to 22% cases between the two sections.

6.3.3.2 Gestational Age

Gestational age is the length of time, measured in weeks, which a foetus grows inside the mother's uterus from inception to birth. Data on gestational age is key for monitoring trends in preterm birth, inform the development of interventions aimed at primary and secondary prevention of impairment and disability in children (Wier *et al*, 2007). A normal gestational age ranges from 37 to 40 weeks. According to Cutland *et al* (2017) infants born at 27 weeks' gestational age or younger are often those associated with extremely low birthweight.

Infants born before 37 weeks and beyond 40 weeks are considered premature or late respectively. Gestational age was collected in all types of records. Table 6.8 presents gestational age as recorded in the data. The level of inconsistency was almost the same across all record types. Recording of gestational age as was the case with birthweight, was not standardised. Entries varied between cases where words such as *Term*, letter "*T"* or 38weeks / 38Wks were recorded.

Table 6.8 Gestational age variable

	Gestational Age	Percentage
<20	114	1.10
21-36	551	5.30
37-40	1118	10.75
>40	178	1.71
Invalid	126	1.21
Term	1516	14.59
Pre-Term	27	0.26
Unknown	26	0.25
Missing	6738	64.83
	10394	100

Above 60% of cases were missing gestational age, while few cases were classified as unknown (where letters such as L or others were captured) and invalid (where single digits or four digit figures were captured). The word *"Term"* was used in over 14% of instances. About 16% of cases gestation was recorded as expected i.e. in weeks, almost 11% of recorded gestational age ranged between 37 to 40 weeks. Just above 5% of cases had gestational age ranging between 21 and 36 weeks. Inconsistencies in recording of this item made it difficult to assess if these were real premature cases or data entry errors.

6.3.3.3 Parity of the mother

The number of times a woman has given birth, regardless of outcomes i.e. live birth or stillbirth is referred to as her Parity. This variable was also collected in all three types of records used in facilities. Table 6. 9 presents parity information in hospital records. More than a quarter of records (3564) did not have information on parity of the mother, highest proportions of these were in Nkomazi facilities (38%). The above notwithstanding, majority of women were parity one (32%), followed by those in parity 2 at almost 19%. Less than 1% of women were parity 6 and 7. Nkomazi also had a number of women at higher parity than Germiston.

Table 6.9 Number and percentage parity of the mother

	Parity	%
0	270	2.60
1	3322	32.00
2	1937	18.63
3	852	8.20
4	275	2.65
5	108	1.00
6	37	0.40
7+	29	0.30
Missing	3564	34.30
Total	**10394**	**100**

Parity and maternal age have been shown to impact on birth outcomes, with both lower and higher parity and maternal age associated with adverse birth outcomes. Figure 6.2 shows parity by age of the mother. Women in the age group 20 to 29 years (These include those aged 20-24 and 25-29) made up 65% of those in parity one. About 34% of those aged 25-29 were parity two, while 25% of those in age group 30-34 years were parity three. Almost 20% of cases in parity one had unspecified (Unsp) age.

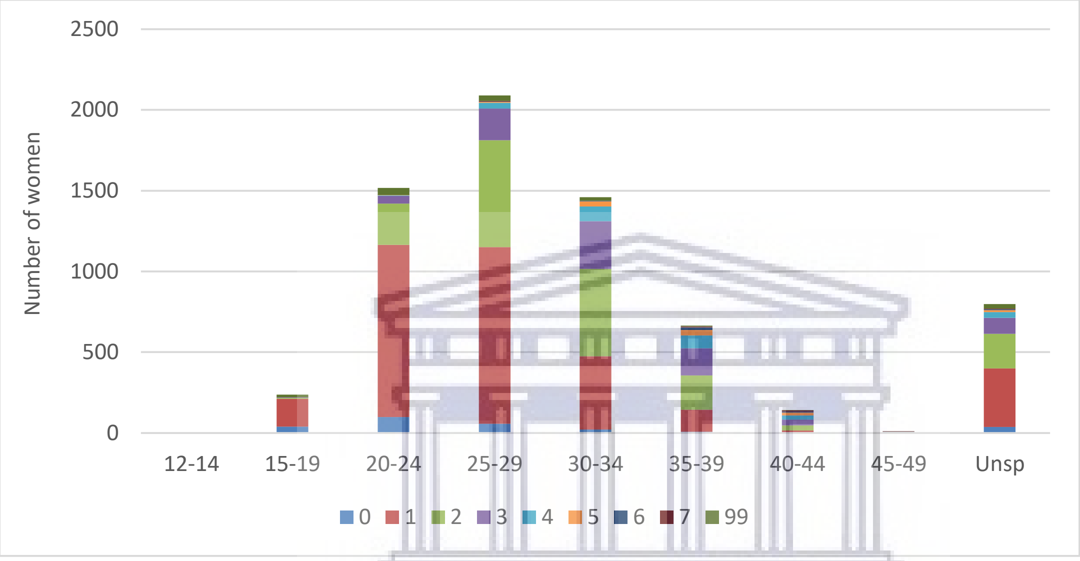


Figure 6.2 Maternal age and parity of the mother (N=10394)

Further analysis (not shown) shows that most women in both areas were in parity one, followed by those in parity two. Most women in parity one were aged 20-24 years followed by those aged 25-29 who were mostly in parity 2 in parity. Nkomazi facilities had the highest number of women aged 15-19 in parity one (10%), and higher number of women at higher parities. Just above 11% of cases had unspecified age

6.3.3.4 Population Group

Beyond providing information needed to understand fertility patterns and trends differentials, population group data item is one of the key inputs into population estimation and projections. Additionally, population group information is collected on the DHA-1663, this information is used for statistical purposes. Availability of information on population group shared light into persistent health disparities among the main population groups in country. Information on population group was available in the MCR but not in the other two records. This stratification is explored in this section.

Table 6.10 shows number of women by population group. A quarter of cases in the MCR did not have information on population group. Almost 2% of women were included in "*Other"* category, these included about twenty-five cases where people identified themselves as African and South Africa. The above notwithstanding, it was also observed that by far the highest proportion of women (71%) identified themselves as Black African. Almost all those who identified with the other three population groups (White, Indian and Coloured) were from Gauteng facilities. For Nkomazi, 78% of mother were Black Africans, in about 23% cases population group was missing and just above 2% were cases where country of birth was recorded instead of population group, all these were from neighbouring countries.

Table 6.10. Number and percentage of women by population group, MCR

	Population Group	Percent
African (Black)	7426	71.45
White	77	0.74
Coloured	100	0.96
Indian	8	0.07
Other	185	1.78
Missing	2598	25.00
Total	10394	100.00

6.3.3.5 Marital Status

Socio-demographic profile of mothers giving birth such as marital status are indicators of circumstances of mothers and their children. Information on marital status was available in the MCR although not in the other two records. The number and percentage distribution of marital status of mothers are presented in Table 6.11.

Table 6.11 Number and percentage distribution of mothers by marital status.

	Marital Status	Percent
Married	1136	10.93
Single	6451	62.06
Divorced	5	0.05
Widowed	2	0.02
Stable relationship	132	1.27
Missing	2668	25.67
Total	10394	100

Most births occurred among single women (62%), while married women accounted for 11% of births and just above 1 % were in stable relationships (Table 6.11). The latter category was interpreted as cohabiting in the study. Just above a quarter of cases did not have information on marital status. The high proportion of unspecified cases was also caused by the unavailability of this data item in the BR.

6.3.3.6 Occupation

Table 6.12 presents reporting on occupation of the mother from the MCR, this variable was not available in the BR. Occupation also had one of the lowest response rates in the data. As was the case with other data items where entries were free text, capturing of this variable was not standardised. For instance, in just above 6% (600) of cases the word “Employed” was recorded. A total of 300 cases consisted of instances where the place of work or employer’ name was written instead of occupation of the mother, or where it was not possible to make sense of what was written. In total, above 50% of information on occupation was unusable for analysis.

Table 6.12 Number and percentage distribution of occupation as reported in the MCR.

	Occupation	Percent
Valid occupation	578	5.56
Invalid Occupation	325	3.13
Employed	650	6.25
Unemployed	3906	37.50
Scholars	610	5.87
N/A	524	5.04
Missing	3801	36.56
Total	10394	100

Above observations notwithstanding, almost 50% of information on occupation had valid responses, this includes those who specified their occupation, scholars (students) and those who were unemployed. Above 37% of mothers indicated that they were unemployed, while almost 6% of mothers were scholars. Only 6% of mothers who were employed indicated their occupations.

Age of the mother is relatively well captured, however inconsistencies due to multiple recording of the data item in MCR creates challenges. The date of birth and sex of the child were well captured in the records, even for this data items recording in two sections was responsible for the inconsistencies observed.

Data items such as population group, occupation and marital status which were collected in the MCR and not in BR had high proportion of unspecified cases. The three measures associated with the health of the mother (parity and gestational age) and the health of the child (birthweight) had higher than expected proportions of unspecified cases, given their importance to health of mothers and children. Although parity information showed expected patterns, above 30% of cases has unstated parity. However, it is observed that majority of women were in parity one followed by those in parity 2. Data on parity of the mother shared some light on parity information from population, however there were concerns about quality completeness of the data. Although birthweight showed expected patterns, high number of unspecified for this variable (20%) and gestational age (66%) was a concern.

The rating of satisfactory is proposed for validity of key data items, and relevance of data items to complement birth register data however, a high proportion of missing and lack of standardise recording on data items such as birthweight and gestational age of the mother attracts ‘unsatisfactory’ rating.

6.4 Comparability

The comparability element is used to assess consistency of reporting on data items across space. In the case of hospital records, this subsection looks at the proportion of missing data in the two study area and by facility type.

6.4.1 Missing data - The proportion of missing key data items

Data can suffer from a range of limitations, chief among which is missing and invalid values. Understanding the extent and nature of these limitations is critical in identifying possible biases. High proportion of missing cases in key data items critical in the analysis of births and fertility has implication for accuracy of data. There is a need to compare the extent of omissions between facilities of different types and sizes in the two locations. Comparability is considered for assessment of validity of this data, looking at consistency of reporting on key data items in the two datasets. Comparisons of proportion of missing cases for key data items by facility type in both Germiston and Nkomazi are presented in Figures 6.3 and 6.4 respectively.

Less than 10% of cases in Germiston did not have age of the mother and status at birth recorded. In Nkomazi only age of the mother had lower proportion of missing cases (the highest proportion was in HMP_1 where almost 16% was unspecified)

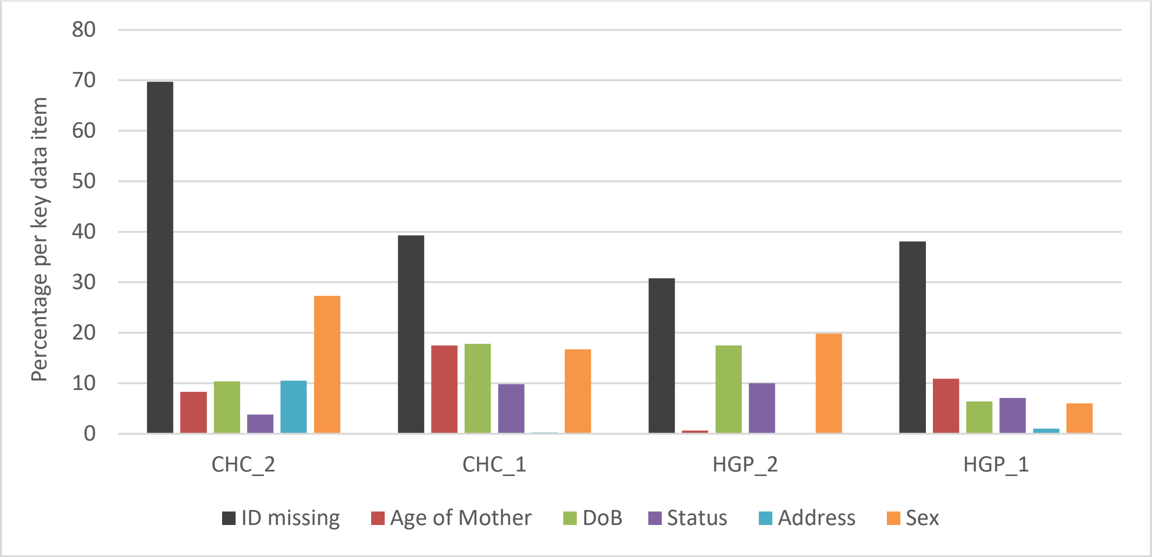


Figure 6.3. The proportion of missing key data items by facility type in Germiston

Regardless of facility type and location, identity number of the mother (ID) had the highest proportion of missing cases of the six key data items, although proportions unspecified in Germiston on this item were slightly lower than those observed in Nkomazi facilities. Percentage of missing data were highest across most items in CHC_6 with the exception of age of the mother, with only 5% was unspecified cases. Only 10% of cases in CHC_6 had valid ID numbers recorded. The same observation in relation to missing ID number of the mother is made in CHC_2, with over 70% of records missing the ID number of the mother (For both of these facilities the BR was mainly the source of data). Information on sex of the child was missing more often from records in all Nkomazi CHC, where all of them above 50% of that item was missing, the highest being CHC_6 where more than 80% did not have sex recorded. Levels of missing data were low (less than 20%) in all hospital for residential address mother, status and sex and date of birth of the child. In the case of Germiston, the second highest proportion missing cases were observed for sex of the child. Just above 30% of records in HGP_2 did not have ID numbers. In CHC_1 and HGP_1 just below 40% of records had missing ID of the mother.

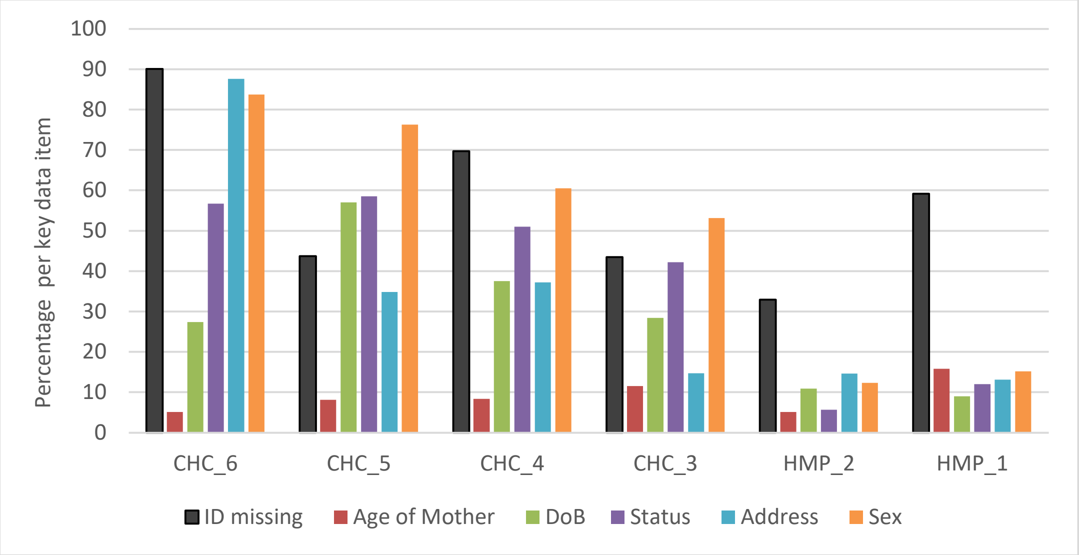


Figure 6. 4 Missing key data items (%) by facility type in Nkomazi

For data items; date of birth of the child, status of birth, address of the mother and sex of the child, most hospitals fared much better and Germiston facilities generally fared better in terms of data validity than Nkomazi. This notwithstanding, validity is rated 'unsatisfactory' for all items with above 20% proportion missing cases.

Overall, recording of most key data items was better in Germiston than in Nkomazi. Percentages of missing cases were relatively higher from CHCs than hospitals, those facilities where data was abstracted from BR, proportion missing was higher for a number of items. The record of ID number was not compulsory in the BR gives mothers option to provide date of birth in cases where the ID number is not available. Additionally, according to one professional nurse, due to high number of fraud cases where women use other people's ID numbers when giving birth, verbal report of ID number is not accepted in their facility. Where an identity card/book was not produced, ID number was not captured. Content validity is rated 'unsatisfactory' for all items with above 20% proportion missing cases.

6.5 Comparability - Attribution of births to catchment areas

The second element within the comparability dimension measures the ability of hospital records to uniquely identify individual records and allocate births by location using identifiers within records. In the section, the data items used to uniquely identify records, individuals and to allocate them by locality are assessed.

6.5.1 Linkage

Public health care in South Africa is based on referral system, where pregnant women are referred from lower to higher levels of care. In terms of this system low risk pregnancies and births are attended at Community health centres (CHC) with an obstetric unit operated by midwives. High risk pregnancies are referred to higher levels of care (DoH, 2015). Women falling within the latter category will likely give birth in facilities outside their usual place of residence, since MCR (and BR) are stored at the facility where birth occurred, identifiers for each birth are critical.

Successful attribution of births to a catchment area requires cases to be uniquely identified and allocated to a locality (residential address), individual patient folder (patient folder number) and individual patient identity number (ID number). The linkage element of the comparability dimension is used to assess possibility of achieving this objective in the context of public health referral system. The three aspects covered in this regard are addresses of mothers giving birth, their identity numbers and patient folder numbers for each birth.

6.5.1.1 Availability of appropriate address of the Mother

The presence of physical addresses to identify each case, considers the proportion of records with correct residential addresses. The first page of the MCR ask information on residential address and postal address of the mother. During processing this information was classified into main place and sub-place. For analysis purposes the mother's main place information was considered, where the main place was outside the two study areas, main place was captured as "*Other"* main place (this was introduced in section 3.3.4).

Generally, the address system in Nkomazi municipality presented a challenge, most records showed ineffective residential addresses. Most residential addresses were reported in relation to some land mark, either a store, a school or a government building. For instance, a large number of cases were observed where address was recorded as "*KaMhlushwa next a shop or Block C next to* *a clinic or next to KaMhlushwa Primary School*". This made it impossible to correctly identity information at sub-place level in most instances, thus only main-place could be established with certainty from the address provided. Analysis of addresses at a sub-place level increased the proportion of invalid/ unknown addresses to almost 50% in this area. Facilities in Germiston had better coverage for addresses, with proper residential addresses captured for most cases.

Figure 6. 5 presents reporting on address of the mother based on the MCR, this variable was mostly not completed in the BR. In CHC_6 this variable had zero responses, while in CHC_2 reporting on this variable from the BR was observed for a few cases.

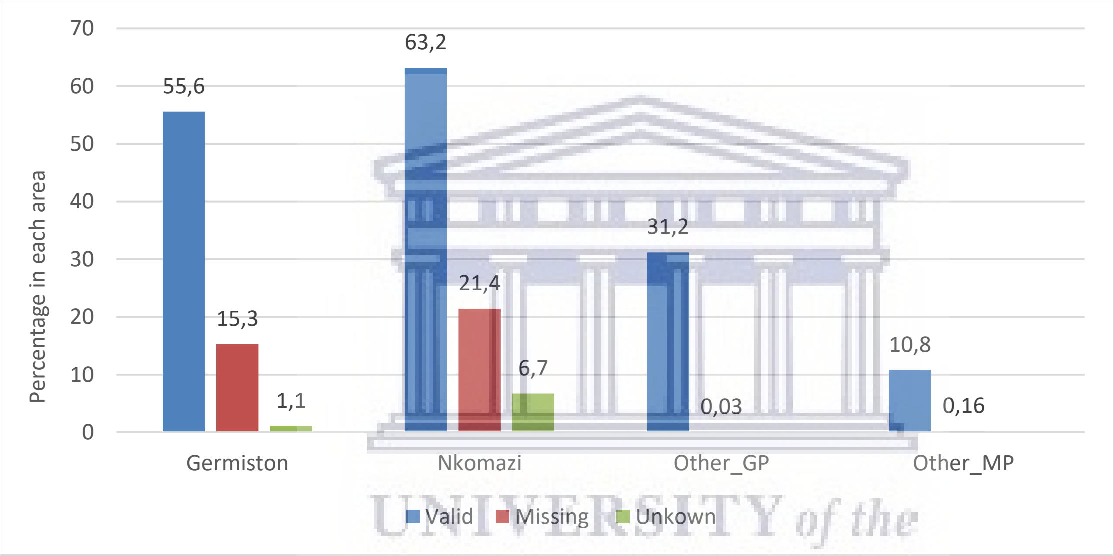


Figure 6.5. The percentage distribution of mother's address by area

Better reporting on address of the mother in Germiston allowed analysis up to sub-place level, this was not possible in the case of Nkomazi as indicated above. Where the sub-place information was used in Nkomazi, unknown cases increased to almost 60%. About 55% of addresses recorded were for mothers whose physical address was within Germiston area, while just above 64% of mothers reported Nkomazi (using only main place). The mother's address was not indicated in 21% of records emanating from Nkomazi facilities, this area also had high proportion (6.7%) of unknown addresses. Unknown addresses were mainly cases with incomplete place names, or just the word ''*Farm*'' written. This brought the proportion of unusable addresses to almost 27% in Nkomazi. A slightly lower proportion of cases with missing addresses (15%) were recorded in Germiston facilities.

Due to the referral system used in public health system some records fell outside the study area. A total of 1722 (31%) forms collected in Germiston represented records of mothers whose main place of residence was outside this area, for Nkomazi, just above 500 (11%) reported addresses outside this area. Part of the reason for the high proportion of cases falling outside the study area in Germiston facilities was because one facility was a regional hospital and seemingly facilities in this area served a wider health catchment area.

6.5.1.2 Unique hospital/ patients record identifiers

The proportion of records with accurate and unique patients' or hospital folder numbers within each facility provides indication of identification of each patient and safeguarding of such information by an institution. Hospital record identifiers are important because where no unique individual identity numbers exist, they provide confirmation of occurrence of an event. In all facilities visited, records keeping personnel were asked about their records identification method. Understandably patient record identifiers were not recorded in the BR as entries were only made once the event occurred, however this item is included in the BR.

The MCR had a number of record identifiers throughout the record. Most MCRs had Hospital/Folder number scribbled by hand on the cover. The data item called *Folder Number*: Clinic/CHC/Hospital was included on the first (background) page. In most instances, this number tended to be consistent with one scribbled on the cover page. Another item named Folder number was recorded on the antenatal page, this number usually differed from *Folder Number* on the background page and a number had codes that were consistent with clinics thus seemed to be allocated at antenatal clinic. The third record identifier called *Hospital number* was included on the *Assessment of New Born* page, this variable was not consistently captured but for cases where it was captured it was identical with the Folder Number: Clinic/CHC/Hospital item on background page. The last record identifier was in the Discharge Summary page titled; Clinic/Hospital number, information captured on this data item was also the same as Folder Number: Clinic/CHC/Hospital on the background page.

The date of birth, being either the mother's date of birth or the child's date of birth, were key elements used in deriving unique hospital record numbers in most facilities. In Nkomazi, in CHC_6 where no MCR could be found and CHC_5 where no clear recording could be established from the 135 records abstracted, it was not possible to identify any discernible record identification systems. Record identifiers in HMP_1 and HMP_2 in Nkomazi were derived based on the first letter of the facility (facility code), the child's year of birth (YoB) and a derived unique record number (Record_ID). Just above 85% of records in HMP_1 had proper hospital record identifiers, this proportion was 52% in HMP_2 (see Table 6. 13). However, 345 (15%) and 204 (18%) records within HMP_1 and HMP_2 respectively had incomplete record identifiers. These records had no facility identifiers captured, but only child's year of birth and a derived record number. HMP_2 also had a higher number of invalid records (29%), i.e. where it was not possible to determine the recording system.

Two CHCs in Nkomazi had some record identification systems to a varying degree, in CHC_4 only 20 (5%) records had discernible record identifiers, which were based on derived unique record number and the child's year of birth. This facility had the highest number of missing records identifiers in the area (85%), there were about 46 cases where it was not possible to establish any sequence or system in this facility.

CHC_3 was the only CHC facility in Nkomazi where facility code and unique record ID were used to derive record identifiers and the highest number of records with valid record identifiers (62%) and no duplicate cases.

Table 6.13 Facilities and unique record identification used by each facility.

	Mother's_ YoB	**Year + Record_ID**	**Facility Code + YoB+ Record_ID**	**Facility Code+ Record_ID**	**Record_ID + YoB**	**Invalid**	**Missing**	**Duplicate**	**None**
CHC_6									-
CHC_5									-
CHC_4					**20**	**46**	**364**		
CHC_3				**216**		**98**	**48**		
HMP_2		**204**	**600**			**339**	**11**	**58**	
HMP_1		**345**	**2097**			**19**		**75**	
CHC_2	**70**						**451**	**24**	
CHC_1	**178**		**648**		**21**	**549**	**156**	**64**	
HGP_2	**696**					**740**	**220**	**538**	
HGP_1				**817**		**150**	**188**	**22**	

Three facilities in Germiston area used the mother's date of birth (Mother's_YoB) as a key record identifier. In HGP_2 and CHC_2 this was the main method of record identification, while in CHC_1, in about 13% of records this system was used. In the latter facility, 47% of records were based on another system where the Facility code, Record_ID and year of birth were the main methods of identifying records. About 70 records where Mother-year of birth was used to derive record numbers in CHC_2, were based on 2016 records from BR. Record identifiers were either missing, inconsistent or invalid for 750 remaining records obtained from this facility.

HGP_1 was the only facility with a different system of deriving record identifiers, the facility derived record numbers based on facility code and an electronically derived unique Record ID. There were no duplicates among electronically derived record numbers. There are about 13% of duplicate record numbers in this facility, these were cases where only date of birth of the mother was captured.

Although the use of unique record numbers is supposed to ensure no duplication of records, a number of facilities had duplicated record numbers as reflected in Table 6. 13. The highest proportion of duplicates were observed in HGP_2 (32% of records were duplicates in this facility), this was to be expected given that this facility only used the Mother's year of birth to uniquely identify records.

6.5.1.3 Unique individual identifiers

Individual identity numbers, such as hospital numbers, driving licence numbers or in the case of South Africa, national identity numbers or other unique identifiers such as passport numbers in case of non - South Africans citizens are most common and practical way of identifying patients in any system. Such information is also needed to facilitate direct matching of records across different sources. The MCR had an item to record the ID number of the mother, the BR on the other hand allowed the ID number of the mother or the date of birth of the mother to be recorded in cases where the ID is not available, in most cases the latter was captured.

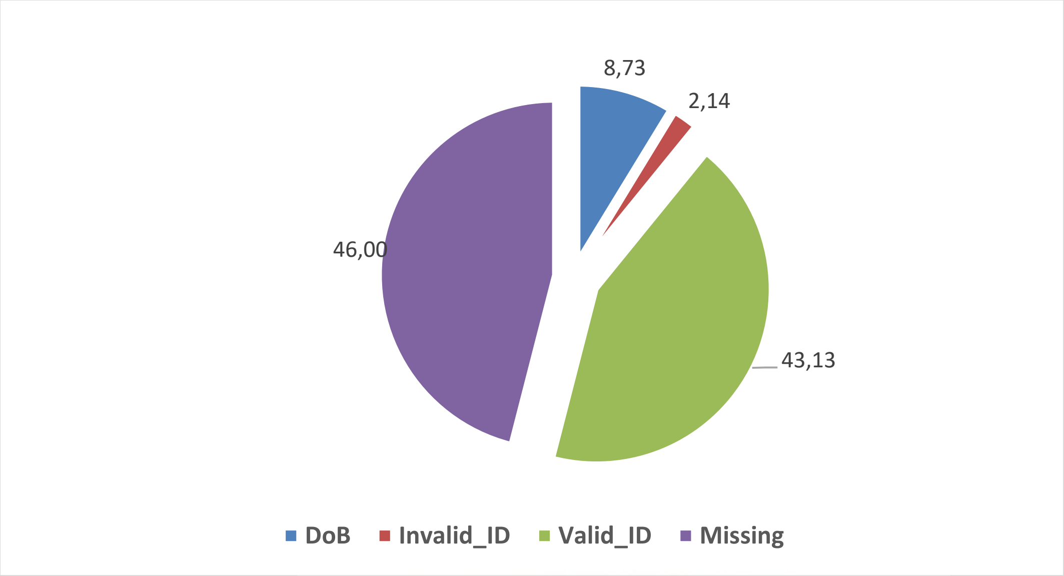


Figure: 6.6 The mother’s ID reporting in records

Results in Figure 6.6 indicate that ID number of the mother was poorly recorded. Just above 56% of values in this items were unusable. Of the 10394 records abstracted, 4569 (43%) had a valid ID number. These were cases where ID number consisted of expected 13-digit and the first 6 numbers reflected date of birth as expected. A total of 84 records had duplicate ID numbers (a high number of these were valid instances where mothers gave birth twice within the study period). The mother’s date of birth was captured in place of an ID in 8.2% cases, while 119 (2.1%) cases had invalid ID numbers. Invalid ID numbers were instances where fewer than 13 digits were captured and where numbers not consistent with date of birth were captured. In the two facilities where data was obtained from BR (CHC_6 and CHC_2) 52 cases of the mother date of birth information were obtained from CHC_6, just above 60% (720) were obtained from BR in CHC_2. A total of 4781 or 46% of records had missing ID number.

Stats SA has a database obtained from movement control centre of the Department of Home Affairs (DHA), from which a publication on monthly tourism statistics is derived, this data consists of passport numbers of travellers that crossed South African borders in a given month. In instances where mothers reported passport numbers, only 49 records contained what seemed like valid passport numbers. Again, there were 29 anomalous cases where the name of a country of citizenship of the mother was captured.

Address system in Nkomazi was poorer than in Germiston, using main place in instead of sub place improve the quality of data on addresses in Nkomazi. Nkomazi also had a higher proportion of unknown addresses.

The weakness in the records management system in health facilities observed was the possibility of creating multiple files for the same individual. There was no consistency in the allocation of unique records identification in most facilities. In instances where women gave birth in the same facility a number of times, a new MCR was created and a new record ID was derived for each pregnancy and birth. This points to inefficiency of recording in facilities and inability of facilities to correctly appreciate the data created by records and building on such data. The ID number of the mother was one of the poorly recorded items, and in the case of the BR the ID or the date of birth are required and in most cases the latter was recorded.

In the case of address of the mother, although validity improved when main-place is considered in Nkomazi, lack of proper address system might compromise validity of information on usual place of residence of the mother. The high proportions of missing cases for data items such ID number and lack of alternative methods of identifying individuals in the absence of ID number is a concern, this coupled with lack of consistent record identification in facilities cast doubt on the ability of hospital records to uniquely identify births for estimation purposes. The ‘unsatisfactory’ rating is proposed for ability of hospital records to uniquely identify individual records and allocate births by location using identifiers within records.

6.6 Conclusion

The three types of records encountered in facilities included all the *key data items* required for this study, and some of those necessary to contribute health information in the birth register.

While some facilities had some form of record keeping and storage system, lack of dedicated records management personnel was a concern. For a number of facilities this function was allocated to medical personnel for whom this was a secondary function, thus not a priority. Record management was relatively better in Germiston CHCs than those in Nkomazi, hospitals also fared better that CHCs. None of the CHCs visited during data collection in Nkomazi had proper storage or filing system for MCRs.

The two provinces had dedicated provincial legislations in relation to management of health records, the challenge was awareness and adherence to the prescripts of legislation and associated regulations. The National Guideline (NDoH, 2017) prescribe that records dormant or inactive for a period of two years must be archived in a separate lockable storage space at the facility if storage space is available or at the district office. In particular, the guidelines prescribe that obstetric records must be kept until the child reached 21 years of age with additional requirement for inactivity for six years. Most CHCs in Nkomazi had misplaced or even lost MCRs in their facilities, only one CHC had indicated that some records were moved to district office for storage. Guidelines also provide for facilities to keep a register of records. Facilities did not have a register of their records and were unable to account for the number of records in their storage in any given year.

The key data items were relatively well captured save for the status of birth (cases of stillbirths and neonatal deaths were under represented), however the completion of some data items in the MCR at two and sometimes three facilities might be accountable for inconsistencies observed in the data. The inclusion of information on health and birth characteristics of newborn babies and their mothers such as birthweight, parity, gestational age, marital status and employment status and in the case of South Africa population group in hospital records data is a positive finding, but quality of records could improve. The recording of health related items must be standardised in future to improve quality of recording.

Cases of missing ID number were pervasive in facilities where data was abstracted from the BR. Where data was obtained from BR, understandably items such as ID and address of the mother are not important for health person to capture correctly as the BR is recorded after the birth of the child. This shows negligence on part of health personnel. Address system in Nkomazi was relatively poor than in the more formal Germiston area. The hospital record identification is an important as a form identification because, where no identity number of the individual is provided, they confirm birth occurrence in a facility. There were inconsistencies in facilities in relations to methods used to allocate record identification, even within the same district. The manual derivation of records numbers might be a contributing factor.

CHAPTER 7

RESULT OF RECORD LINKAGE: HOSPITAL AND REGISTRATION DATA

7.1 Introduction

Chapter 6 dealt with implementation of the assessment framework on hospital data looking at usability, relevance and comparability dimensions.

Measurement of extent of data reliability can be used to assess data quality in one source relative to another. One method for assessing validity and reliability of data is matching such data with other data sources, using common variables within the two sources. This chapter implements the accuracy dimension of the framework using the precision element to assess quality of data across hospital records and birth registrations data through record matching. Section 7.2 describes the results of matched of birth register and hospital data, with sub-section 7.2.1 and 7.2.2 presenting the first phase match and second phase results respectively. Characteristics of matched data which covers matching rates and agreement levels are shown in section 7.3. Quality of matched data is discussed under section 7.4, while unmatched data is covered in section 7.5. Section 7.6 deals with new information obtained from matched data which enhances the data.

7.2 Outcome of matching process

There were 9 798 hospital birth data available to be linked to births register data for birth occurring over the study period 2014-2016. Matching variables and method were discussed in section 3.5. The process followed for matching hospital records data and register data is shown in figure 7.1.

7.2.1 Results of first phase matching

Figure 7.1 presents the process and results of matching hospital records data to the births register. Among the three approaches used in the matching process, the first phase approach produced successful matching of 4007 for cases and the highest matching rate (44%) of the three approaches adopted. The nature of births register data produced duplicate case through linking through the ID number. Of the total records matched through direct method 102 were duplicate cases (See table 7.1). These duplicate cases consisted of births that occurred and were registered over this period. Seventy-six (76) of duplicates represented birth of twins, the MCR had an additional data item to capture twin (and triplet) births.

Since a woman is likely to give birth more than once, her ID number then appears in the register data for all the years when births occurred. A total of 480 cases were multiple births by women that were subsequently registered with DHA, these were identified manually using the date of birth of each child. Of the 480 multiple births, 78 births were reported by women in the Antenatal section of the birth records (MCR). Births registered with DHA could not be identified for 52 cases in the hospital data, either because they were not reported in the Antenatal section or records were incomplete.

Table: 7.1 Result of matching by ID number

Matched records 2014-2017	4007
Duplicate cases	102
Twins	76
Multiple births by same woman (*within study area*)	480
Unmatched ID numbers	559

There were 559 cases referred to as valid ID numbers that remained unmatched. Of these, for 121 cases the date of birth (either the day, month or year) was inconsistent with the first six characters of the ID number as per convention. In 39 and 12 instances respectively, the date of birth was unspecified or the ID number was incomplete (with just the first six characters and zeros). For the remaining 387 cases it might be that other aspects of the ID numbers were incorrect, this could not be verified.

7.2.2 Result of second phase matching

Figure 7.1 also show the result of the second phase matching (discussed in chapter 3, section 3.5). Of a total 9798 hospital records data matched with register data, 5 791 cases remained unmatched through the ID number. This number was 86 983 from the register data. A further two step matching process was undertaken where unmatched cases that did not link on ID numbers were matched. Firstly, using common variables from the two data sources on sex, age of the mother and date of birth of the mother and child, producing a total of 1 223 matched cases from the two datasets.

From the result of the first step matching process about 4568 and 85 760 cases remained unmatched from hospital records data and register data respectively. The 1223 successfully matched cases and unmatched cases from both data sources were subject to a further match using the Levenshtein's algorithm method which yielded an additional 2527 positive match.

The 2527 cases matched in this stage were subjected to further manual inspection. Based on this process a further 135 cases needed confirmation using register data, these were cases where either the name or surname were consistent but one of the two was misspelled or had a different spelling. Of these 135 cases, 85 were converted to full match. About 610 of the 2527 cases which matched only by age, sex and dates of birth and not by name and surname, were dropped. A further 89 cases matching only by surname or one of the names were dropped. After manual inspection a total of 1673 positive matched were confirmed from the second step matching process, implying that the second step contributed an additional 450 positive matches. The matching process for the two datasets yielded a matching rate of 59.6%.

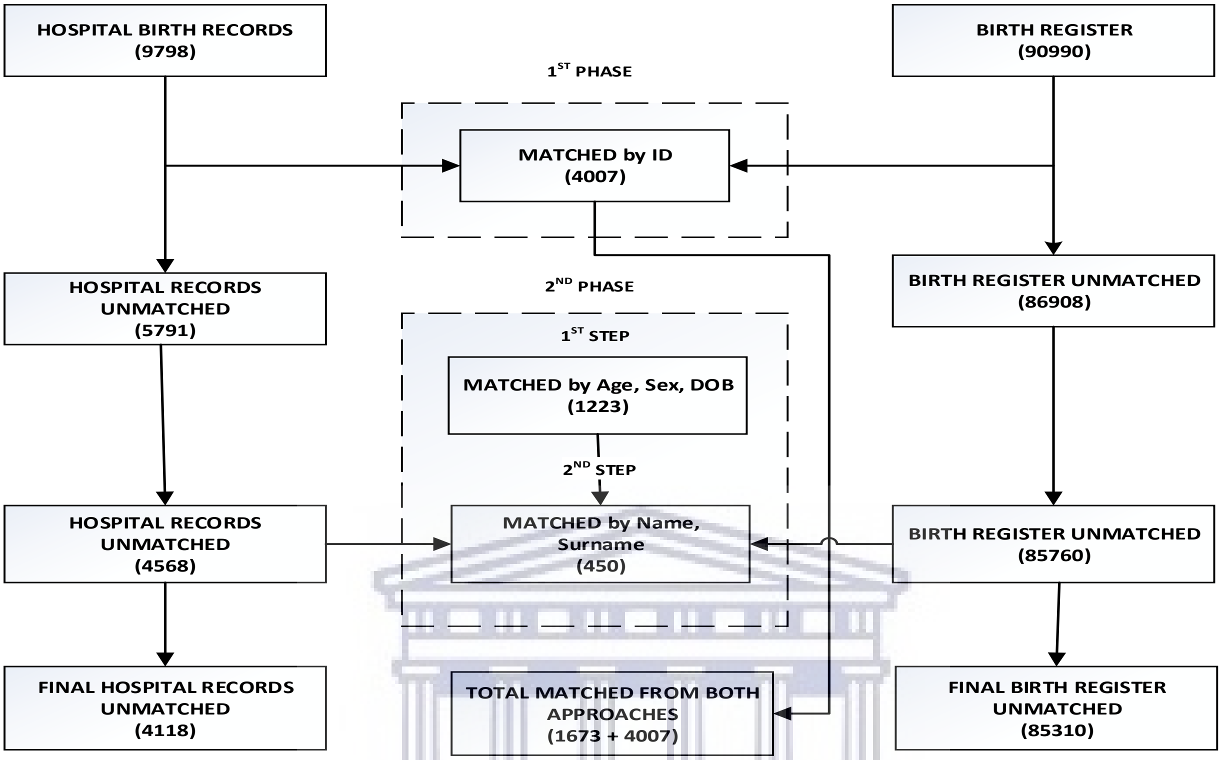


Figure 7.1 Matching process between birth register and hospital records data

7.3 Characteristics of matched data

The characteristics of the matched data will confirm the quality births data based on the two sources. Aspects such as matching rates for the various data items and number and proportions of missing cases give insight into the quality of data.

7.3.1 Matching rates

The overall matching rate produced was 59.6%, matching rate for common individual data items matched between hospital records data and register data are presented in table 7.2. The matching rate is defined as the percentage of all births for which values reported in one source (the register) agree with values in the hospital records data.

Table 7.2 shows total number of cases based on key data items matched successfully. Matching rates were computed for both hospital and register data. For each data item, the numerator was the number of matched cases by the total. The percentage of unmatched, is the proportion for each item that remained unmatched. Values on the left show results based on hospital data, while those on the right indicate result from register.

Matching rates for individual data items varied across the two data sources. A number of data items in both data sources had a matching rate below 50% save for alive status at birth, and valid ID number in both data sources. ID number of the mother in the hospital data accounted for both the highest number (1 333) and highest proportion of unspecified cases (23%). About 203 cases of ID numbers were invalid. These were mainly instances where the date of birth was recorded instead of ID number, and less than 13 digits was recorded. For the individual age groups, the two data sources had consistently lower matching rates. The highest matching rates for this items were observed for the age group 20-24 at almost 30% for both data sources, while the terminal age groups of 12-14 and 45-49 had the lowest matching rates. The highest cases of unmatched data were observed for age group 25-29 and this was true for both data sources. Matching rates were less consistent between the two data sources for several items, for instance for status of birth, year of birth and sex, matching rated were between the two data sources varied. Additionally, status at birth was the only data item where the proportion unspecified were higher after matching than before matching, for example there were 662 unspecified status at birth cases prior to data matching, these increased to 909 after matching for hospital data. There was equally some similarity in the unmatched data across a number of variables in both data sources.

The lowest percentage match was also observed for 2014 births (17.7 and 16.5 respectively) than the other two years which had matching rates of 35% and 38.5% respectively for 2015 and 2016. The proportion unmatched were highest for 2015 and 2016 at almost 40% and 39% respectively Most matched data items in hospital data was characterised by unspecified cases, this was also the case for matched register data

Table: 7.2 Matching rates, hospital records data and birth register data

	Number of records matched Hospital	Percentage matched (n/N)	Number not matched	Percentage unmatched (n/N)	Number of records matched Register	Percentage matched (n/N)	Number not matched	Percentage unmatched (n/N)
12-14	5	0.08	26	0.63	6	0.11	185	0.22
15-19	866	15.25	515	12.51	762	13.42	10235	12.00
20-24	1682	29.61	996	24.19	1694	29.82	21003	24.62
25-29	1463	25.76	1063	25.81	1595	28.08	23020	26.99
30-34	946	16.65	407	9.88	935	16.46	18022	21.13
35-39	394	6.94	201	4.88	465	8.19	9780	11.45
40-44	77	1.36	69	1.68	101	1.78	2605	3.05
45-49	6	0.11	5	0.12	9	0.16	240	0.28
Unspecified	241	4.24	836	20.30	113	1.98	220	0.26
	5680	**100.00**	**4118**	**100.00**	**5680**	**100.00**	**85310**	**100.00**
Year of Birth								
2014	1009	17.76	892	21.66	936	16.48	30379	35.61
2015	2003	35.27	1631	39.61	1850	32.57	28421	33.31
2016	2188	38.52	1595	38.73	2288	40.28	26510	31.08
Unspecified	480	8.45			606	10.67		
	5680	**100.00**	**4118**	**100.00**	**5680**	**100.00**	**85310**	**100.00**
Status at birth								
Status	4771	84.00	3809	92.50	5124	90.21	85200	99.87
Unspecified	909	16.00	309	7.50	556	9.79	110	0.13
	5680	**100.00**	**4118**	**100.00**	**5680**	**100.00**	**85310**	**100.00**
Sex of the child								
Male	2498	43.98	2110	51.24	2793	49.17	43200	50.64
Female	2485	43.75	2008	48.76	2857	50.30	42110	49.36
Unspecified	697	12.27			30	0.53		
	5680	**100.00**	**4118**	**100.00**	**5680**	**100.00**	**85310**	**100.00**
ID number								
Valid	4144	72.96	3501	85.02	4897	86.21	82992	97.28
Invalid	203	3.57	121	2.94	783	13.79	2171	2.55
Missing	1333	23.47	496	12.04			147	0.17
	5680	**100.00**	**4118**	**100.00**	**5680**	**100.00**	**85310**	**100.00**

7.3.2 Exact agreement and sensitivity of matched data – Accuracy

For those records which were matched, a number of data items were analysed for agreement between the two data sources, these are presented in Table 7.3. They were age of the mother, sex, status and date of birth of the child. Table 7.3 show the level of agreement, kappa scores and sensitivity and false discovery rate for above variables.

There was a high level of agreement between birth register and hospital records for age groups 15-19 to 30-34 and the age group 40-44 and slightly lower for ages 35-39 and even much lower at ages 45-49. Both sources had relatively higher agreement at 91% and 92% respectively for male and female births. Whereas agreement was substantially high where status at birth was alive (99.4%), it was extremely low where status was dead (3.6%). As can be seen from Table 7.3, for year of birth there was 91 percent agreement for 2015 births and slightly lower agreement for 2014 births at 76.6%.

Table 7.3 Percentage agreement, sensitivity and false rates

	Agreement				
	Number	%	Kappa	Sensitivity	False Discovery rate
All ages	5108/5680	89.30	0,86		
15-19	836/906	92.27		96,54	7,73
20-24	1578/1730	91.21		93,82	8,79
25-29	1372/1505	91.16		93,78	8,84
30-34	882/964	91.49		93,23	8,51
35-39	359/394	91.12		91,12	11,79
40-44	74/80	92.50		96,10	7,50
45-49	4/7	57.14		66,67	42,86
Sex			0,92		
Male	2258/2478	91.12		93,29	8,88
Female	2290/2465	92.90		92,80	7,10
Status			0,17		
Alive	4397/4422	99.43		99,78	0,57
Dead	9/247	3.64		*4,04	95,58
Year of Birth			0,79		
2014	746/974	76.59		85,65	14,35
2015	1745/1913	91.22		96,84	3,16
2016	2067/2287	90.38		96,63	3,37

* Figure may not be reliable; numerator too small for the calculation.

Kappa scores were substantial higher for sex of the child and in case of all ages combined (86%). Although agreement for alive status at birth were high, this data items had lowest kappa scores at just 0.17, confirming lower agreement for variable dead status for this variable. Slightly lower Kappa scores of 0.79 for the year of birth of the child were observed suggesting fair agreement for this item.

Sensitivity levels were substantial for all age groups save for age group 45-49 (66.7%); Lowest sensitivity were also obtained for children whose status at birth was dead. For the year of birth 2014 births had lower sensitivity (86%) than the other two years at 96.8% and 96.4% respectively. False discovery rate (FDR) varied by item, naturally age groups with high agreements and high sensitivity showed lower FDR, for instance. Information on births with dead status which had low agreement had highest FDR while births with alive status at birth showed lowest FDR (0.6). FDR ranged from moderate to high across the age groups had FDRs ranging from 7.5 % for age group 40-44 to 42% for ages 45-49 years. Fairly low FDRs were observed for sex of the child 8.9% and 7.1% for male and female children respectively.

7.4 Quality of matched data

Successful matching of data using common identifiers does not imply lack of discrepancy among matched items pertaining to same individuals. Equally, evaluation of agreement between the birth register and hospital records data must be able to account for proportions of missing data from the two data sources for data items specified. Matched register and hospital records were compared based on other variables and unspecified cases.

7.4.1 Names and surnames

One common linkage problem with using the name variable as a common identifier was that an individual's name could be represented in many different ways, with alternate spellings, initials, abbreviations and shortened forms of names making the linkage difficult. Equally a mother’s surname can change before she registers the birth.

Table: 7.4 Quality of surnames based on matched ID number

	Surname
Correct surname	3491
Name in place of surname	705
Misspelled Surname	415
Different Surnames (Same ID)	115
No Surname	34

Table 7.4 shows the results of matched surname matched, 3491 surnames were the same from the two data sources. Just above 20% of cases the name was recorded instead on surname. About 9% of the surnames were misspelled. No surname was provided for 34 cases.

7.4.2 Missing data

A number of unspecified cases for some data items were observed from matched data and after the agreement analysis, thus a separate analysis of missing cases was undertaken. In this study, higher proportion of missing cases were observed for data items collected from hospital records than the register data The number and proportion of missing data by item are shown in table 7.5

Table: 7.5 Number of missing cases from agreed data

Age	Hospital data	Birth register data	Missing from both sources
			3
15-19	40	59	
20-24	48	67	
25-29	42	87	
30-34	18	41	
35-39	13	14	
40-44	3	6	
45-49	1		
Status			
			16
Alive	276	283	
Dead		2	
Date of birth			
			71
2014	103	21	
2015	111	6	
2016	148	9	
Sex			
Male	349		
Female	342		

The number of missing data from both sources were observed for all age groups. The highest number of unspecified cases were in the age group 20-24 years in the case of hospital data and for register data the highest number was in the 25-29 age groups. Levels of missing data were low for year of birth in the register, but higher for all the three years in the hospital data with the highest number unspecified for 2016 deaths. Information on sex was missing only from the hospital records data, although constituting only 6% of the matched data, no missing sex was observed from the register.

7.4.3 Status at birth

As observed from Table 7.5, status at birth was missing from both sources for those born alive. Recording of status at birth in the two data sources was discussed in chapters 4 (register data) and chapter 5 (hospital record data). A further analysis on the matched data show inconsistencies between the status of birth variable from the two data sources. Although agreement between the two data sources was high where status was alive, there were 283 cases indicated alive in hospital data but had unspecified status in the register, and 276 unspecified instances in the hospital records data, which were recorded as alive in the register. More unusual was twenty-four deaths recorded in hospital data but indicated as alive in the register.

Table: 7.6 Comparison of birth outcomes - Status at birth

	Alive	Dead	Neonatal death	Unspecified	Total
Alive	**4397**	25	12	283	4737
Dead	24	**9**	0	3	27
Unspecified	276	0	**0**	16	292
Total	4697	34	12	302	5056

Only nine deaths were reported consistently between the two sources. A positive outcome of the match in case of status of children were the 25 and 12 children who were alive in hospital data and subsequently died and (neonatal death) and registered with the DHA.

7.5 Unmatched data

A total of 4118 cases from hospital records data could not be linked to the register data. Analysis in previous chapter pointed that only 4007 ID numbers from hospital data could be validated by the match. However, Figure 7.2 shows that there were about 575 (14%) cases with expected 13 digits that failed to link to the DHA data. Above 60% on unmatched hospital records were missing ID numbers, 36% of these were from Nkomazi, and 27% from Germiston area. The 49 cases containing passport numbers and those where the name of country of citizenship of the mother was recorded as identified in Chapter 6, were part of the unmatched data.

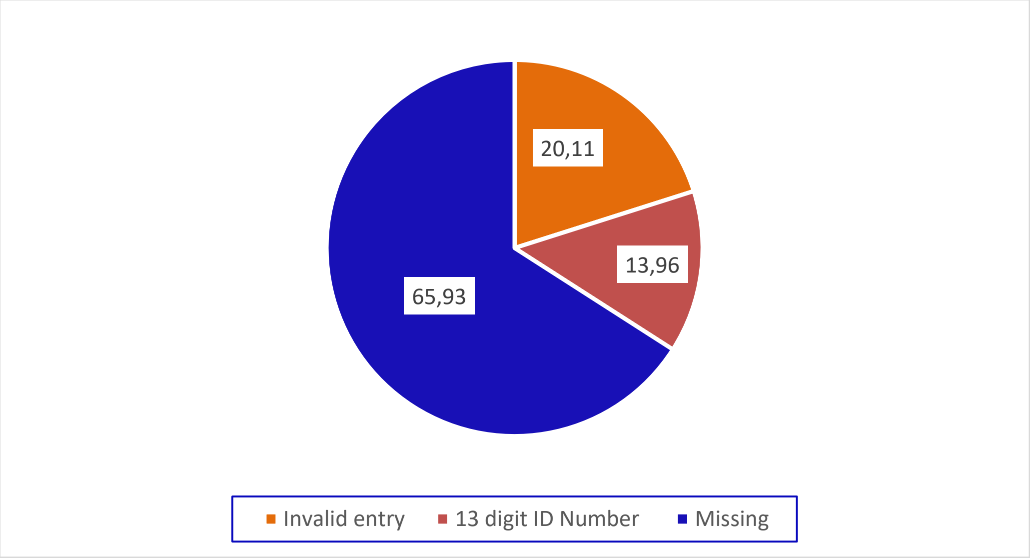


Figure: 7.2 ID number in unmatched hospital data

7.5.1 Matching by location

Figure 7.3 present the proportion matched and unmatched cases by location.
Slightly more records abstracted from Nkomazi facilities matched (20%) than records abstracted from Germiston (19%), this area also had a higher proportion unmatched than Nkomazi. Almost 13% of data matched were for individuals residing outside the two study sites (with the highest proportion of these were births in Germiston area at 62% of those from other location)

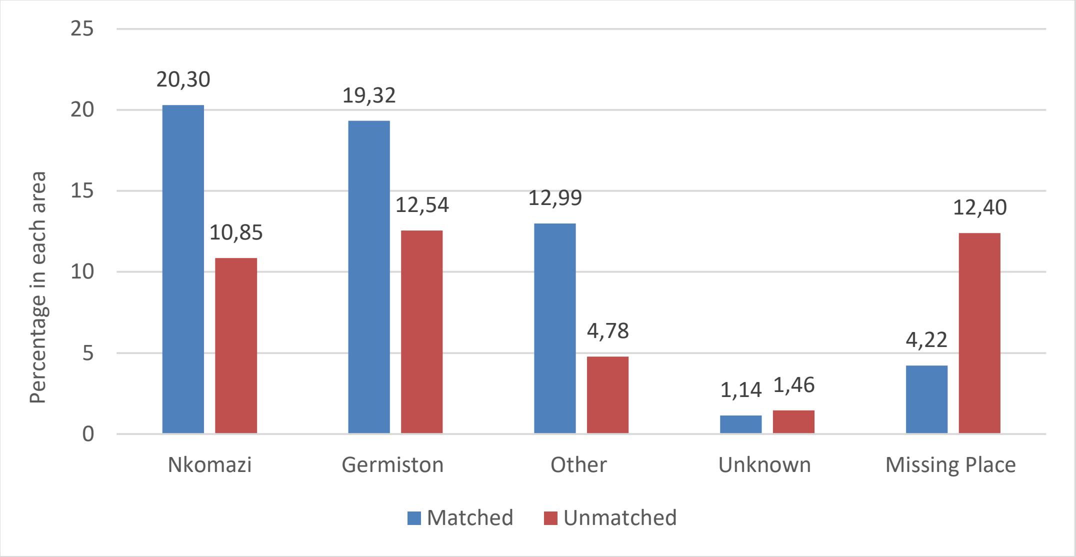


Figure: 7.3 Matched and unmatched cases by location

Most cases with unspecified place of residence failed to match. The proportion of missing place of residence was higher in unmatched data as compared to unmatched data at 12% and 4% respectively. The proportion with unknown address were fairly similar for both matched and unmatched cases at just above one percent.

7.6 New information obtained from data matching

One of the key concerns with current status of birth registrations data is limited number of data items beyond the one needed by DHA to effect registration. The matching exercise provided additional information, which gave some insight on characteristics of women and their children at the time of birth. Generally, DHA-24 does not include some of the demographic information and any information on health outcome of births.

7.6.1 Population group

Research has shown that the four population groups in South Africa continue to experience differentiated health outcomes. Availability of information on population group in the death notification form (DHA-1663) currently used to register deaths in South Africa also shared light into health differences among the main population groups in country, this information is used only for statistical purposes and is not publicly available. At the height of the HIV/AIDS pandemic, data from death registration gave us information on population group differentials on impact of this pandemic and resulted in the introduction of such intervention as the PMTC programmes. Information on population group was available in the MCR but not in the other two records, however this information can be collected. The population group of women giving birth in health facilities in the two study sites are presented in Table 7. 6.

Table: 7.7 The number and percentage of women by population group

	Number	Percent
African (Black)	3873	68.19
White	40	0.70
Coloured	146	2.57
Indian	9	0.16
Other	53	0.93
Missing	1559	27.45
Total	**5680**	**100.00**

Of the 5680 successfully matched records, 68% were reported as Black African, almost 3% were Coloured and less than one percent was reported as white (0.70%) and Indian (0.16%). There were 27 percent of matched cases with no stated population group. Almost 1% of women were recorded under other, all of these were women who reported foreign identity.

7.6.2 Marital status

Socio-demographic profile of mothers giving birth such as marital status are indicators of circumstances of mothers and their children. Research on births in South Africa has revealed high proportion of births outside marriage as well as within cohabiting union (Palamuleni (2010; Nhlapo 2016). Although the DHA-24 had an item for marital status of the mother, this data is not obtained by Stats SA. Marital status of the mother is asked in the MCR, although this is not included in the BR, these cases will likely contribute to the higher proportion of missing cases for this data item.

Table: 7.8 The number and percentage of women by marital status

	Number	Percent
Married	693	12.20
Single	3857	67.90
Divorced	8	0.14
Widowed	11	0.19
Stable relationship	203	3.57
Missing	908	15.99
Total	**5680**	**100.00**

Marital status responses options based on the MCR are shown in table 7.7. About 68% of women who gave birth in the facilities in this study reported being single at the time of birth, whereas only 12% of the births occurred to married women. Almost 4% of women reported being in stable relationships (*assumed to be cohabiting in this study*). Again 16% of cases had missing marital status, a large percentage of these were based on BR.

7.6.3 Parity data by place of residence

Parity refers to the number of live births that a woman has. Parity data is not part of birth register data, yet once a woman registers a birth, her child becomes linked to her on the National Population Register. All three types records encountered during data collection had a data item for parity of the mother, the MCR also recorded the years they gave birth and the status of those births (*whether they are currently alive of dead*).

Parity by age of the woman and place of residence of the mother based on matched data is shown in Table 7. 8 for Nkomazi and table 7.9 for Germiston. For both areas the highest number of women were parity 1, For Nkomazi, the highest number of parity one women were in the age group 20-24, in Germiston the highest number in Parity one were in the age group 25-29

Table: 7.9 Parity by age of the mother - Nkomazi

	0	1	2	3	4	5	6	7	8	9	Unsp	Total
15-19	9	99	1	0	0	0	0	0	0	2	2	113
20-24	25	428	146	30	0	0	0	0	0	0	2	631
25-29	12	402	257	127	23	9	2	0	0	2	4	838
30-34	8	212	211	154	60	35	4	0	0	1	2	687
35-39	0	43	55	69	61	18	17	2	4	2	0	271
40-44	2	3	6	13	19	12	1	2	1	1	0	60
45-49	0	0	0	2	3	0	2	0	0	1	0	8
Unsp	2	16	8	1	2	2	0	0	1	1	0	33
Total	**58**	**1203**	**684**	**396**	**168**	**76**	**26**	**4**	**6**	**10**	**10**	**2641**

Where else Germiston area had higher number of women in parity 0 (4%), Nkomazi had a higher number of women at higher parities (2.8%). About 45 % of women in Nkomazi were in parity one, this figure for Germiston was 54%

Table: 7.10 Parity by age of the mother - Germiston

	0	1	2	3	4	5	6	7	8	9	Total
15-19	11	31	5	0	0	0	0	0	0	0	47
20-24	29	366	61	8	0	0	0	0	0	0	464
25-29	26	443	200	39	1	0	0	0	0	0	709
30-34	11	200	208	89	16	3	0	0	0	0	527
35-39	4	63	90	65	16	1	0	1	1	0	241
40-44	3	13	19	17	11	0	0	0	4	2	69
45-49	0	0	0	1	1	0	6	0	0	4	12
Unsp	1	12	1	1	1	0	0	0	1	1	18
Total	**85**	**1128**	**584**	**220**	**46**	**4**	**6**	**1**	**6**	**7**	**2087**

There were 33 cases in the matched data where age was not stated in Nkomazi even though parity was stated, only 18 cases had unspecified age in Germiston data. Nkomazi had both unstated parity and age.

7.6.4 Gestation age and Birth weight

Health information produced at birth such as birth-weight, and gestational age are critical for informing health services and in epidemiological studies examining short and longer term clinical outcomes (Cutland et al, 2017). Gestational age is the length of time, measured in weeks, which a foetus grows inside the mother's uterus from inception to birth. The birthweight of an infant is the first weight recorded after birth, ideally measured within the first hours after birth (Margett et al, 2002). Gestational age and birthweight are associated with morbidity and mortality through childhood and beyond (Wier et al, 2007).

Birth certificate data is the most common source of population-based gestational age data that informs public health policy and practice (Wier *et al*, 2007). Cutland *et al* (2017) notes as one of major challenges in monitoring the incidence of LBW as lack of information on birthweight and gestational age for half of infants in Low- and middle-income countries. From hospital records data about 60% cases had unspecified gestation information, in the matched data 64% of cases had unspecified gestation age. Issues besetting gestational age recording in hospital data were discussed in section 6.2.1.2, given the observed shortcoming in the matched data for this data item, this analysis is not shown

As indicated in section 6.2.1.2 birthweight was recorded in all records types found in facilities. Classifications presented in table 7.10 are based on WHO recommended classification for birthweight (*These were discussed in section 6.2.1.2*).

Table: 7.11 Birthweight categories (Matched data)

	Number	Percent
Extremely low birthweight	39	0.69
Very low birthweight	49	0.86
Low birthweight	505	8.89
Normal birthweight	4271	75.19
Macrosomia birthweight	122	2.15
Unspecified birthweight	694	12.22
	5680	100.00

About 75% of cases in the matched data had normal birthweight. Almost 9% of children had what is classified as low birthweight, while just above 2 percent had macrosomia birthweight. Below one percent of children were born with very low and extremely low birthweight. Twelve percent of cases has unstated birthweight and less one percent of children can be classified as low to extremely low weight.

7.7 Conclusion

This chapter dealt with data matching and quality of matched data. The two phase matching process followed in this study produces varied results, with a higher linkage rates produced through direct match by ID number than the second stage. Relatively fewer new cases were added to the matched data during the second step matching compared to the first.

The matching rate of 59.6% obtained in this study is relatively low by global standard, however this could be explained by poor reporting of ID number of the mother at facility level and fewer common data items to facilitate efficient matching across the two data sources. The high proportions of unspecified cases pertaining to some of the linking variable, use of nicknames, misspelled names and surnames also contributed to lower matching rates produced. This notwithstanding, matching rates by individual data items varied, data items that were well reported in hospital data such as sex of the child and positive birth outcome produced higher matching rates than others.

Differences in data quality between hospital records and register data were evident when agreement levels were seen by data item. Exact agreement and sensitivity were high for a number of variables for both data sources. Compared to adverse birth outcomes, better agreement was observed for positive birth status, this was also observed for the terminal age groups (45-49). Low sensitivity and a high FDR, were obtained in the two cases mentioned (Although the fewer cases available for the children reported dead, cast doubt on the FDR obtained). The fewer numbers available for this data item is concerning and suggests pervasive misreporting in hospital records. Another contributing factor might be that children who experience complication after birth are transferred to neonatal unit and new record is open (*based on conversations with health personnel* *during data collection),* the fate of such births are recorded elsewhere and are beyond the boundaries of this study.

Equally, concerning was cases where children were reported dead in hospital records but were alive in the register.

The challenges with demographic data in hospital records was presence of high unspecified cases. Just above 27% women had unspecified population group, while marital status was missing for 16% of cases. Other health related data items such as gestational age also had high unspecified cases.

On a positive note, matching produced new information about woman giving birth in facilities visited for this study. Data items such as marital status, population group and parity and residential address of the mother gave insight into other aspects about the study population. It was demonstrated that Nkomazi women have higher parities than Germiston women. Parity information in South Africa has always been based on data reported by women in Census and Survey, editing data on parities always present a problem because there is always uncertainty on the plausible total number of children born to women. As results some of the data are cleaned out because they are perceived as data errors. Evidence in hospital records provide a true picture of parities and the number of children ever born to women to inform health decisions.

Almost 9% of children in the study areas had low birthweight, with just above 2 with macrosomia birthweight, this is consistent with findings in other countries, where only a small percentage of children are born with very extreme low birthweight.

CHAPTER 8

A MORE SYSTEMATIC AND COMPREHENSIVE BIRTH REGISTRATION SYSTEM

8.1 Introduction

Births registration data provide basic information on the number of births occurring in a country. Over and above this basic function, these data are an important source of information on health issues affecting mothers and their children at the time of birth. For policy makers, they provide information on quality of care delivered in facilities and areas for intervention. A complete and rapid birth registrations system that include every birth occurring in the country also enables analysis of sub-national populations, thereby enabling targeted intervention at any level.

Preceding chapters have shown numerous challenges besetting acquisition and use of births data in the country. This chapter responds to the fourth objective of the study which seeks to identify appropriate interventions needed to build a more systematic and comprehensive birth registration system. A system based on appropriate legislative intervention, processes and data collection instruments is proposed and ways to meet data needs of various stakeholders with interest in birth register data are recommended. Possible interventions are identified in relation to operations and data content under three sections:

- Institutional interventions; ensuring correct, rapid and universal birth registration system
- Processes and procedures at operational level, and
- Redefining content, i.e. restructuring available instruments to improve the content of birth data

An overview of birth certificate data globally, looking at developments over time is undertaken in section 8.2. Section 8.3 deals with birth registrations data within the South African context. Current institutional arrangements, processes and procedures in relation to registrations, data acquisition and processing towards the production of births statistics. An alternative system for acquisition, registration of births and production of births statistics is proposed in section 8.4. Policy interventions towards improved processes and procedures are discussed under section 8.5. Manual processes flow for registration of births and production of births and other statistics are dealt with under sections 8.6. Proposed improvements to the contents of the DHA-24/PB are introduced in section 8.7. Lastly is the discussion on possible automated processes flow for registration of births and production of births and other statistics in the country in section 8.8.

8.2 Birth certificate data globally

Globally, a birth certificate has progressed from being just a legal document to critical source of information on maternal and child health, while providing key national and local statistics. (Brumberg *et al,* 2012). Empirical evidence in the US has shown dramatic increase in the amount of information collected through birth certificates (Brumberg *et al,* 2012; Northam and Knapp, 2006; Salemi *et al,* 2017). The evolution of birth certificates is reflected through growth in the number of data items collected through this instrument over time for instance, in 1906, only about seven fields were included on a birth certificate. Contents primarily included the date of birth and residential address of the mother, whether there was multiple gestation, mother's age and race, legitimacy, paternal name and age, and previous live births (Salemi *et al,* 2017).

However, by the end of the century, more than 60 data items (*See attached US birth certificate data items-appendix E*) were collected as part of births certificate data (Brumberg *et al,* 2012). These data items were added through several revisions over a number of years including major revisions in 1979, 1989 and the 2003 revision which saw the introduction of electronic certificate and standardisation of contents across all states (Salemi *et al,* 2017). Infant information has grown from collecting the child's name and birth date to reporting of congenital abnormalities and other birth defects.

Developments noted above are testament of recognition by both health specialist and researchers of the importance of birth certificate data in planning for maternal and child health programs and as an evaluation tool. In relation to data quality, Brumberg *et al,* 2012) note that it has been demonstrated that the party responsible for completion of the birth certificate at facility level was a major contributing factor to the quality of the data.

8.3 The South African birth data

The foregoing discussion illustrates that the birth certificate must be viewed as a living document that matures and evolves (Brumberg *et al*, 2012). Two primary purposes of birth registration are legal; which is acknowledgement of the child's existence and entitlements; secondly; statistical, which allows recording of national demographic and health data (Giese and Smith, 2007). In South Africa, registration of births and subsequent issuing of a certificate still focusses on legal aspects, save for the interest shown by Statistics South Africa (Stats SA) and few researchers to derive statistics on births from the system, notwithstanding limited data items.

8.3.1 Legislation, processes and procedures for registration and production of births statistics

The registration of births, deaths and stillbirths throughout South Africa is governed by the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992). The Act was subsequently amended in 1996 (Act No. 40 of 1996); 1997 (Act No. 67 of 1997); 1998 (Act No. 43 of 1998); 2002 (Act No. 1 of 2002); and in 2010 (Act No. 18 of 2010).

The current legislation on births and deaths, mainly the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992), only deals with production of statistics from vital registrations in relation to the DHA-1663 forms. Section 15 of the Act deals with confirmation of natural death, certification of causes of deaths by a medical practitioner.

Stats SA and the Department of Home Affairs (DHA) currently have a Memorandum of Understanding (MoU) and Service level agreement (SLA) in lieu of the collection (and sharing of data), processing and publishing of vital statistics data from civil registration. DHA-1663 forms are collected by Stats SA regularly from DHA head office for sorting, capturing, processing, analysis and report writing. This information is disseminated annually as statistical releases on mortality and causes of death (Stats SA, 2017). Births and marriages data are acquired from DHA through SITA as part of the MoU. The Births and Deaths Registration Act, 1992 (Act No. 51 of 1992) deals with procedure for confirmation of occurrence of a death and certification of causes of deaths. The Act is silent of processes and procedures related to births.

The National Health Act (Act No. 61 of 2003) does not link births occurring in health facilities to registration and any data that emanates from vital event in facilities. Only section 66 of the Act provides the framework for dealing with post-mortem examination of deceased bodies, if necessary, to determine the cause of death of the deceased person.

Guidelines for maternity for maternity care (Guidelines), is published by the Department of Health (DoH) periodically to provide guidelines on the care of pregnant women and child birth (DoH, 2015). The guidelines are intended for doctors and midwives providing obstetric, surgical and anaesthetic services for pregnant women in district clinics, health centres and district hospitals (DoH, 2015). However, these do not deal with births beyond the facility.

It also describes good record keeping practices, however, this is in relation to recording of events, handover communications and discharge summaries and reporting within facilities. No reference to management of records produced in facilities on maternity care and their archiving. No indication of using these records as source of health planning information, informing intervention and health research in the country.

The DoH and the DHA have MoU in relation to facilitation of registration of births in health facilities. A study commissioned by DHA in 2017 on evaluation of birth registration in health facilities (the DHA study) concluded that the MoU was not sufficiently detailed, particularly with regards to the roles and responsibilities of the respective parties (DPME, 2017).

8.3.2 Processes for registration of births

Until recently, application for a birth certificate at DHA was based on the clinic card (*also known as a Road to Health chart*) as proof of birth occurrence. The card which is issued by DoH to women at the birth of a child is used primarily to record immunisations and to track the health and development of the child. For both health and registration authorities, the challenge with the above practice was that the road to health chart was only intended to assist health workers to monitor the child’s health after delivery. For DHA on the other hand, it did not include all information required for registration of births and was opened to abuse and fraud. Giese and Smith (2007) documented instances where clinic cards were rejected as proof of birth by DHA officials in cases where even the slightest amendment to mother’s name, child’s name, date of birth or gender were observed, with mothers instructed to return to the place of birth to obtain a new clinic card.

The DHA-24/PB was introduced through the Regulation on Births and Deaths, 2014, intended to change the practice of using the road to health chart as proof of birth occurrence, and came into effect on 1st March 2014 (*See attached DHA-24/PB in appendix F*). The DHA-24/PB is currently issued to all public health facilities and is completed at the facility where a birth occurred and taken to DHA by mothers or parents as proof of birth occurrence.

The DHA-24/PB captures the same information contained in the DHA-24 (*discussed in section 2.2.3*), and includes additional information about the facility, requiring facility stamp and particulars of the health personnel present at delivery of the baby. The DHA-24/PB was also intended to standardise the data-collection process and improve quality of data collected from facilities on births, the use of the form is however still not universal. The DHA study, found that a number health facilities regard DHA-24/PB as an administrative burden and that there was no ownership of the process by DoH personnel.

Until recently, an abridged certificate was issued to parents at registration of birth while unabridged certificates were issued to the public on application and at a cost. With effect from March 2013 unabridged birth certificates were issued at first registration for all new-born babies at no cost. This was introduced through the South African Citizenship Amendment Act 2010 which was accompanied by the review sections of the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992). Whereas the abridged certificate only included information on the child, the unabridged birth certificate also added particulars of both parents, where possible, and their ID numbers.

To complete the registration process at DHA, parent/mother complete the DHA -24 and submit both documents (DHA 24 and DHA 24/PB) to officials for registration. Registration of events at DHA offices occurs in real time, the birth is included on the birth register and linked to the mother on the National Population Register. The process follows DHA documented Standard Operating Procedures (SOP) for their offices on the registration of all vital events.

8.3.3 Acquisition and production of births statistics

The acquisition, compilation and dissemination of vital statistics are the mandate of Stats SA. The production and utilisation of all statistics in South Africa is legislated though the Statistics Act, 1999 (Act No. 6 of 1999). Vital statistics disseminated by Stats SA include on recorded live births, marriages and divorces, and deaths and causes of deaths.

The Act deals with productions of statistics from vital registration as part of all statistics produced by the Agency, it is silent on processes and procedures for acquisition and production of births statistics. The practice until recently was for Stats SA officials to collect data on registered births from DHA using CDs and tapes. This was in contravention of the Protection of Personal Information Act, 2013 (Act No. 4 of 2013), but also potential bridge of confidentiality of data. A recent amendment to the MoU and inclusion of the SLA between Stats SA and DHA enable direct access for birth data and other administrative data by Stats SA though main frame. Table 8.1 shows current processes in relation to registration of births and production of births statistics.

Table 8.1 Current processes in registration and production of births statistics

BIRTHS	
Birth registration: Child born at home/at a place other than a health institution	• Parent collects the necessary documents for birth registration at DHA offices • Parents' documents are verified • Complete DHA-24 PBA and DHA-24 • Online verification (RSA citizens) • Register child on NPR, issue unabridged certificate
Birth registration: Within a health institution	• Health professional completes DHA-24 P/B • Parents' documents are verified • Complete DHA-24 P/B and DHA-24 • Online verification (RSA citizens) • Register a child • If office is connected to mainframe, certificate is issued immediately • If office is not connected to mainframe, parent has to collect certificate from the nearest DHA office
Birth registration: Small/ medium/large office	• Present completed copy of DHA-24 P/B, ID copies to official DHA officials • Verify supporting documents • Conduct online verification • Complete DHA-24 (and 288 in case of LRB) ○ Conduct LRB interviews • Register child on NPR, issue unabridged certificate • Send record to Back Office at DHA
Production of births statistics:	• DHA makes data available on mainframe • Birth data shared between Stats SA and SITA servers • Data editing at Stats SA • Data analysis and report writing • Dissemination of report

Source**:** Preliminary Comprehensive Civil Registration and Vital Statistics (CRVS) Assessment Report, South Africa: 2014/15 Stats SA (2018)

8.4 Conceiving an alternative system for registration and production of birth statistics

A well-functioning civil registrations system plays a central role for public health and explaining the demography of a country. Although data collected through this system provide basic information needed to register children towards realisation of their fundamental rights, it must also provide additional information needed by the health sector for planning and interventions needed to improve the circumstances of mother and their children. Phillips *et al* (2018) concedes that while completeness of registration of birth registration remains the fundamental measure of the quality data, other specific information about new-born children, and their mother should be routinely collected for each birth and included in the certificate are birth order and birthweight among others.

To realise the potential utility of birth data, accuracy and completeness of the data must improve. The introduction of DHA-24/PB is an important step towards improving births data from civil registration system in the country. One of the main challenges in civil registration and vital statistics (CRVS) system in South Africa is fragmented collaborative efforts between various entities and utilising existing systems to close loopholes and achieve long-term development of the system. This notwithstanding, the high proportion of births occurring at facilities and existing collaborations can be leveraged to introduce interventions.

8.4.1 Data sources available for birth

The OCR and MCR - The Obstetrical Clinical Records (*now obsolete*) and the Maternity Case Record (MCR) were adopted in the public sector, the latter was introduced to standardise treatment and intervention during pregnancy and childbirth across facilities in the referral system (*This was discussed at length in section 6.2.1.1*).

One of the observation made by the study was lack of perceived use of the MCR by facilities beyond the above mentioned objectives. Record retrieval challenges experienced during data collection for this study are also testament to this effect. On a number of occasions where the MCR was not available, the Birth Register (BR) was provided by the facility, the BR was also provided even in cases where certain enquiries were made about entries in the records to facility personnel.

Nonetheless, it was shown in previous chapters that most data items needed to enhance quality and content of births data are available in the MCR and BR, in spite of quality and completeness of data concerns. The two records are an important source of data on births in public facilities.

The Birth Register - Most facilities kept records in the BR and these were forwarded to the team in cases where the MCR was unavailable. The BR is completed post birth occurrence, while the MCR is generated at the beginning of pregnancy. It was also observed that the BR mostly captured data items critical for the day to day functioning of facilities and probably for reporting. The BR also seem to be more complete than the MCR.

In a few facilities observation were made during data collection that mothers are required to return to the maternity ward after a few days to collect the DHA-24/PB (Based on discussions with health personnel) necessary for registration at DHA. The facility personnel depended on entries made in the BR to complete some of the information needed in the DHA-24/PB. This makes the BR an important source to intervention and improvements of births data. In the eventuality the BR is the chosen form of recording births for registrations purposes, it must be the focus of intervention. The BR covered all *key data items* and provided additional data items to enhance births data, they included birthweight, information on birth defects, and information on the health of the mother including gravida and parity of the mother, gestational age, complications of labour including HIV status. However, the BR did not include some socio-demographic information on the mother.

The non-completion of ID number and residential address of the mother in the BR talks to its necessity for health workers for birth purposes. In an environment where the main the mandate is provision of health services, the availability of an ID document is not a paramount, this might call for another method to identify patients (mothers) who give birth in facilities, given that in South Africa, undocumented individuals do not have any method of identification when presenting at facilities.

8.5 Improving policy, processes and procedures

The foundation of every CRVS system is a strong legal framework that defines the type of vital events to be registered, specifies the time allowed and other registration requirements, designates the person or informant responsible for notification, and outlines the registration place and the information to be collected (Garenne *et al*, 2016). A well-functioning CRVS systems even where located across a range of entities should be sufficiently coordinated through laws and regulations. Such laws must also define clearly processes and procedures underpinning within the system. There are a number of short coming in current legislation in relation to processes for registration and the production of birth statistics;

The DHA instituted a number of satellite offices in facilities across the country. The number of facilities with satellite offices for registering births and deaths immediately after occurrence have grown over time, however, this is intervention is well coordinated. The DHA study found that of the 800 hospitals in South Africa with maternity services, 391 (49%) have been connected to the DHA online system for facilitate registration. The presence of a satellite office was confirmed in only two facilities in the study. Observations made during data collection for this study were that DHA officials were not always available to register births. For a number of facilities, and this was mainly in CHCs, DHA officials visited facilities on certain days to help mothers with registrations. In one facility where permanent the office was created outside the maternity unit, DHA official was absent for most of the week. Mothers often left facilities without registering the birth. According to health personnel, (Through personal discussion) mothers are informed of the days when DHA officials will be available for registering children and asked to return for this purpose. These observations were also made by the DHA study. In one facility, new mothers were queuing outside the maternity unit and on enquiry we were informed that they were returning to register births that occurred in the unit.

The other challenge with registering a birth immediately after birth was that most children were not assigned a name at birth, the name of the new born was supposed to be reflected under *Examination of the neonate* section of the MCR, however in most instances BT (born to): (*Name of the mother)* was recorded in that space. The introduction of hospital satellite units was done to ensure that registration of births immediately after occurrence. The intervention was also meant to reduce the cost of travelling to DHA offices for mother for birth registration.

Although sections 24, 25 and 26 of the Act state procedures to follow in case of name change, the Act does not provide for registration of birth without a name or insertion of a name after a specified period. The disadvantage with this provision is that some cultures in South Africa still require performance of certain rituals prior to naming of a child. There will be instances where these children die before they are registered. The other effect is that Act currently prohibits registration of infant death if the birth was not registered (*registration posthumously*).

The Act does not allow registration of infant whose parents are not South African citizens or those whose details do not appear on the Population Register. The Act does not place any obligation for the registration authority to keep a database of births by non-South African citizens, asylum seekers, refugees and other special groups. Currently, upon registration only handwritten certificates issued to the informant (but according to DHA officials most mothers without ID numbers do not come for registration).

Stats SA does not process births forms (DHA-24) although the death notification forms (DHA - 1663) are processed at the agency. The advent of DHA-24 PB provides an opportunity for Stats SA to acquire the forms for processing purposes. However, not all DHA-24/PB are presented at DHA offices for registration purposes these are undocumented individuals and South Africans without ID documents. The study also found 533 cases where births occurred prior to arrival at the facility. These are home births that are accounted for, there remains a likelihood that some of these births that occur outside facilities remain unaccounted, particularly those that end in death and those whose mothers do not have reasons to present at DHA (as in cases of undocumented individuals). Further analysis of these births was beyond the scope of this study.

The DHA-24/PB is not issued in duplicate and not serialised, the original copy is issued to the mother, and thus not copy remains of the birth at facilities. This affects the authenticity of the form presented to DHA by parents. The DHA study also noted that this opens opportunity for fraud.

The production and utilisation of statistics in South Africa is legislated though the Statistics Act, 1999 (Act No. 6 of 1999). There is currently no clear provision made for the collection and processing of vital statistics in legislation. Only the use of deaths data from civil registration process for producing statistics on vital events is implied because of section B of the DHA-1663, which is in the Act. DHA-1663 forms are collected by Stats SA regularly from DHA head office for sorting, capturing, processing, analysis and report writing. This form is issued to health facilities and is serialised and regulated in terms of the Act. This practice ensures the maintenance of confidentiality of individual’s information on causes of deaths. Although there are still documented challenges with data obtained from the DHA-1663, there is equal appreciation of improving data quality over time (Grandin *et al*, 2006; Joubert *et al*, 2013; Garenne *et al*, 2016). Duplicating the procedures followed in the processing and production of deaths statistics from DHA 1663 will not resolve the missing births. It requires stakeholder collaboration and operational arrangements to enter into between the various entities e.g. MoUs and SLAs which allow cooperation and data-sharing between the entities.

As indicated earlier, Stats SA currently has an MOU and SLA with DHA in relation to access to data on vital events, including deaths, marriages, human movement and documented migrants, however, no MOU exist between Stats SA and DoH on any data produced by DoH. This arrangement can provide short term intervention in the availability of births and deaths data produced from health facilities. The long term goal must be to include these collaborative efforts within legislation of the various entities and to harness technological advances to improve efficiency in the process by introducing a system connecting key stakeholders. However, Katuu (2015) cautions that while technology may "enhance the efficiency and effectiveness of any systems, technology alone doesn't determine the performance of an information system. If the underlying system is not founded on sound processes and procedures, technology will not provide enhancements. It makes it critical for processes and procedures to be well defined and implementation to be perfected prior to introduction of any technology

8.6 Envisaged manual births registrations data and production of statistics

An efficient birth registration system allows the establishment of individual's legal identity at birth, which in turn enables individuals to exercise their rights. The byproduct of the registration process is vital data which is immediately available for all stakeholders. The production of national vital statistics is dependent upon cooperation between the three responsible departments, any proposal to review documents and associated procedures used in the registration must be a cooperative effort. Although the three departments affected by births all have needs for information, what each entity require from the data on births varies.

The DoH needs data to improve maternity services provided to women at facility level, beyond that it needs data to on the status of births of the children and their mothers in order to provide case related to immunisation and support to new mothers. The data needed by the DHA is already available in the current data, however it will be ideal for efforts to be made to increase coverage by the DH. Data required by stakeholders to improve the current birth statistics is discussed in detail in section 8.7

A number of intervention are necessary to the current system to improve coverage and completeness of reporting of births;

This requires the DHA 24/PB to be issued in duplicate and serialised to ensure authenticity of the form and identification of each birth. The serial number might also be used to derive individual case identifiers used by Stats SA during data processing and further for data linking purposes, since not all births recorded on the DHA 24/PB will reflect on the birth register. Figure 8.1 show the proposed process flow for recording, processing and production of statistics for births data

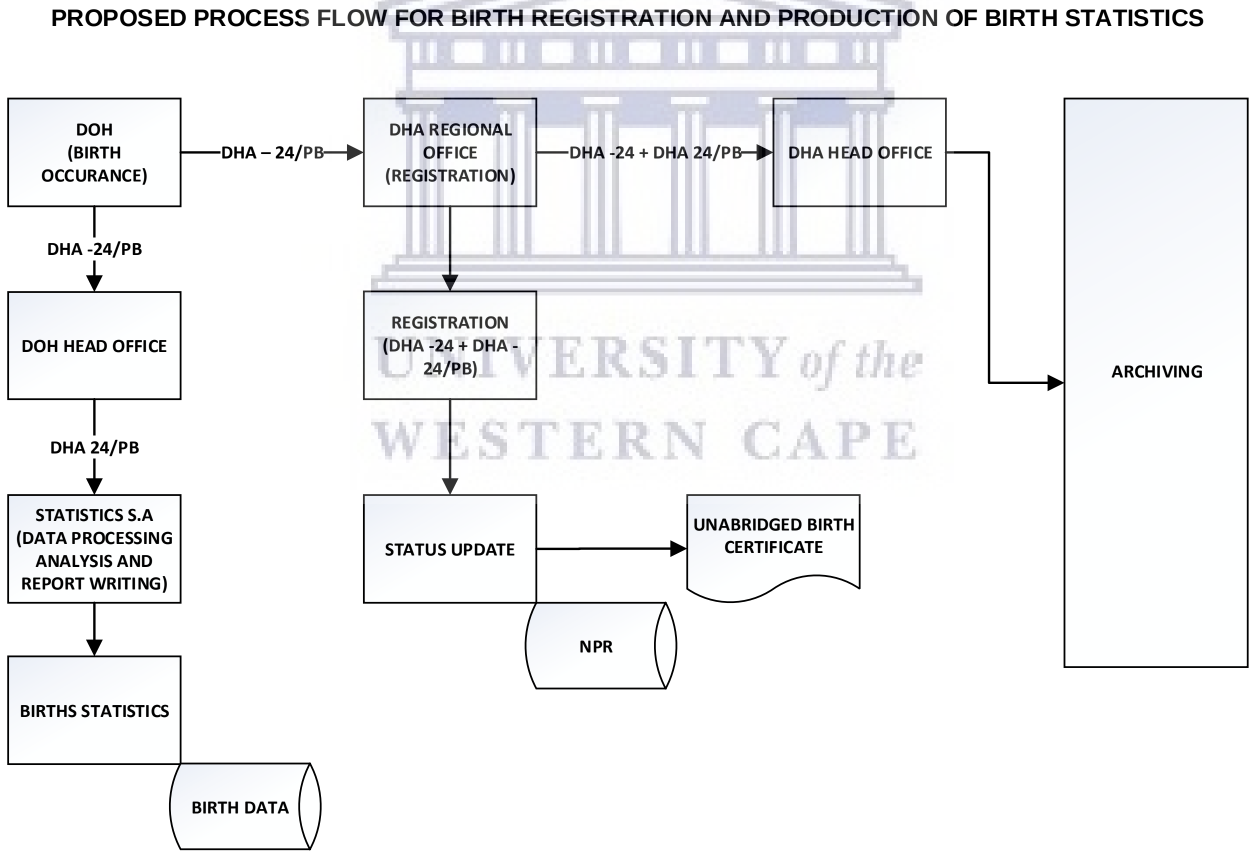


Figure 8.1 Proposed process flow for births registrations and vital statistics

Once a birth occurs in a health facility (both public and private), the mother will be issued with the original copy of DHA 24/PB completed by the attending health practitioner. The original copy of the DHA 24/PB will be used to register birth at the DHA. Once at the DHA the standard operating procedures (SOP) for the registration of births within DHA will be implemented. Ideally, the collection of DHA 24/PB for processing could be at the DHA, however, given that not all births that occur at facilities are reported to DHA, this proposal might perpetuate the status quo.

The remaining copy of the DHA 24/PB will be transferred from the health facility where the birth occurred to the DoH head office for collection by Stats SA for processing, analysis and dissemination of births statistics. This proposed process flow must be seen as an interim measure to make data available. Long term improvement will require the three entities involved in the process for births must institute appropriate amendments for their individual legislations to institute necessary improvement.

To improve collaboration on births data, Stats SA must enter into an MOU with both DoH and DHA to improve processes and procedure related to the registrations of births and production of statistics. In the long term;

- DHA must institute amendments to the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992) to:
    - Allow for registration without a name. The provision to allow allocation of an ID number to such children and implementation of the provisions of sections 24, 25 and 26 of the Act once a name is allocated.
    - Medical personnel present at the birth of a child must be obligated to notify the registration office about the birth. The notification role in the current legislation is only in relation to the health institution and parents, this change will enable all births in facilities to be notified to the DHA regardless of citizenship status.
    - Register all births including non-South African citizens born in the country. Currently there is no obligation for the DHA to register and keep a database of births by undocumented individual residing in the country, asylum seekers, refugees and other special groups. Currently, upon registration only handwritten certificates issued to the informant.

- The production and utilisation of statistics in South Africa is legislated though the Statistics Act, 1999 (Act No. 6 of 1999). There is no current dedicated section in the legislation specifically dealing with the production and dissemination of vital statistics. Vital statistics is dealt with broadly along with other statistics:
    - Due to the unique nature of each vital event, the amended Act should deal with the acquisition and production of each vital events separately.
    - The mandate of Stat SA to acquire vital data from civil registration from source (DoH) must be included in legislation.
    - Data coordination role of Stats SA in relation to all administrative data produced in the country
    - Data sharing between stakeholder entities and the frequency must be included in legislation
- Amendments to the National Health Act (Act No. 61 of 2003) must deal with data from all events occurring in facilities in country;
    - The role of the department in the CRVS process must be included in legislation
    - Responsibility of health personnel in the management of health records produced in health facilities must be included and clarified in legislation

8.7 Improving contents of the DHA-24 PB

The BI-24 was a predecessor to the current DHA-24, the form included a number of additional health-related data items envisioned to be completed at health facilities. The BI-24 form consisted of two parts. Part 1 on page 1 contained four sections; on the child, the natural father and mother and acknowledgement of paternity (*In case of births out of wedlock*), the last section was for the informant. Information collected on the child included name, surname, date and place of birth and marital status of parents. The next two sections required parental information including ID number, surname, date and place of birth, and citizenship status.

According to Bradshaw *et al* (1998) the inclusion of the second page to the birth registration form was part of a collective effort by the three key CRVS government departments aimed at improving registration of births and ensuring collection of additional health-related information. Data items on page 2 of the BI-24 were never completed at health facilities (*based on conversation with DHA officials*). Page 2 of the BI-24 would have provided critical information not only related to births but also birth defects, births outcome and hopefully accurate causes of deaths in case of neonatal deaths. In case of births, changes from BI-24 to DHA-24 resulted in reduced data items and removal of all health related data items from the new form.

Subsequent items introduced through the new DHA-24 were reduced to those that were deemed to be collectable with reasonable completeness and accuracy and none of these are from health facilities.

The basic function of registration and the issuing of certificate serve as legal record of a person's birth. The DHA and other interested departments and agencies have an interest on a number of data items necessary for fulfill statutory mandates and for legal purposes that are collected in the process. These data items include information regarding name, age, and date and place of occurrence; marital status; social security number requested for child, facility identification, mother's social security number, and father's social security and addresses.

Beyond this, and for other stakeholders such as health practitioners, researchers and statisticians' data on births are necessary for public health research to measure and analyze rates of population growth and changes in population composition, to study social issues and to plan and evaluate health programs.

The advent of the DHA-24 PB provides the opportunity to reinstate the health section. Although the DHA-24/PB is still not at the level of DHA-1663 which capture health related and socio economic variables over and above the basic variables required by DHA for registering a death; Expanding the contents of the DHA-24/PB to incorporate additional socio-economic variables such, marital status, and population group is important for improving births data. Variables on health of the child and mother such as birthweight, gestational age and maternal condition are critical for informing health outcomes. Internationally, these data items are standard items included as part of the birth certificate.

There is a general recognition that DHA-1663 is used for both the registration of deaths (legal function) and to derive data to produce national vital statistics, this recognition is still not extended to the DHA-24. The DHA-1663 is distributed to be the public and private facilities, the record is serialised, and the serial number is unique to each record.

The current version of the DHA-24/PB collects information required by DHA for registration purposes. It consists of four sections requiring particulars of medical practitioner who attended the birth and facility stamp. The next two sections require parental information including ID numbers, surname (maiden surname for the mother where applicable), date and place of birth, and citizenship status residential address and telephone contact. Information on the child collected in the last section and includes name, surname, sex, date and place of birth and information on multiple births.

Northam and Knapp (2005) note that the development of a reliable data collection instrument is the first critical step to securing the reliability of the contents. The usefulness of these data sources for research depends on the accuracy and completeness of the information they contain. Based on experience from the collection and processing of deaths data (DHA-1663), it is important to include only data items likely to elicit the best data and enhance the quality of data collected. Equally, observation made from the study on level of completeness of data items recorded by health personnel as noted above provide additional motivation on inclusions. The current version of DHA-24/ PB contains data items on demographic data on the mother and father and the child and no information about on maternal and infant health. Table 8.1 show the number of data items in the current version of the DHA-24/ PB and proposed data items for inclusion:

For the mother, the following data items are proposed for inclusion,

Marital status - This is one of the key data items that provides information on socio-economic situation of mothers and have been shown to impact on maternal and child outcomes. About 75% of cases had valid responses for marital status, with about a quarter of cases missing.

Population group - In South Africa, the history of previous socio economic deprivation have been proven to justify continued used of historical stratification of the population into four population groups referred to as Black Africans, Coloureds, Indians/Asians and Whites (Dorrington *et al* ,2004). Data based on the death notification form (DHA-1663) has also shown persistent disparities in health outcomes among these four population groups, some of which attributed to the historical stratification of the population.

The Population Registration Act Repeal Act, 1991 (Act No. 114 of 1991) as amended, abolished the distinction made between population groups. However, information on population group in DHA-1663 was incorporated for statistical use, though not included in the National Population register, has been used successfully for statistical purposes, it is also not published by Stats SA.

Evidence from censuses and surveys point to differences in fertility patterns and levels between the main four population groups in South Africa (Moultrie and Dorrington, 2004; Udjo 2009; Stats SA, 2010). The above is further attested by fact that, in South Africa official population estimates are done separately for each of the four population groups.

Country of birth – South Africa is a migration destination country, in light of in-migration from other countries into South Africa, there is be a need to include in the DHA-24/PB an item on the country of birth of the mother to help account for births by non- citizens. Migrant receiving countries with diversified populations such as United States, Australia, New Zealand, and Canada collect data on country of birth, ethnic group and race in birth and death registrations demonstrating the feasibility of such collection in civil registration processes.

Education level – Education is an important profiler in fertility and child births. Studies in fertility differentials in South Africa has pointed to population groups, but equally pointing to the impact on education on the number of children borne by women. In most developed countries, the rise in educational attainment and labour market participation has been associated with negative effect on higher-order birth rates and increasing mean age at first birth.

Medical history - Medical history of the mother is collected during pregnancy which allows health personnel to track the mother's health during pregnancy and birth and equally to ensure appropriate referral of the mother at birth of the child. The medical status of the mother also has impact on health outcomes.

Parity of the mother - It has been shown that both higher and lower parity and maternal age are associated with adverse birth outcome. Parity information from this study found that almost 83% cases had valid responses for parity with variation across the two study sites.

***Gestational age* –** The length of time, measured in weeks, which a foetus grows inside the mother's uterus from inception to birth is called gestational age. Data on gestational age are needed to monitor trends in preterm birth, inform development programmes for mother and babies. Evidence from this study show that gestational age was recorded in a consistent manner, this was noted in chapter 6, sub-section 6.2.1.2. This notwithstanding, data on gestational age is key for monitoring trends in preterm birth. It must be indicated on the form that gestation must be in weeks and only numbers must be recorded**.**

For the father, the following data items are proposed for inclusion;

Marital status - Studies have shown link between non-marital births and a range of negative outcomes, including increased risk of poverty, life in unstable relationships and welfare (Romero and Agénor, 2009; Joseph et al 2007; Kara and Maharaj, 2015). In most UE countries changes in education level of women and increases participation in labour force have been attributed to declining levels of marriage and marital fertility rates (Baranowska-Rataj, 2014). Other studies also found increasing occurrence of non-marital births within cohabiting relationships in societies where births traditionally occurred within marriage (Lesthaeghe, 2010; Sobotka, 2008). In South Africa, Geyer and Mosidi (2019) found evidence of marriage and fertility postponement, births in cohabitation, and even premarital fertility trends with population group variation within the country.

Hospital records do not record information on the father (partner), indeed results of marital status show that 62% of mothers reported being single. However, not much information is known about the fathers in the case of births, it will be ideal for this information to be recorded. There remains a challenge though, as demonstrated in section 4.3 information of the father is one of the most poorly recorded in the register.

For the child, the following data items are proposed for inclusion;

***Birthweight (grams*)** - Birthweight is associated with infant mortality, provide insight into prenatal care, maternal age, socioeconomic status, and other factors associated with the birth. Birthweight was one of the data items which were not properly recorded in hospital records, it varied from cases where weight was in grams to Kg and instances where just numbers were recorded.

Birth defects – Countries with advanced health system keep a register of birth defects cases that occur in their facilities in order to track the health of the children over time. Information on births defect within the MCR is recorded under the section called Summary of labour, while the BR has a data item on Births defect. In more developed countries there is a register of births defect which is kept to allow health authority to trach development of children born with defects.

Table 8.2 Proposed data items for the reviewed DHA-24/PB.

Section	Current data items	Proposed data items
Particulars of the facility	• Name and surname of medical practitioner who attended the birth (requiring facility stamp) • HPCSA/SANC Reg.No • Telephone • Signature	
Particulars of the mother	• ID number • Citizenship • DoB • Surname • Maiden name • Forenames • Physical address • Telephone	Residential address Marital status Population group Country of birth Level of education Medical history Parity Gestational age (Weeks)
Particulars of the father	• ID number • Citizenship • DoB • Surname • Forenames • Physical address • Telephone	Marital status Population group Country of birth
Particulars of the child	• DoB • Surname • Forenames • Place of birth • Information on multiple births	Birthweight (grams) Birth defects Status at birth Gestational age

Observation made from the study on the level of completeness of data items, show that the DHA-24PB needs to be completed by attending health personnel at the time of birth (instead of the clerk or someone not involved with the birth). Brumberg et al, (2012) note that in the development of the US births certificate, it has been demonstrated that the party responsible for completion of the birth certificate was a major contributing factor to the quality of the data. The authors raise the need for training ensure that medical personnel recognize importance of data items collected and report these items. Additionally, the health personnel must also be educated on the necessity to record information properly. The entities involved in the births data must also include arrangement for periodic training for personnel responsible for completing the DHA -24/PB at facilities to ensure quality of data is improved.

8.8 Envisaged automated births registrations data and production of statistics

The ultimate improvement in births data in the country involves harnessing technology to improve efficiency. The DHA already incorporates technology in the registration of events. Births and death are registered in real time in the various regional offices across the country and certificates are issued immediately to the public. The DHA data is located at SITA which is the custodian of all government data. However, this has not eliminated the travel costs incurred by citizen to access these services. It has also not resolved the availability of data needed to inform policy and planning. The ideal will be the adoption of electronic registration at the source (hospital). Brumberg et al (2012) note that since the introduction of electronic birth certificate in the US, births records are completed at the source (hospital of birth) and data is immediately available for the various data partners.

The South African system is currently manual, however, country can leverage the existing DHA system to be extended to serve the needs of the entire system. Information on births occurring at facilities can be collated daily and transmitted electronically to the DoH (Head Office), DHA (Head Office) and to Stats SA.

The DHA will be provided with data items needed to register births, neonatal deaths and stillbirths, most of the data items needed by DHA are already in the DHA-24/PB and provided in the current data.

The DoH needs data to improve maternity services provided to women at facility level, information on maternal and child health to plan for services needed for this group. Countries with well-developed systems keep register of birth defects that are noticeable at birth, they also keep a data based on discharge information. The MCR and BR ask information on births defect, although the quality of this information was poor for reasons mentions prior. The last page of the MCR, called Discharge Summary, collects information on the birth including;

- Date of delivery
- Date of discharge
- Name and date of birth of the mother
- Method of delivery
- Any medical problem emanating from the pregnancy
- HIV status and treatment
- Any medical problem encountered during delivery of the baby
- Examination of infant at discharge
- Vital information on the baby including sex, birthweight, head circumference, length and any immunisation administered.

The data items can be expanded to included status of birth and other items needed by the department. The DoH can be encourage to develop a birth discharge data in order to inform planning better and a database of birth defect that are noticeable at birth. This information will also be forwarded to the DoH head office from facilities.

Stats SA will require registrations data (supplied to DHA) including data items proposed in Table 8.1 on the mother, father and child

The following data flow is envisaged in an automated system;

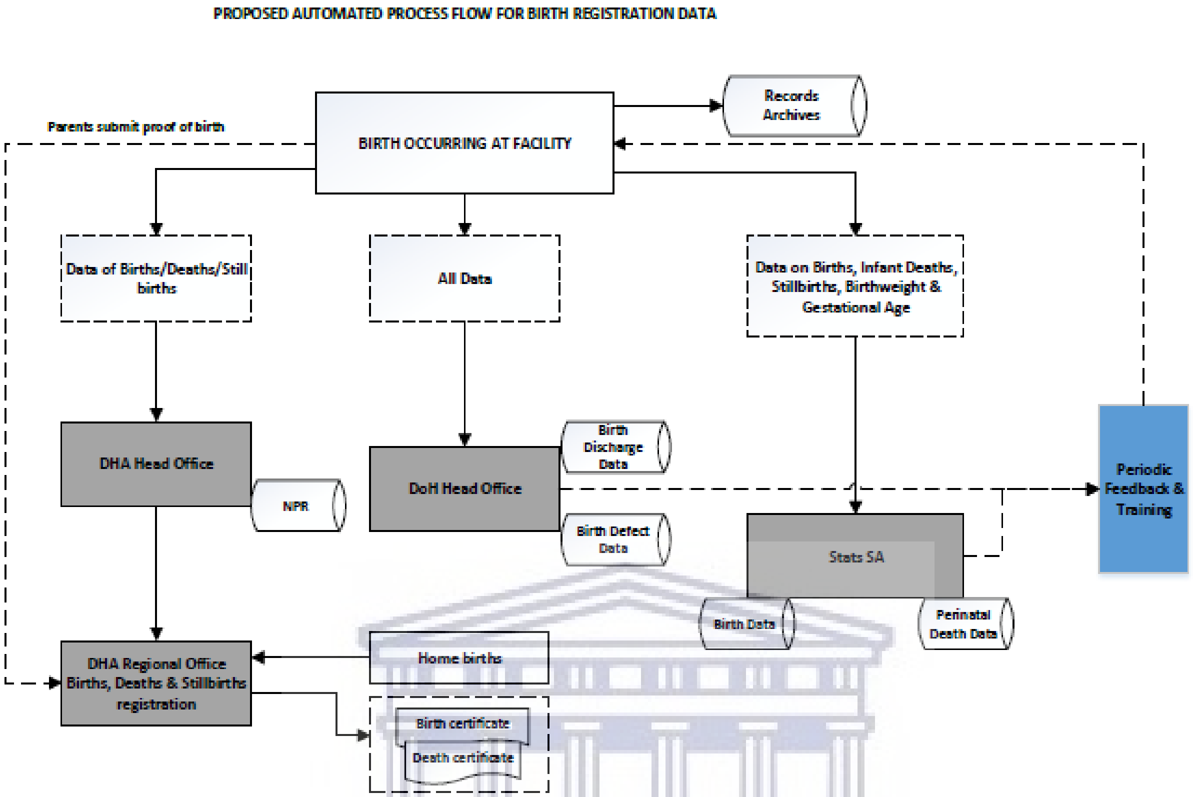


Figure 8.2 Proposed automated process flow for births registrations and vital statistics production

In an automated environment, once a birth occurs in a health facility (both public and private), data can be collated at the facility and transmitted via server to the three departments through SITA. The DHA will receive data necessary to effect registration, to create a new birth on the birth register and update the NPR. The DoH head office will receive all data from births to create both birth discharge and birth defects databases. Also to create reports for facilities and reports on maternal and infant health. Stats SA receives data on birth, infant deaths and stillbirths as well as all data items forwarded to the DHA for registration purpose to facilitate the production of births and perinatal statistics. Data produced by Stats SA include births perinatal deaths data. Improvement on the births statistics will be inclusion of health related data items on the mother and child. To ensure sustainability of the system and to remove administrative burden on health workers, facilities should have dedicated data capturers ably trained to collect data correctly. Development of comprehensive manuals to support data collectors at facility level is thus critical, as well as periodic training, associated data audit and regular feedback incorporated as part of standard operation procedures for the integrated system.

8.9 Conclusion

Although quality and content concerns observed in the data were highlighted in this study, hospital records data has provided evidence of potential to be the most relevant source of birth and infant death data, while also providing detailed information on maternal and child health conditions at birth. The data can provide key information on the complications experienced by mothers at pregnancy and birth. Interventions proposed offer opportunity for improvement in the system for registering births and production of data and statistics.

The challenges documented in this study in relation to data on record management and recording of births are indicative of the broader challenges of CRVS system in South Africa. Key among these are limitations in current legislation dealing with CRVS in relation to creation of coordination mechanisms among key stakeholders. For improvement in vital registrations data to be realised, data must serve a wide range of stakeholders. In the interim some of the key stakeholders have entered into interim arrangements to facilitate efficient operations between all entities. However, long term developments in this process require institutionalisation of coordination mechanisms.

Institutionalising coordination between key stakeholders will enable documentation of all standard processes and procedures, data sharing mechanism, describe linkages in the CRVS systems and allow broader ownership of innovations introduced in civil registration such as mobile and hospital units introduced by DHA.

It is currently clear that DoH does not realise the benefits of incorporating vital events in their operation. One of the most important data sources for the DoH is the DHIS, there might be a need to find ways of incorporating births data into DHIS. Formalising the notification role of DoH in relation to all births occurring in health facilities, is another necessary intervention to ensure notification of all child births (including deaths). The DHA-24PB will bring South Africa closer to achieving this notification role by DoH.

The DHA must find a way to accommodate births that occur to all individuals within the country including undocumented individuals. The provision prohibiting registration of children of mother without ID numbers contributes to illegitimating of millions of children, some of whom reappear at the time of application for school or matric year when an ID becomes necessary. The registration of all births that occur in a country is a human right imperative, the continued focus of DHA on fulfilment of core mandate is only to the detriment of other stakeholders.

The expansion of data items collected in birth registrations data, will improve the quality of the data and serve a wider number of stakeholders including researchers. The more data utilised its quality improve as it is subject to more interrogation and proposal for improvements. Literature has also shown that registrations data should not be static, but should rather evolve and respond to the needs of society.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

One of the advantages of a well-developed health information system is the significant role played by records produced by the system beyond just recording medical history of individuals. They often provide the basis for validation of contents and consistency of data items reported in other sources, and their completeness form the basis for health planning and estimation purposes and to study other aspects of data content.

The primary aim of this study was to assess the potential of hospital birth records to estimate the number of births in the country and supplement data items in the birth register. Hospital records data provided evidence of their potential as a source of birth data, and for providing detailed information on maternal and child health conditions at birth unavailable in the birth register data. A positive finding in relation to contents of all instruments found in health facilities is their ability to provide information on key data items identified in this study and other additional data items to supplement births data in the country. However, challenges observed in relation to records management particularly at lower levels of care, cast doubt on accessibility of these records for research purposes.

Although data items needed for births registration and those that can enhance births registrations data were available in hospital records, quality concerns were raised. Overall, there seems to be a lack of awareness on the importance of accurate recording of information in facilities. Inability of these records to capture deaths of children and circumstances of such deaths although space is provided for recording is a concern. Record linkage shed light on reliability of data, although low matching rates and varied levels of agreements cast doubt on accuracy of hospital data.

Some of the concluding thoughts and recommendations were made in preceding chapters, in particular in relation to the fourth objective discussed in chapter 9. Synopsis of key findings based on the four objectives of the study are addressed in sections below. Section 9.2 provide final conclusion in relation to the first objective. Response to the second objective in relation to the quality of hospital birth records and recommendations are discussed in section 9.3. Section 9.4 responds to the third objective of the study on effect of referral system on ability of hospital records to clearly identify individuals and their usual place of residence. The last section is conclusion on proposals for improving the current system.

9.2 Content validity of hospital birth records data

Records management issues observed in this study at facility level points to lack of awareness by facility personnel of the value of birth records to the mission of their institutions beyond clinical function. Discarding of Maternity Case Records (MCR) in some facilities after births is a short coming within the health sector and a missed opportunity to create continuity in relation to women's health information and history. Even for facilities where records were properly stored, managers raised concerns about protection against litigation than preservation of these records as a source of data and research. Record retrieval challenges experienced during data collection, as well as lack of adherence to record management practices particularly at lower levels of care including cases where records were not available was further validation of this effect.

Manual derivation of record identifiers in facilities contributed to inconsistencies observed in records numbers, including duplicate records identified during data collection. Non- adherence to prescribed period for storage and archiving of records prior to disposal was observed in facilities, particularly at lower levels.

Personnel allocated record management function in facilities were placed at very low level in the organisational structure or this function was allocated as a secondary function, as in the case of nurses given record management responsibilities. The same conclusion is drawn by Ngoepe and Van der Walt (2009), the authors recommended appointment of record managers at higher level and inclusion of record management as a performance management requirement.

The MCR - The objective for which the MCR was created i.e. treatment and intervention during pregnancy and childbirth might explain the attitude towards this record. These seemed to be lack of perceived use of the MCR by facilities beyond child birth. Most facilities did not keep a register of the number of MCRs in their storage for any given year, this was the case even for those with proper storage facilities.

The system of creating new MCR at each pregnancy for women is inefficient and costly, and points to the short sightedness of the health sector to opportunities to create continuity in relation to women’s health information and history. Upon each pregnancy the same information on obstetric history of the woman is created again with possibility of inconsistency in reporting and loss of information. Creating a permanent database of women which will be used every time a new pregnancy is presented could improve data quality on obstetric history of women and improve efficiencies at facility level.

The Birth Register - The BR is completed post birth occurrence and records events of births and infant death at facility level. The record also seemed more complete than the MCR for data items critical for day to day functioning of facilities and for reporting. The BR seemed more reliable in terms of accessibility. A number of facilities also depended on entries in the BR to complete DHA-24/PB. Most data items needed to enhance quality and content of births data were also available save for socio-demographic data items such as marital status and population group.

All key data items identified in this study due to their importance for estimation of a number of births were available in the BR and the MCR. For a number of these variables, the data was moderately complete, there is still space for improvement. Overall, recording of most key data items was better in Germiston than in Nkomazi. Inconsistencies and discrepancies introduced by the design of the DAF are acknowledged. However, it was impossible to conclusively identify and confirm child deaths from hospital records, the practice of not completing relevant parts of the MCR where infant deaths and stillbirths occur in facilities is a concern.

Data items such as population group, occupation and marital status collected in the MCR had high proportion of unspecified cases. The poor quality of these data items which are not critical for day to day operations of facilities was consistent with the quality of these items in the death notification form DHA-1663. The challenge is to impress on facilities managers the importance of completing data items important to other stakeholders and to see the benefits of birth and other vital data generated within facilities.

The quality of data items important for indicators associated with the health of the mother such as parity and gestational age and birthweight in the case of the child may be attributable to lack of awareness by hospital personnel as these are critical indicators for health facilities.

A positive finding in relation to contents of the instruments found in health facilities is their ability to provide information for key data items necessary for estimating births and other additional data items to complement births data in the country. However, data utility will be hampered by accessibility of records for research purpose and quality concerns in relation to these data items. Quality was also impacted by completion of MRC in different facilities.

9.2.1 Recommendation

Professionalising the record keeping function within the health sector will assist to improve quality of record management, in the interim creation of awareness among health personnel on existing regulations and legislation and the role of hospital records beyond clinical purpose is key.

Records in facilities were completed manually, in some instances hand writing was not clear. Additionally, records filled or kept in cabinets are prone to loss or tampering. In relation to records, the following is recommended;

- A computerised system will eliminate weaknesses in the system and improve the quality and security of information.
- The challenge of duplicate and inconsistent record number allocation can be resolved through automation of records. One facility in the study already initiated automation of records.
- A copy of document retention policy describing the period documents must be made available at all facilities.
- Continuous development (training) of administration staff (record keeping and filing staff) to enhance their skill in record keeping is needed. This will enhance record keeping skills and ensure improved monitoring of records in order to determine archival and disposal time frames

9.2.2 Proposed further study

The observed practice at facilities of using the BR for completing DHA_24/PB and in light of the importance of BR as a reporting tool within facilities, a study on quality of reporting within this source will be ideal. The content of this data source and how it is used in facilities has already been established through this study.

About 5% of children were born before arriving at facilities in this study, these were births that presented to health facilities, it is possible that there remains a proportion of BBAs that never makes it to health facilities, which is unknown. A study by Khupakonke et al (2017) in a district heath facility in Mpumalanga found factors such as being unbooked in the facility, residence in an informal settlements and higher gravida among others were predictors of BBA. The continued occurrence of births before arrival in facilities warrants further research to understand circumstances around the occurrence for BBA. In particular, the proportion of BBAs at one facility responsible for over 80% of such births warrants further research given the rural location of that facility.

9.3 To assess the quality of hospital birth records data

Hospital records and register data were successfully matched, this notwithstanding limited common variables between the two data sources. Despite challenges mentioned in relation to the ID number, higher percentage of cases matched through the ID number, points to the importance of this data item as a unique identifier in data matching. However, the matching rate obtained in this study is relatively low by global standard, quality of linking in this study was affected by three key aspects;

- Limited common data items from the two data sources.
- A number of data items used in the data matching process had high levels of missing data and limiting data accuracy. Almost 57% of records had unusable ID number, for 13% of

cases, surname of the mother was either missing, misspelled or different surnames were recorded or there was name only and no surname provided.

- Higher proportion of mothers from lower socio economic background in the study. Although high proportion of the occupation variables was unspecified (36%), for cases with valid responses, over 37% of mothers reported being unemployed and 62% were single (never married).

High agreement and sensitivity obtained for a number of variable points to high quality of matched data. Exception is made for adverse birth outcomes (death). Fewer numbers available for this data item suggested pervasive misreporting in hospital records. This unfavourable outcome in relation to child deaths imply that in their current state, hospital records were unable to provide solution to the misreporting observed in the birth register in relation to accurate number lost to mortality.

Studies comparing the characteristics of linked and unlinked records have identified the likelihood of vulnerable or hard to reach populations being missed, with the probability of a missed match associated with a range of characteristics including gender, age, ethnicity, deprivation and health status (Bohensky *et al*, 2010; Harron *et al* 2017; Rentsch *et al*, 2018 Gould *et al*, 2002). The high proportion of missing ID numbers and missing key data items used in data matching can be blamed for lower matching rates. Rentsch *et al* (2018) conclude that in the absence of reliable unique identifiers, record linkage has to rely on other personal identifiers such as date of birth, age and names which are highly susceptible to errors. This issue was noted in the study.

Health disparities in South Africa as evidenced by the use of public and private health care was discussed in section 2.3.2, with over 80% of disadvantaged population using public health and majority of these being black African. The study was entirely based on data collected from public facilities, about 71% of the study population in this study were black African (shown in Table 6.8). Section 6.4.1 showed the disproportionately high unstated cases in Nkomazi than Gauteng, out of the six key data items important for estimating birth only two had missing data below 20%. Section 6.3.3.5 also provided the marital status of women giving birth in facilities, above 60% of mothers were single, with only 11% married.

9.3.1 Recommendation

Inclusion of additional data item in the birth register must be encouraged to increase the number of common variables in the hospital records and register data. Including additional data items will improve utility of both data sources and quality of future matching exercises.
Facilities must institutionalise continuous training of personnel responsible for completion of records to improve quality of data. This training must also include conscientising health personnel on the importance of all data items collected in birth records even those not necessary for their daily operations and reporting.

9.3.2 Proposed further study

Achieving high matching rate is essential for ensuring and maintaining the quality and integrity of research based on linked data. A further study incorporating births within private health facilities will provide clarity on the influence of socio-economic status on matching rates observed in this study.

9.4 To establish the extent to which the health referral system affects localisation of birth indicators obtained from health facilities

The three data items identified by the study as important to localisation of births were available in the data, however, they were poorly captured in hospital birth records. Variation in availability of residential address of the mother between the two study locations, reflected differences in level of development. Using Stats SA main-place allocation enabled analysis of data from Nkomazi. At sub-place level meaningful data analysis could not be achieved in this area due poor address system. The quality of address variable was also a contributing factor, 28% of records in Nkomazi had missing and unknown address.

The non-completion of ID number of the mother in the BR talks to its necessity to health workers for birth purposes. In an environment where the main mandate is provision of health services to all, the availability of an ID document is not a paramount. That notwithstanding, the high matching rates obtained through the ID number points to the usefulness of this identifier in South Africa. Given the high proportion of unstated ID numbers it is impossible to attribute missing national identity numbers to births due to undocumented mother and also, there are still some South Africans without valid identity documents due to historical reasons.

Although most facilities claimed to have a system for deriving unique record ID, inconsistency in the application of derivation rules created duplicates and invalid record numbers. Inconsistencies in facilities in relations to methods used to derive record identifiers might indicate the perception of health personnel about the MCR as an adhoc record not needed beyond child birth.

Successful attribution of births to a catchment area requires cases to be uniquely identified through a record ID number and allocated to individual patient identity number (ID number) and locality through a mother's usual place of residence. The poor quality of three identifiers points to their inability successfully allocate all births to appropriate locality thus attracts unfavourable response to objective three of this study.

9.4.1 Recommendation

The provision of proper addresses for all households in South Africa must be prioritised. Beyond facilitating data matching, the need for accurate residential addresses for all is a human rights issue, it enables provision of social and emergency services for citizens and allows individuals to enter into business and other transactions necessary for development.

Lack of consideration for inclusion of ID number of the mother for purpose of receiving services in public health facilities imply that quality of reporting for this data item will never improve. This calls for another method of identification for patients (mothers) giving birth in facilities, given that in South Africa, undocumented individuals and South Africans without ID numbers have no other method of identification when presenting at facilities. This will also help improve data for research purpose by creating uniquely identifiable units of analysis.

The ultimate improvement in births data in the country involves harnessing technology to improve efficiency. Automation of records will enable automatic derivation of record identification; this will be the most efficient ways of creating unique records numbers. The DHA derives unique national identity numbers on daily basis, although there has been instances where duplicate ID numbers have occurred, this system is the most effective of uniquely identifying individuals, which can be expanded for health sector.

9.5 Developing a more systematic and comprehensive system to ultimately improve the coverage and accuracy of birth registration

The role of births registrations data must be seen beyond the provision of information on legal identity. It can be an important tool for evaluating maternal child health programmes, capable of providing input into population projection and giving valuable insight into the behaviour of fertility in the country even at lower levels. Quality and content concerns highlighted in relation to hospital records data in this study do not detract from evidence of potential of these records. For hospital records to be the source of improvements for birth register data, quality of the data must improve, this requires collaboration among key stakeholders. Standard practice internationally is for births data to incorporate basic infant and maternal health indicators such as birthweight, gestational age and parity, this is currently missing in the birth data. The complete implementation of the DHA-24/PB within health facilities offers an opportunity to improve quality of births data and include information on birth characteristics. The expansion of data items collected in birth registrations data, will improve the quality of the data and serve wider stakeholders including researchers.

In more developed health systems, the by-product of vital events occurence; vital data, is located within health agencies, this allows easy access and immediate use of these data to identify health challenges, implementing interventions and monitoring of health status of the population. In South Africa there seem to be a dislocation between the DHA and DoH in relation to vital data. A lack of interest in births records and associated data as key inputs into the birth registrations data and the most basic and cost effective source of births and deaths data to facilitate planning and monitoring of population health was apparent.

Interim measures such as service level agreements and memorandum of understanding to improve efficiency of the system between key role players in CRVS is critical. Long term legislative reforms needed to improve the efficiencies must be prioritised by the three key entities involved.

Introduction of the DHA-24/PB offers a window of opportunity for role players to improve the status quo, however it requires harmonisation of standard operating procedures within the three key entities involved, including streamlining processes and procedures related to data acquisition and sharing to be prioritised.

9.5.1 Recommendation

Improvements in the DHA-1663 were largely driven by collaboration between key stakeholder, training and awareness raising among various key personnel responsible for data entry. In the main the responsibility taken by Stats SA to process and analyse this information.

Creation of the DHA-24/PB in duplicate and periodic review of this form must be undertaken and appropriate training programmes designed for personnel responsible for completion of the form.

The review of birth register data item is a standard practice internationally. It will be ideal for the periodic review of register data items to be institutionalised to remove redundant data items and to introduce new data items as new needs emerge.

The health department should recognise the need for capturing health indicators on the DHA-24/PB and ensuring that such data are accurate reflection of conditions of babies and their mother is important in providing data for public health interventions necessary for health improvement.

The registration of all births that occur in a country is a human right imperative. The DHA must be encouraged to accommodate births that occur to all individuals within the country including births to asylum seekers, refugees and other undocumented immigrants. Provisions prohibiting registration of children of mother without ID numbers contributes to illegitimating of millions of children, some of whom reappear at the time of application for school or during matric year when an ID document becomes necessary. Additionally, legislation must play an enabling role for local cultures and customs, in relation to births, it must embrace local customs such as naming conventions that defer child naming by allowing registration of births without a name to improve completeness of registration.

9.6 Conclusion for the study

Vital data are basic outputs of the health information systems. Availability of adequate and reliable data on vital events for the health system is a measure of the level of development of its health care and statistical services. It has been shown that hospital records have great potential to provide valuable information, but to achieve this quality of data must improve. It must also be borne in mind that these records were designed for other purposes, in the case of the MCR, its purpose was standardisation of treatment and intervention during pregnancy and childbirth, their inability to readily provide other information is understandable.

Automation of record keeping and retrieval will improve efficiency and reduce costs in facilities. It will resolve ineffective and inefficient records creation system, whereby a new record (MCR) is created every time a women present with pregnancy in public health facilities. This will ensure consistencies of obstetric history, security of data of women giving birth in public health facilities and availability of data for research purposes.

Professionalising the collection of health data within facilities is critical. Arrangement for periodic training for personnel responsible for completing birth records at facilities must be documented and should involve the three key stakeholder departments to ensure quality of data improves and is sustained.

Interventions such as hospital satellite units that were created to improve efficiency of registration and bring services closer to the public are hampered by lack of cooperation between the two key entities involved in this intervention i.e. DoH and DHA. In the process mother continue to incur cost of travelling back to maternity units for birth registration. Collaboration will increase efficiency and effectiveness of registration and contribute to long-term cost reduction.

The lack of adequate data on death of children during neonatal period (and beyond) in South Africa warrants special attention, observation from the study point to continued inability to obtain information on child death even from hospital records. Neonatal mortality is mostly evidence of inefficiencies in quality health care services provided to pregnant women and infants in the health sector, availability of reliable data to enable intervention within the health sector is unfortunate. It is in the interest of all key stakeholders with vested interest in improving the health of mothers and children in the country.

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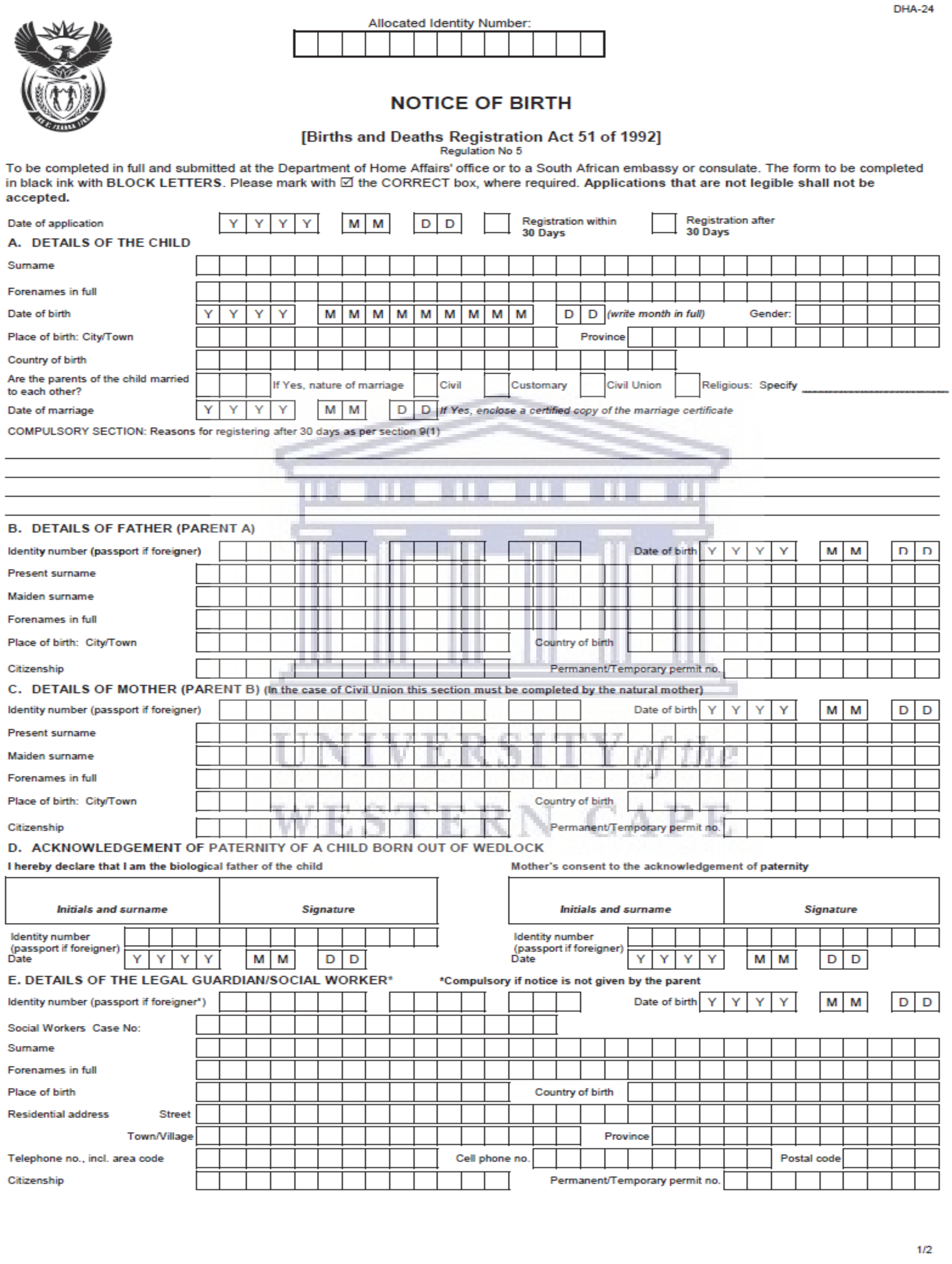
APPENDIX A: Notice of birth form (DHA-24)



DHA-24

Allocated Identity Number:

NOTICE OF BIRTH

[Births and Deaths Registration Act 51 of 1992]
Regulation No 5

To be completed in full and submitted at the Department of Home Affairs' office or to a South African embassy or consulate. The form to be completed in black ink with **BLOCK LETTERS**. Please mark with ☑ the CORRECT box, where required. **Applications that are not legible shall not be accepted.**

Date of application Y Y Y Y M M D D ☐ Registration within **30 Days** ☐ Registration after **30 Days**

A. DETAILS OF THE CHILD

Surname
Forenames in full
Date of birth Y Y Y Y M M M M M M M M M D D *(write month in full)* Gender:
Place of birth: City/Town Province
Country of birth
Are the parents of the child married to each other? If Yes, nature of marriage ☐ Civil ☐ Customary ☐ Civil Union ☐ Religious: Specify ______________
Date of marriage Y Y Y Y M M D D *If Yes, enclose a certified copy of the marriage certificate*
COMPULSORY SECTION: Reasons for registering after 30 days as per section 9(1)

B. DETAILS OF FATHER (PARENT A)

Identity number (passport if foreigner) Date of birth Y Y Y Y M M D D
Present surname
Maiden surname
Forenames in full
Place of birth: City/Town Country of birth
Citizenship Permanent/Temporary permit no.

C. DETAILS OF MOTHER (PARENT B) (In the case of Civil Union this section must be completed by the natural mother)

Identity number (passport if foreigner) Date of birth Y Y Y Y M M D D
Present surname
Maiden surname
Forenames in full
Place of birth: City/Town Country of birth
Citizenship Permanent/Temporary permit no.

D. ACKNOWLEDGEMENT OF PATERNITY OF A CHILD BORN OUT OF WEDLOCK

I hereby declare that I am the biological father of the child

Initials and surname	***Signature***

Identity number (passport if foreigner)
Date Y Y Y Y M M D D

Mother's consent to the acknowledgement of paternity

Initials and surname	***Signature***

Identity number (passport if foreigner)
Date Y Y Y Y M M D D

E. DETAILS OF THE LEGAL GUARDIAN/SOCIAL WORKER* ***Compulsory if notice is not given by the parent**

Identity number (passport if foreigner*) Date of birth Y Y Y Y M M D D
Social Workers Case No:
Surname
Forenames in full
Place of birth Country of birth
Residential address Street
Town/Village Province
Telephone no., incl. area code Cell phone no. Postal code
Citizenship Permanent/Temporary permit no.

1/2

F. DECLARATION

I, ____, hereby declare that the information supplied is to the best of my knowledge and belief, true and correct, I understand that a false statement is punishable under section 31 of the Births and Deaths Registration Act of 1992.

Informant

Initials and surname	***Signature***

Date Y Y Y Y M M D D

Place

Relationship to the child: ☐ Father (Parent A) ☐ Mother (Parent B) ☐ Legal guardian ☐ Social worker

G. FOR OFFICIAL USE ONLY - OFFICE OF ORIGIN

Office stamp - Office of origin

NOTICE OF BIRTH RECEIVED BY:

Identity number

Surname

First name

Persal number

Stat		Birth	
I	O	S	M

DOCUMENTS SUBMITTED WITH THIS APPLICATION: PLEASE TICK ☑

Birth Registration within 30 Days:

- ☐ Confirmation of Birth
- ☐ Certified copy of Father's/Parent A's ID document (if applicable)
- ☐ Certified copy of Mother's/Parent B's ID document
- ☐ Certified copy of Legal Guardian/Social Worker's ID document
- ☐ Certified copy of Marriage Certificate of parents (if married)
- ☐ BI 1658 if married religiously i.e. Moslem, Hindu
- ☐ Medical Report: Same Sex Parents
- ☐ Certified copy of Social Worker's Registration Certificate

Birth Registration after 30 Days, additional documents:

- ☐ Proof of Paternity

If foreign birth, additional documents:

- ☐ Certified copy of the Foreign birth certificate of the child
- ☐ Citizenship determination form BI-529 (SA Parent)
- ☐ Citizenship determination form BI-529 (Child)

Online verification performed and printouts attached for following persons:

☐ Father (Parent A) ☐ Mother (Parent B) ☐ Legal guardian ☐ Social worker

Date Y Y Y Y M M D D

Signature ________________________________

H. APPLICATION VERIFIED

Date Y Y Y Y M M D D

I hereby declare that I have verified the application and registration

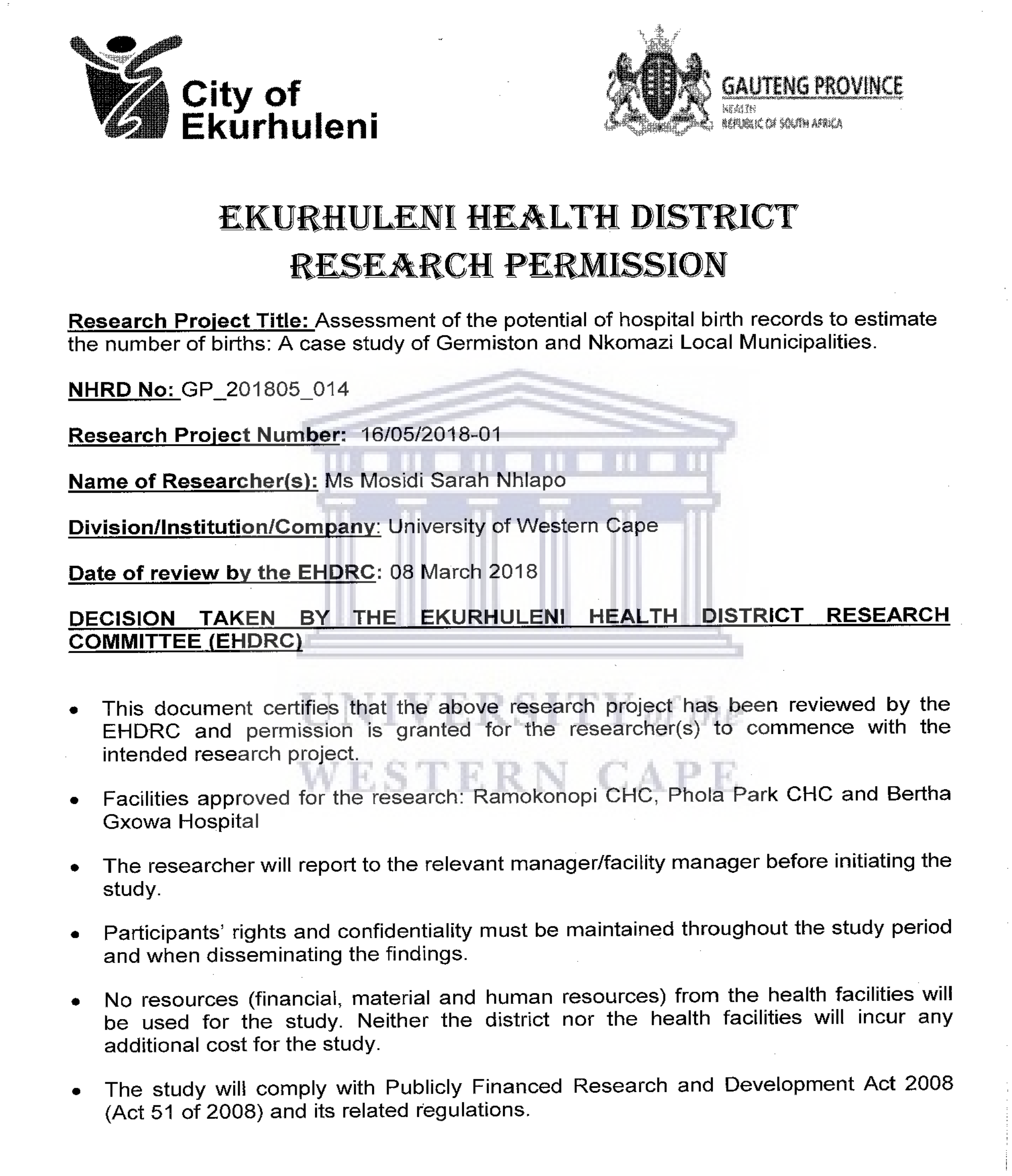
Initials and surname ________________________________

Signature ________________________________

Identity number

Persal number

APPENDIX B: Research approval letter



City of
Ekurhuleni

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

EKURHULENI HEALTH DISTRICT RESEARCH PERMISSION

Research Project Title: Assessment of the potential of hospital birth records to estimate the number of births: A case study of Germiston and Nkomazi Local Municipalities.

NHRD No: GP_201805_014

Research Project Number: 16/05/2018-01

Name of Researcher(s): Ms Mosidi Sarah Nhlapo

Division/Institution/Company: University of Western Cape

Date of review by the EHDRC: 08 March 2018

DECISION TAKEN BY THE EKURHULENI HEALTH DISTRICT RESEARCH COMMITTEE (EHDRC)

- This document certifies that the above research project has been reviewed by the EHDRC and permission is granted for the researcher(s) to commence with the intended research project.
- Facilities approved for the research: Ramokonopi CHC, Phola Park CHC and Bertha Gxowa Hospital
- The researcher will report to the relevant manager/facility manager before initiating the study.
- Participants' rights and confidentiality must be maintained throughout the study period and when disseminating the findings.
- No resources (financial, material and human resources) from the health facilities will be used for the study. Neither the district nor the health facilities will incur any additional cost for the study.
- The study will comply with Publicly Financed Research and Development Act 2008 (Act 51 of 2008) and its related regulations.

- The EHDRC must be informed in writing before publication or presentation of research findings and a copy of the report/publications/presentation must be submitted to the EHDRC

- The district must be acknowledged in all the reports/publications generated from the research.

- The researcher will be expected to provide the EHDRC with

  - Six monthly progress updates including any adverse events
  - The final study report in electronic format
  - Present the final research findings at the annual Ekurhuleni research conference if possible.

- The EDHRC reserve the right to withdraw the approval, if any of the conditions mentioned above have being breached

- The research committee wishes the researcher(s) the best of success.

DR. J. SEPUYA

DEPUTY CHAIRPERSON: CITY OF EKURHULENI

Dated: 31/05/2018

Dr. R. Kellerman

CHAIRPERSON: GAUTENG DEPARTMENT OF HEALTH (EKURHULENI HEALTH DISTRICT)

Dated: 31/05/2018.

health
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

MPUMALANGA
THE PLACE OF THE RISING SUN

No.3, Government Boulevard, Riverside Park, Ext. 2, Mbombela, 1200, Mpumalanga Province
Private Bag X11285, Mbombela, 1200, Mpumalanga Province
Tel l: +27 (13) 766 3429, Fax: +27 (13) 766 3458

Litiko Letemphilo Departement van Gesondheid UmNyango WezeMaphilo

Letter of Support Signed by Chief Director (CD)/CEO/District Manager (DM)/Programme Manager (PM)

1. Name & contact no. of Applicant	MOSIDI S. NHLAPO, 0845646619
2. Title of Study:	Assessment of the potential of birth data from hospital records to estimate the number of births: A case of Germiston and Nkomazi municipalities
3. Aim and population target:	To investigate the feasibility of using hospital records to estimate the number of births
4. Period to undertake the study	**From:** 15 JANUARY.18 **to:** 09 Februry 2018

5. Resources Required from Facility/Sub-district/Community

5.1: Facility Staff Required to assist with the Study	**Yes** ✓		**NO**
	How many: 1		
	Nurses:		
	Doctors:		
	Other, please specify:	Record Clerk	
5.2: Patient Records/Files	**Yes** ✓		**NO**
5.3: Interviewing Patients/ participants at Facilities	**Yes**		**NO** N/A ✓
5.4: Interviewing Patients/ participants at Home	**Yes**		**NO** N/A ✓
5.5: Resource Flow (Are there benefits to Patients/community)	**Yes**		**NO**
	Please list: Informed intervension		
5.6: Resource Flow (Are there benefits to Facility/District)	**Yes**		**NO**
	Please list: Data for health planning		

6. Availability of Required Clearance

6.1: Ethical Clearance	**Yes**	**Pending** ✓	**NO**
	Clearance Number:		
6.2: Clinical Trial	**Yes**	**Pending**	**NO** N/A ✓
	Clearance Number:		
6.3: Vaccine Trial	**Yes**	**Pending**	**NO** ✓ N/A
	Clearance Number:		
6.4: Budget	**Yes** ✓		**NO**
	Source of fund: National Health Scholership.		

Declaration by Applicant:
I ~~Mr~~/Ms/~~Dr~~/~~Prof~~/~~Adv~~. MOSIDI S. NHLAPO agree to submit✓/present✓ the result of this study back to the CEO/Institution/District.

Comment by CEO/DM/PM: **Supported / Not Supported**

Signature of CEO/CD/DM/PM **Stamp/Date:**
Name:

Please email completed form to: JerryS@mpuhealth.gov.za or ThembaM@mpuhealth.gov.za

Please note that this letter is not an approval to undertake a study, but a support letter from identified facility/district, i.e. the CEO/District Manager acknowledges to have been consulted on the study

APPENDIX C: Data Abstraction Form (DAF)

THE HOSPITAL BIRTH RECORDS PROJECT

DATA ABSTRACTION FORM

2018

GAUTENG

IDENTIFICATION DATA

Record ID.

7	2						

Date of Abstraction:

				2	0	1	8
d	*d*	*m*	*m*	*y*	*y*	*y*	*y*

Abstraction time:

Start Time					End time				
	m	*m*	*h*	*h*		*m*	*m*	*h*	*h*

Patient Folder Number:

(*Please capture as written on the record*)

Data Collector ID:

Response code:

PATIENT BACKGROUND (*Page 1*)

Province…………………………………………………………………..

District: ……………………………………………………………….

Facility………………………………………………………………….

Level of care

I	II	III

Name …………………………………………………………………………….

Folder Number:

…………………………………………………………………………………….

Date of Birth………………………………………………..………………….

Referred from:……………………………….

DR/GP	Clinic	MOU	District Hosp	Sec Hosp	Tertiary

Referred to:……………………………………………………………………….

MOU	District Hosp	Sec Hosp	Tertiary

Identity Number:													

Residential Address:…………………………………………………………….

…………………………………………………………………………………………….

……………………………………………………………………………………………..

Postal address:…………………………………………………………….

…………………………………………………………………………………………….

……………………………………………………………………………………………..

Postal code……………………………………………………………………….

Age :……………………………………………………………….

Marital Status:…………………………………………….

Occupation: …………………………………………….

Race: ……………………………………………………….

ANTENATAL RECORD *(Page 2)*

Name :…………………………………………………………………………………………

Folder Number:……………………………………………………………………………

Date of Birth:…………………………………………………………………………………

Clinic/CHC:……………………………………………………………

Address:…….

………...

Age:……………….. (yrs) **G**…………………… **P**…………………… **Misc**……………………

OBSTETRIC & NEONATAL HISTORY	*A=Alive NND=Neonatal Death* *ID=Infant Death IUD=Intra-Uterine Death*					
Year	**Gestation**	**Delivery Methods**	**Weight**	**Sex**	**Code**	**Complications Y/N**
Description of complications:						

MEDICAL AND GENERAL HISTORY

Hypertension	Epilepsy	Diabetes	Cardiac	TB	Healthy

Other …………………………………

SUMMARY OF LABOUR *(Page 22)*

SECOND STAGE

Method of delivery: NVD | Breech | Twins | Caesarean section | Instrumental

Other ………………………………………………………………

Fetal Heart: Present | Absent | Uncertain

Fetal distress: Yes | No

Comments:………

………

NEONATAL DETAILS

Resuscitation done: Yes | No

Describe:………………………………………………………………………………………………

Birth injuries: Yes | No

Describe:…………………………………………………………………………………………………

Neonate	**Male**	**Female**	**Alive**	**FSB**	**MSB**	**NND**	**Weight**
1.							g
2.							g

ASSESSMENT OF THE NEW BORN *(Page 27)*

Infant Name………………………………………………………………… Birth Time……………………………………………..

Hospital Number:…………………………………………………………. Birth Date:……………………………………………..

Gender:	**Birth Weight:**	**Head Circumf:** **cm**	**Gest Age Score:** **weeks**	**Resuscitation: (Circle)**			
				None:	Oxygen	Mask	Incubat

Apgar Score	0	1	2	1 Min	5 min	Details of resuscitation
Heart Rate	Absent	>100/min	>100/min			
Respiration	Absent	Slow or irregular	Good crying			
Muscle Tone	Limp	Slight flexion	Active moves			
Response to stimulation	No Response	Grimace	Vigorous cry			
Colour	Blue or Pale	Body pink Limbs blue	Pink all over			

DISCHARGE SUMMARY *(Page31)*

Date delivered:…………………………………………………

Date discharged:……………………………………………..

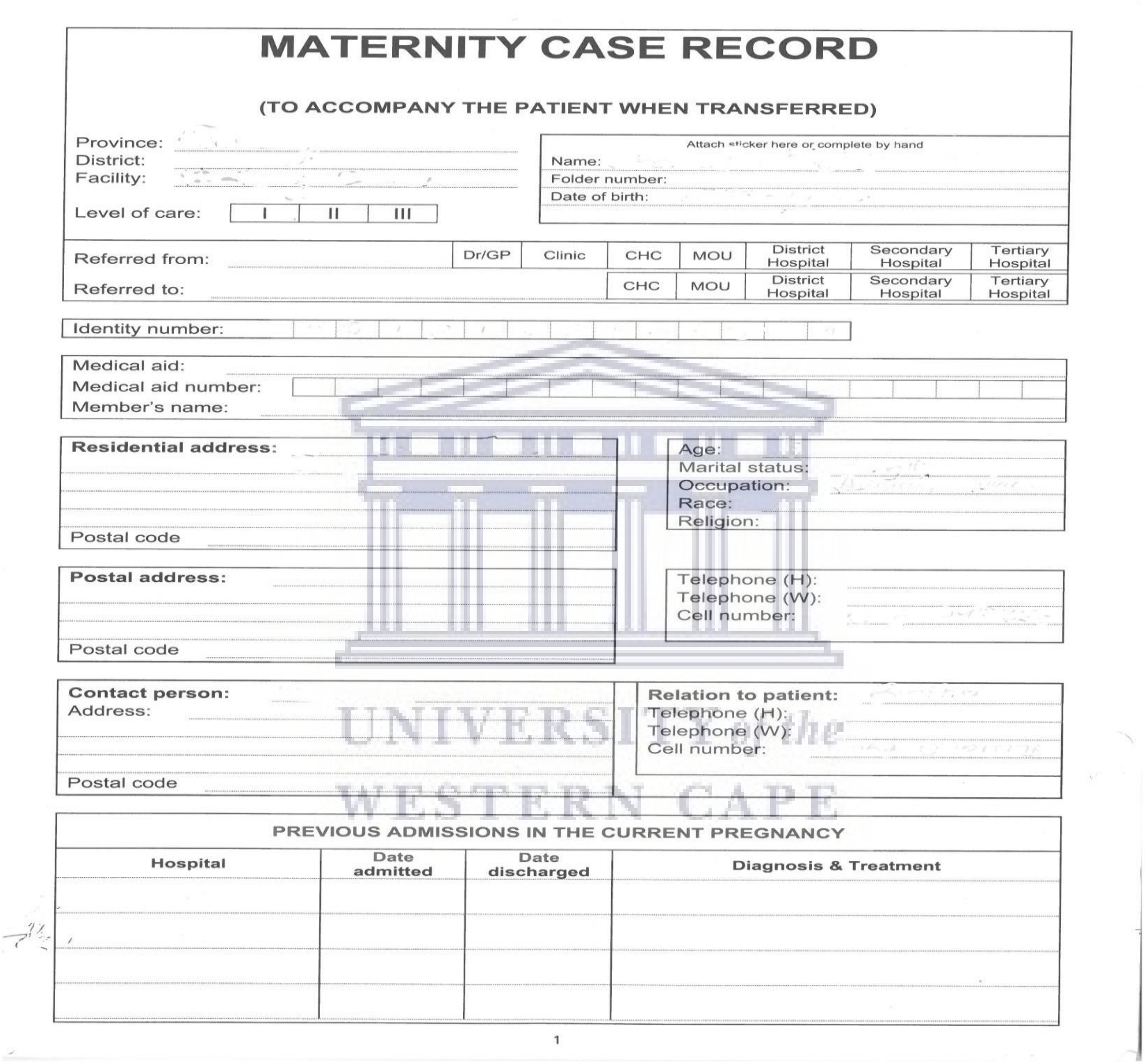
Name………………………………………………………………………

Clinic/hospital No:…………………………………………………..

Date of birth:………………………………………………………….

HIV:	**Non-Reactive**	**Reactive**	**Declined**	**Dual Therapy**	**HAART**	**CD4:**

APPENDIX D: Maternity Case Record



MATERNITY CASE RECORD

(TO ACCOMPANY THE PATIENT WHEN TRANSFERRED)

Province:
District:
Facility:

Level of care: ☐ I ☐ II ☐ III

Attach sticker here or complete by hand
Name:
Folder number:
Date of birth:

Referred from:	Dr/GP	Clinic	CHC	MOU	District Hospital	Secondary Hospital	Tertiary Hospital
Referred to:			CHC	MOU	District Hospital	Secondary Hospital	Tertiary Hospital

Identity number:

Medical aid:
Medical aid number:
Member's name:

Residential address:
Postal code

Age:
Marital status:
Occupation:
Race:
Religion:

Postal address:
Postal code

Telephone (H):
Telephone (W):
Cell number:

Contact person:
Address:
Postal code

Relation to patient:
Telephone (H):
Telephone (W):
Cell number:

PREVIOUS ADMISSIONS IN THE CURRENT PREGNANCY

Hospital	Date admitted	Date discharged	Diagnosis & Treatment

1

NAME:

FOLDER NO:

DATE OF BIRTH:

Address:

Postal code: Tel:

Age: (yrs) G P Misc

OBSTETRIC & NEONATAL HISTORY	A = Alive ID = Infant Death	NND = Neonatal Death IUD = Intra-uterine Death				
Year	Gestation	Delivery	Weight	Sex		Complications

Descriptions of complications:

MEDICAL & GENERAL HISTORY

Hypertension	Epilepsy	Diabetes	Cardiac	TB	Healthy

Other (specify)

If yes to any of the above, give further details:

Medication:

Operations:

Allergies:

Social: Single / Married / Stable relationship

Family History

Twins	Diabetes	TB	Congenital	Other

Details:

CLINIC

EXAMINATION

Date d d m m y y BP /

Height cm Weight kg

Thyroid: Breasts:

Urine:

Heart:

Lungs:

Abdomen:

Other: MUAC: BMI:

SF measurement cm Correlation with dates? Y N

VAGINAL EXAMINATION

Done Not done

Vulva & Vagina:

Cervix:

Uterus:

Pap Smear done? Y N Date:

Result:

INVESTIGATIONS

Rapid syphilis test: Pos Neg Repeat syphilis test: Pos Neg

RPR (titre): TPHA:

Rx received: 1st 2nd 3rd

Rhesus: Antibodies: Y N

Hb: g/dl

Tetanus toxoid: 1st 2nd 3rd

RVD test: Date: Reactive Non-reactive Declined

CD 4: Therapy: Date: HAART DUAL

RVD retest at 32 weeks: Reactive Non-reactive Declined

WHO STAGE: I II III IV

OTHER INVESTIGATIONS/PROTOCOLS

ANTENATAL RECORD

PLAN

Antenatal care:	Labour or 36+ weeks
Transport:	

DATES

LNMP d d m m y y Certain? Y N

ULTRASOUND

Date:

BPD

FL

Abd. Circ.

Placenta

Other

EDD

d d m m y y According to Dates U/S SF height

FUTURE CONTRACEPTION

Injectable Oral IUCD T/L Dual Protection

LIFESTYLE COUNSELLING

	User	Quitter	Non-user
Tobacco:			
Alcohol:			
Drugs/Substances:			

HIV Counselling:

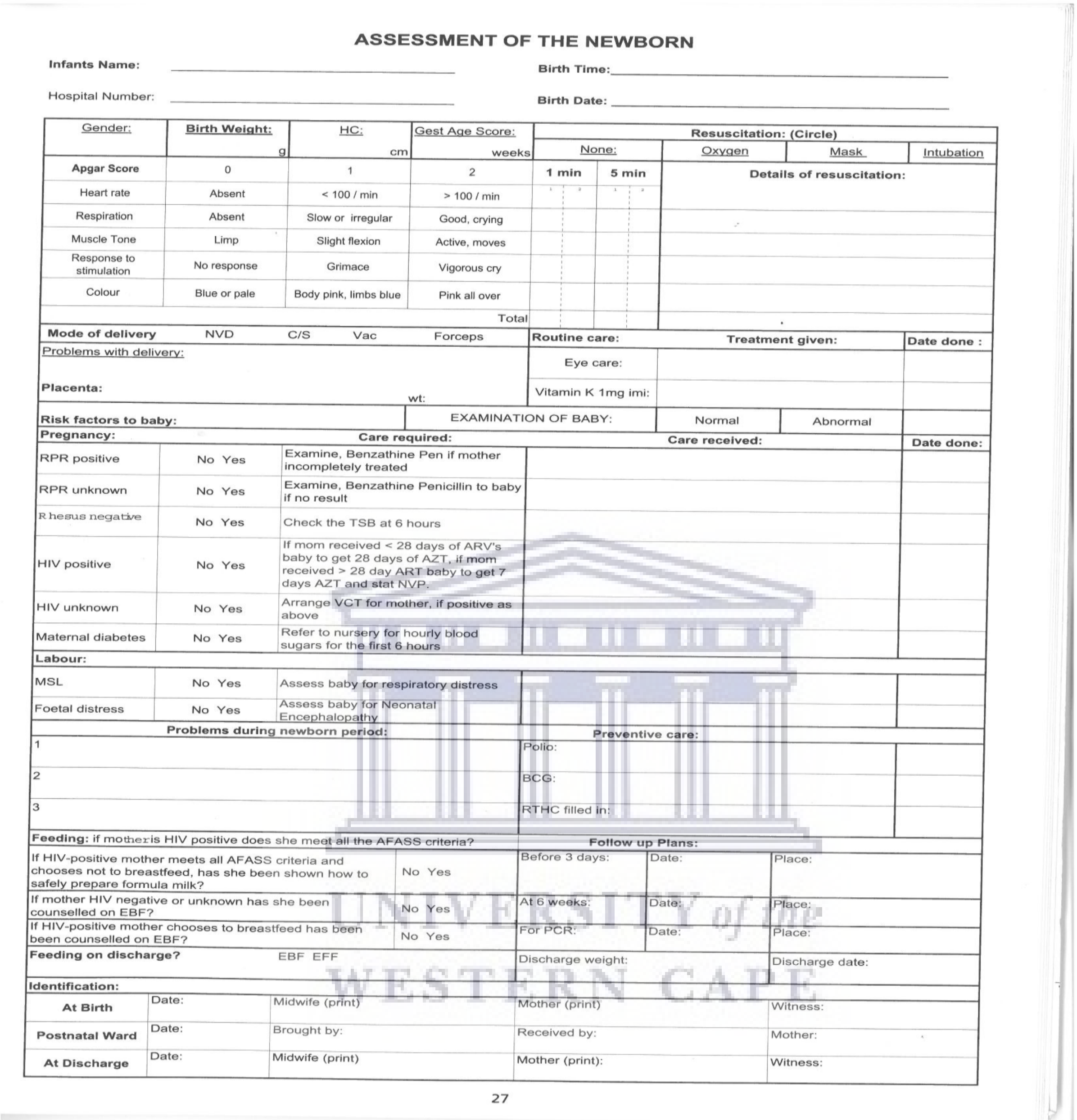
INFANT FEEDING

Feeding option chosen: Breast Formula

Comments:

Booking visit and Assessment of Risk done by:

Name & Title



ASSESSMENT OF THE NEWBORN

Infants Name: ______________________ **Birth Time:** ______________________

Hospital Number: ______________________ **Birth Date:** ______________________

Gender:	**Birth Weight:** g	HC: cm	Gest Age Score: weeks	**Resuscitation: (Circle)**			
				None:	Oxygen	Mask	Intubation

Apgar Score	0	1	2	**1 min**	**5 min**	**Details of resuscitation:**
Heart rate	Absent	< 100 / min	> 100 / min			
Respiration	Absent	Slow or irregular	Good, crying			
Muscle Tone	Limp	Slight flexion	Active, moves			
Response to stimulation	No response	Grimace	Vigorous cry			
Colour	Blue or pale	Body pink, limbs blue	Pink all over			
			Total			

Mode of delivery NVD C/S Vac Forceps	**Routine care:**	**Treatment given:**		**Date done :**
Problems with delivery: **Placenta:** wt:	Eye care:			
	Vitamin K 1mg imi:			
Risk factors to baby:	EXAMINATION OF BABY:	Normal	Abnormal	

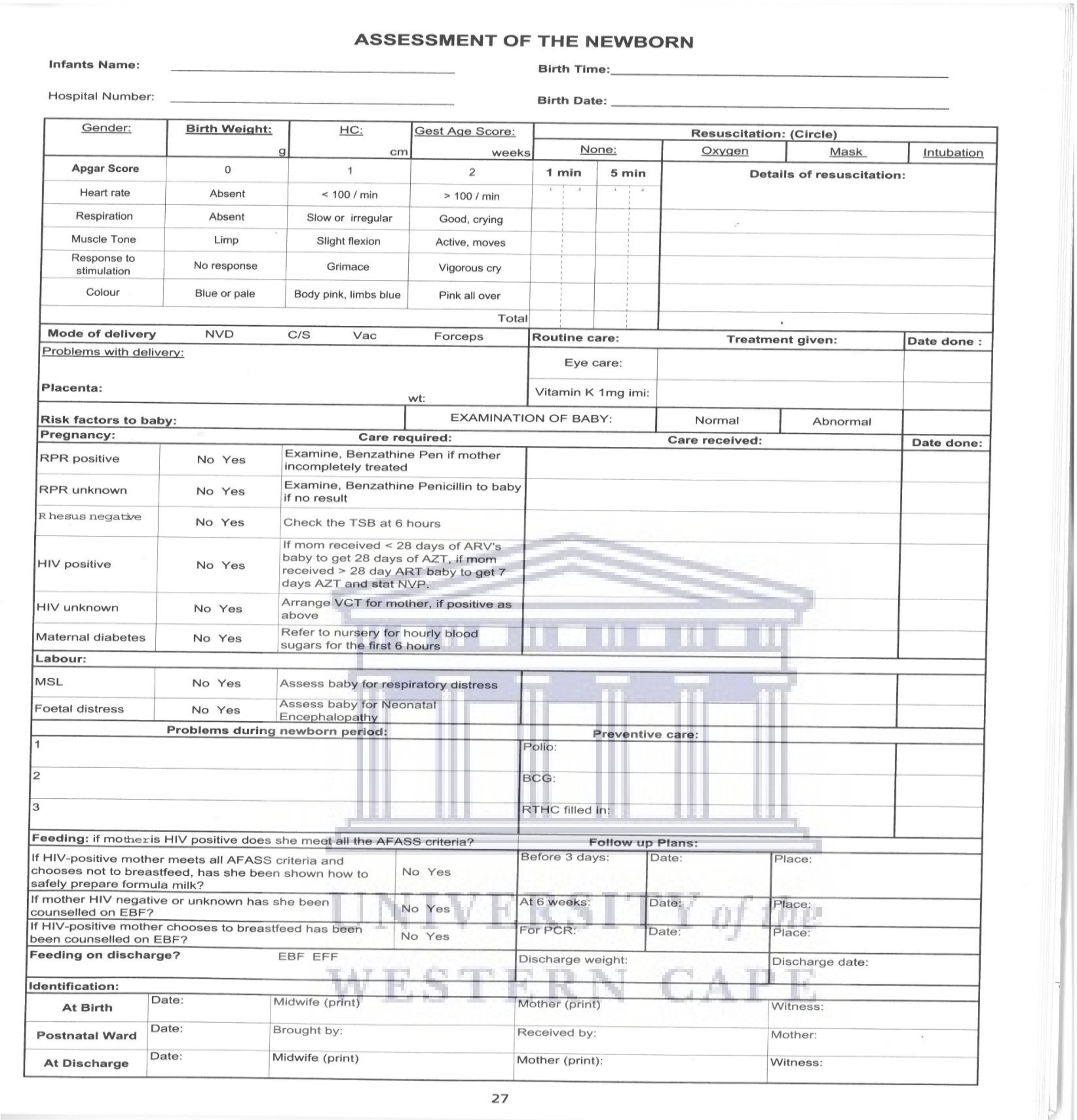
Pregnancy:		**Care required:**	**Care received:**	**Date done:**
RPR positive	No Yes	Examine, Benzathine Pen if mother incompletely treated		
RPR unknown	No Yes	Examine, Benzathine Penicillin to baby if no result		
Rhesus negative	No Yes	Check the TSB at 6 hours		
HIV positive	No Yes	If mom received < 28 days of ARV's baby to get 28 days of AZT, if mom received > 28 day ART baby to get 7 days AZT and stat NVP.		
HIV unknown	No Yes	Arrange VCT for mother, if positive as above		
Maternal diabetes	No Yes	Refer to nursery for hourly blood sugars for the first 6 hours		
Labour:				
MSL	No Yes	Assess baby for respiratory distress		
Foetal distress	No Yes	Assess baby for Neonatal Encephalopathy		

Problems during newborn period:	**Preventive care:**	
1	Polio:	
2	BCG:	
3	RTHC filled in:	

Feeding: if motheris HIV positive does she meet all the AFASS criteria?		**Follow up Plans:**		
If HIV-positive mother meets all AFASS criteria and chooses not to breastfeed, has she been shown how to safely prepare formula milk?	No Yes	Before 3 days:	Date:	Place:
If mother HIV negative or unknown has she been counselled on EBF?	No Yes	At 6 weeks:	Date:	Place:
If HIV-positive mother chooses to breastfeed has been been counselled on EBF?	No Yes	For PCR:	Date:	Place:
Feeding on discharge?	EBF EFF	Discharge weight:		Discharge date:

Identification:				
At Birth	Date:	Midwife (print)	Mother (print)	Witness:
Postnatal Ward	Date:	Brought by:	Received by:	Mother:
At Discharge	Date:	Midwife (print)	Mother (print):	Witness:

27



ASSESSMENT OF THE NEWBORN

Infants Name: ____________________ **Birth Time:** ____________________

Hospital Number: ____________________ **Birth Date:** ____________________

Gender:	**Birth Weight:**	HC:	Gest Age Score:	**Resuscitation: (Circle)**			
	g	cm	weeks	None:	Oxygen	Mask	Intubation

Apgar Score	0	1	2	**1 min**	**5 min**	**Details of resuscitation:**
Heart rate	Absent	< 100 / min	> 100 / min			
Respiration	Absent	Slow or irregular	Good, crying			
Muscle Tone	Limp	Slight flexion	Active, moves			
Response to stimulation	No response	Grimace	Vigorous cry			
Colour	Blue or pale	Body pink, limbs blue	Pink all over			
			Total			

Mode of delivery NVD C/S Vac Forceps		**Routine care:**	**Treatment given:**		**Date done :**
Problems with delivery:		Eye care:			
Placenta:	wt:	Vitamin K 1mg imi:			
Risk factors to baby:		EXAMINATION OF BABY:	Normal	Abnormal	

Pregnancy:		**Care required:**	**Care received:**	**Date done:**
RPR positive	No Yes	Examine, Benzathine Pen if mother incompletely treated		
RPR unknown	No Yes	Examine, Benzathine Penicillin to baby if no result		
Rhesus negative	No Yes	Check the TSB at 6 hours		
HIV positive	No Yes	If mom received < 28 days of ARV's baby to get 28 days of AZT, if mom received > 28 day ART baby to get 7 days AZT and stat NVP.		
HIV unknown	No Yes	Arrange VCT for mother, if positive as above		
Maternal diabetes	No Yes	Refer to nursery for hourly blood sugars for the first 6 hours		
Labour:				
MSL	No Yes	Assess baby for respiratory distress		
Foetal distress	No Yes	Assess baby for Neonatal Encephalopathy		

Problems during newborn period:	**Preventive care:**	
1	Polio:	
2	BCG:	
3	RTHC filled in:	

Feeding: if mother is HIV positive does she meet all the AFASS criteria?		**Follow up Plans:**		
If HIV-positive mother meets all AFASS criteria and chooses not to breastfeed, has she been shown how to safely prepare formula milk?	No Yes	Before 3 days:	Date:	Place:
If mother HIV negative or unknown has she been counselled on EBF?	No Yes	At 6 weeks:	Date:	Place:
If HIV-positive mother chooses to breastfeed has been been counselled on EBF?	No Yes	For PCR:	Date:	Place:
Feeding on discharge?	EBF EFF	Discharge weight:		Discharge date:

Identification:				
At Birth	Date:	Midwife (print)	Mother (print)	Witness:
Postnatal Ward	Date:	Brought by:	Received by:	Mother:
At Discharge	Date:	Midwife (print)	Mother (print):	Witness:

27

DISCHARGE SUMMARY

(To be filled in the Postnatal Ward. Original to go with patient to the clinic and/or doctor)

Date delivered: ……………………
Time delivered: ……………………
Date discharged: ……………………

Type of delivery:

NVD	**C/S**	**Breech**
Forceps	**BBA**	**Vacuum**

Name: ……………………
Clinic/hospital number: ……………………
Date of birth: ……………………
Use patient label if available

HIV	Non- Reactive	Reactive	Declined	Dual Therapy	HAART	CD 4:	WHO stage	I	II	III | IV

Tests for syphilis:	pos	neg	Treatment (dates)	1.	2.	3.	Rhesus status	pos	neg

Medical or surgical problems in pregnancy and delivery:
……………………
……………………

Obstetrical problems in pregnancy and delivery:
……………………
……………………

Vitamin A given:	Yes	No
Anti-D given:	Yes	No

Discharge medication:
-
-
-

Examination on discharge

Looks well | Looks ill | Pulse: …… BP: …… Temperature …… Breasts: ……

HOF: …… Hb: …… **Vaginal bleeding:** Mild | Moderate | Severe*

Perineum: Intact | Epis/Tears | Clean | Septic **Urine output:** Good | Poor | None

Remarks:
……………………
……………………

*(If severe vaginal bleeding do not discharge)

Family Planning

Method discussed:	Oral contraceptives	Injectables	IUCD	Condoms	Tubal ligation	Vasectomy

Method given: …………………… **Given by:** ……………………

Postpartum sterilisation done: Yes | No **Appointment date given for sterilisation:** ……………………

Remarks:
……………………

Feeding Options

Discussed Yes | No If no, explain: ……………………

Initiated successfully Yes | No If no, explain ……………………

Remarks:
……………………

BABY

	Male	Female	Weight	Head	Length	BCG	Polio	AZT given			Method of feeding
1			g	cm	cm			No	7 days	28 days	
2			g	cm	cm			No	7 days	28 days	

Remarks:
……………………

POSTNATAL ADVICE ON DISCHARGE

Advice for next pregnancy: ……………………

Future mode of delivery: NVD | VBAC | Elective CS ATT next dose: ……………………

Future Pap smear/ Breast care: …………………… CD 4 count repeat at 6 months: ……………………

Immunisations: ……………………

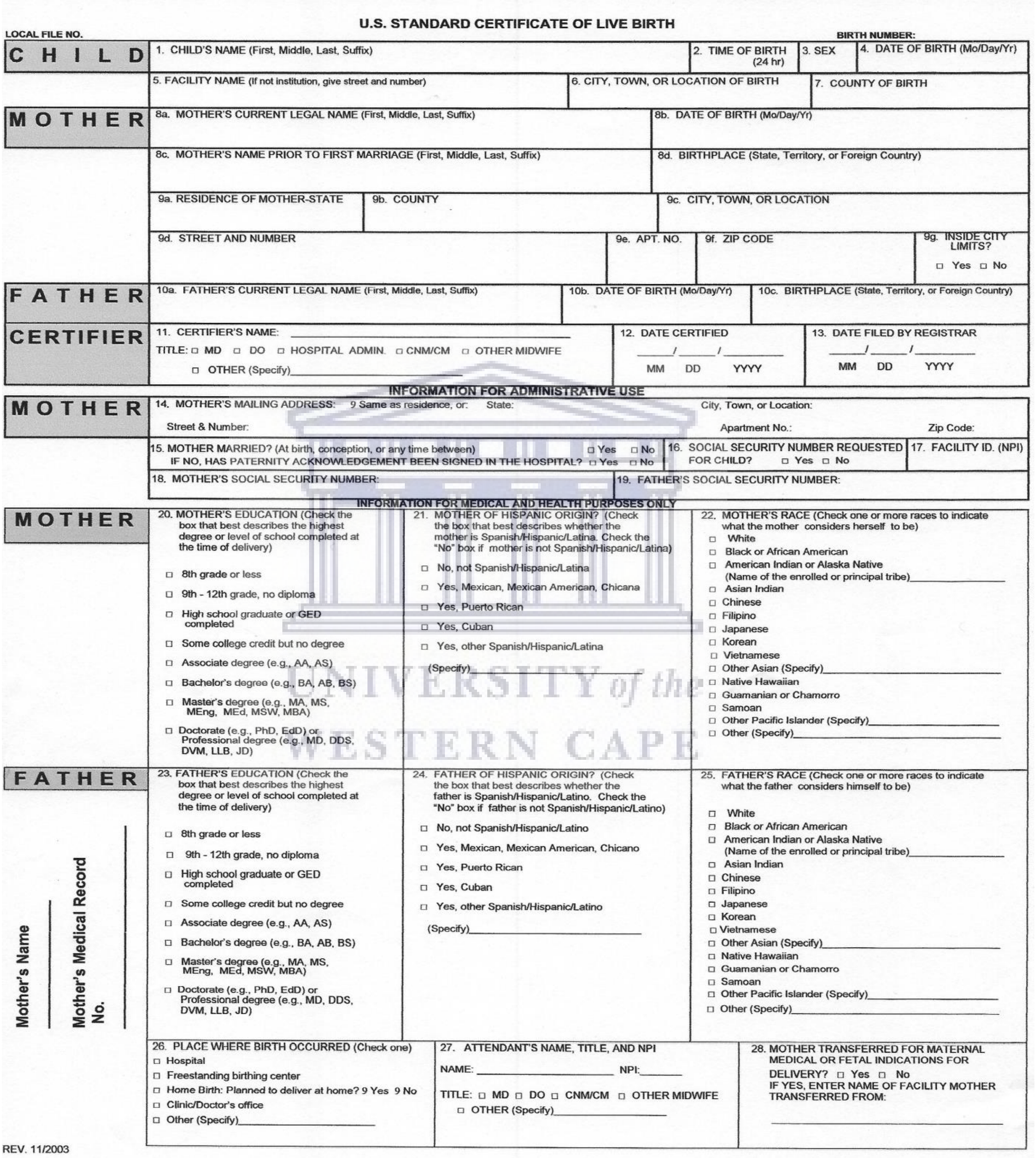
Postnatal visit: Date: …………………… Clinic/Hospital: ……………………

Notification/Registration of birth: ……………………

Care of the baby: ……………………

Name …………………… **Rank** …………………… **Signature** ……………………

APPENDIX E: US birth certificate data items



U.S. STANDARD CERTIFICATE OF LIVE BIRTH

LOCAL FILE NO.

BIRTH NUMBER:

C H I L D

1. CHILD'S NAME (First, Middle, Last, Suffix)
2. TIME OF BIRTH (24 hr)
3. SEX
4. DATE OF BIRTH (Mo/Day/Yr)
5. FACILITY NAME (If not institution, give street and number)
6. CITY, TOWN, OR LOCATION OF BIRTH
7. COUNTY OF BIRTH

M O T H E R

8a. MOTHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
8b. DATE OF BIRTH (Mo/Day/Yr)
8c. MOTHER'S NAME PRIOR TO FIRST MARRIAGE (First, Middle, Last, Suffix)
8d. BIRTHPLACE (State, Territory, or Foreign Country)
9a. RESIDENCE OF MOTHER-STATE
9b. COUNTY
9c. CITY, TOWN, OR LOCATION
9d. STREET AND NUMBER
9e. APT. NO.
9f. ZIP CODE
9g. INSIDE CITY LIMITS? ☐ Yes ☐ No

F A T H E R

10a. FATHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)
10b. DATE OF BIRTH (Mo/Day/Yr)
10c. BIRTHPLACE (State, Territory, or Foreign Country)

CERTIFIER

11. CERTIFIER'S NAME: ______________________________
TITLE: ☐ MD ☐ DO ☐ HOSPITAL ADMIN. ☐ CNM/CM ☐ OTHER MIDWIFE
☐ OTHER (Specify)______________________
12. DATE CERTIFIED ____/____/______ MM DD YYYY
13. DATE FILED BY REGISTRAR ____/____/______ MM DD YYYY

INFORMATION FOR ADMINISTRATIVE USE

M O T H E R

14. MOTHER'S MAILING ADDRESS: 9 Same as residence, or: State: City, Town, or Location:
Street & Number: Apartment No.: Zip Code:
15. MOTHER MARRIED? (At birth, conception, or any time between) ☐ Yes ☐ No
IF NO, HAS PATERNITY ACKNOWLEDGEMENT BEEN SIGNED IN THE HOSPITAL? ☐ Yes ☐ No
16. SOCIAL SECURITY NUMBER REQUESTED FOR CHILD? ☐ Yes ☐ No
17. FACILITY ID. (NPI)
18. MOTHER'S SOCIAL SECURITY NUMBER:
19. FATHER'S SOCIAL SECURITY NUMBER:

INFORMATION FOR MEDICAL AND HEALTH PURPOSES ONLY

M O T H E R

20. MOTHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)

☐ 8th grade or less
☐ 9th - 12th grade, no diploma
☐ High school graduate or GED completed
☐ Some college credit but no degree
☐ Associate degree (e.g., AA, AS)
☐ Bachelor's degree (e.g., BA, AB, BS)
☐ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
☐ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

21. MOTHER OF HISPANIC ORIGIN? (Check the box that best describes whether the mother is Spanish/Hispanic/Latina. Check the "No" box if mother is not Spanish/Hispanic/Latina)

☐ No, not Spanish/Hispanic/Latina
☐ Yes, Mexican, Mexican American, Chicana
☐ Yes, Puerto Rican
☐ Yes, Cuban
☐ Yes, other Spanish/Hispanic/Latina

(Specify)______________________

22. MOTHER'S RACE (Check one or more races to indicate what the mother considers herself to be)

☐ White
☐ Black or African American
☐ American Indian or Alaska Native (Name of the enrolled or principal tribe)______________
☐ Asian Indian
☐ Chinese
☐ Filipino
☐ Japanese
☐ Korean
☐ Vietnamese
☐ Other Asian (Specify)______________________
☐ Native Hawaiian
☐ Guamanian or Chamorro
☐ Samoan
☐ Other Pacific Islander (Specify)______________________
☐ Other (Specify)______________________

F A T H E R

23. FATHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)

☐ 8th grade or less
☐ 9th - 12th grade, no diploma
☐ High school graduate or GED completed
☐ Some college credit but no degree
☐ Associate degree (e.g., AA, AS)
☐ Bachelor's degree (e.g., BA, AB, BS)
☐ Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA)
☐ Doctorate (e.g., PhD, EdD) or Professional degree (e.g., MD, DDS, DVM, LLB, JD)

24. FATHER OF HISPANIC ORIGIN? (Check the box that best describes whether the father is Spanish/Hispanic/Latino. Check the "No" box if father is not Spanish/Hispanic/Latino)

☐ No, not Spanish/Hispanic/Latino
☐ Yes, Mexican, Mexican American, Chicano
☐ Yes, Puerto Rican
☐ Yes, Cuban
☐ Yes, other Spanish/Hispanic/Latino

(Specify)______________________

25. FATHER'S RACE (Check one or more races to indicate what the father considers himself to be)

☐ White
☐ Black or African American
☐ American Indian or Alaska Native (Name of the enrolled or principal tribe)______________
☐ Asian Indian
☐ Chinese
☐ Filipino
☐ Japanese
☐ Korean
☐ Vietnamese
☐ Other Asian (Specify)______________________
☐ Native Hawaiian
☐ Guamanian or Chamorro
☐ Samoan
☐ Other Pacific Islander (Specify)______________________
☐ Other (Specify)______________________

Mother's Name ______

Mother's Medical Record No. ______

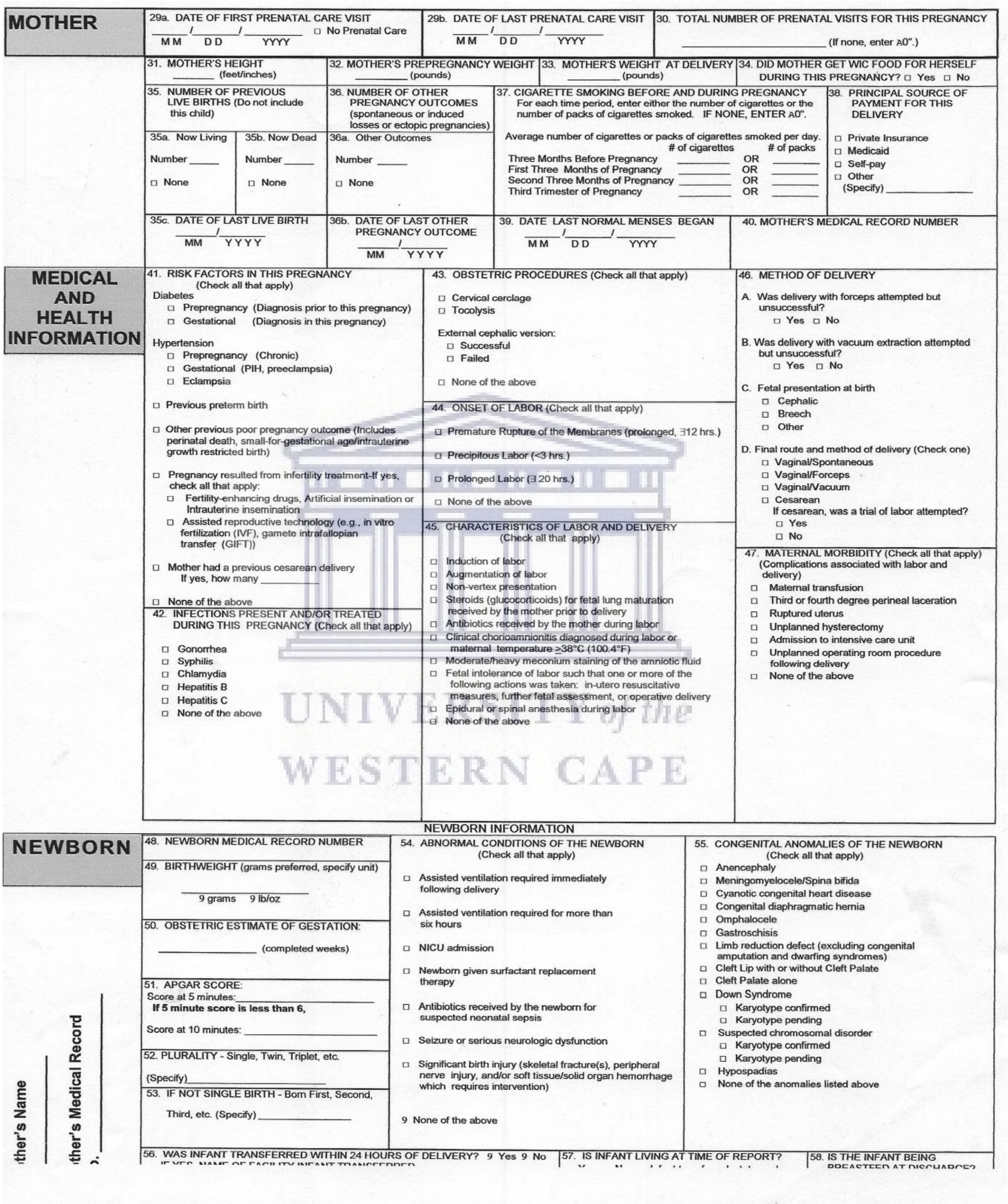
26. PLACE WHERE BIRTH OCCURRED (Check one)

☐ Hospital
☐ Freestanding birthing center
☐ Home Birth: Planned to deliver at home? 9 Yes 9 No
☐ Clinic/Doctor's office
☐ Other (Specify)______________________

27. ATTENDANT'S NAME, TITLE, AND NPI
NAME: ______________________ NPI:_______
TITLE: ☐ MD ☐ DO ☐ CNM/CM ☐ OTHER MIDWIFE
☐ OTHER (Specify)__________________

28. MOTHER TRANSFERRED FOR MATERNAL MEDICAL OR FETAL INDICATIONS FOR DELIVERY? ☐ Yes ☐ No
IF YES, ENTER NAME OF FACILITY MOTHER TRANSFERRED FROM:
____

REV. 11/2003



MOTHER

29a. DATE OF FIRST PRENATAL CARE VISIT
____/____/____ ☐ No Prenatal Care
MM DD YYYY

29b. DATE OF LAST PRENATAL CARE VISIT
____/____/____
MM DD YYYY

30. TOTAL NUMBER OF PRENATAL VISITS FOR THIS PREGNANCY
____________ (If none, enter A0".)

31. MOTHER'S HEIGHT
____ (feet/inches)

32. MOTHER'S PREPREGNANCY WEIGHT
____ (pounds)

33. MOTHER'S WEIGHT AT DELIVERY
____ (pounds)

34. DID MOTHER GET WIC FOOD FOR HERSELF DURING THIS PREGNANCY? ☐ Yes ☐ No

35. NUMBER OF PREVIOUS LIVE BIRTHS (Do not include this child)

35a. Now Living
Number ____
☐ None

35b. Now Dead
Number ____
☐ None

36. NUMBER OF OTHER PREGNANCY OUTCOMES (spontaneous or induced losses or ectopic pregnancies)

36a. Other Outcomes
Number ____
☐ None

37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY
For each time period, enter either the number of cigarettes or the number of packs of cigarettes smoked. IF NONE, ENTER A0".

Average number of cigarettes or packs of cigarettes smoked per day.

	# of cigarettes		# of packs
Three Months Before Pregnancy	____	OR	____
First Three Months of Pregnancy	____	OR	____
Second Three Months of Pregnancy	____	OR	____
Third Trimester of Pregnancy	____	OR	____

38. PRINCIPAL SOURCE OF PAYMENT FOR THIS DELIVERY
- ☐ Private Insurance
- ☐ Medicaid
- ☐ Self-pay
- ☐ Other (Specify) ____________

35c. DATE OF LAST LIVE BIRTH
____/____
MM YYYY

36b. DATE OF LAST OTHER PREGNANCY OUTCOME
____/____
MM YYYY

39. DATE LAST NORMAL MENSES BEGAN
____/____/____
MM DD YYYY

40. MOTHER'S MEDICAL RECORD NUMBER

MEDICAL AND HEALTH INFORMATION

41. RISK FACTORS IN THIS PREGNANCY (Check all that apply)

Diabetes
- ☐ Prepregnancy (Diagnosis prior to this pregnancy)
- ☐ Gestational (Diagnosis in this pregnancy)

Hypertension
- ☐ Prepregnancy (Chronic)
- ☐ Gestational (PIH, preeclampsia)
- ☐ Eclampsia

- ☐ Previous preterm birth
- ☐ Other previous poor pregnancy outcome (Includes perinatal death, small-for-gestational age/intrauterine growth restricted birth)
- ☐ Pregnancy resulted from infertility treatment-If yes, check all that apply:
  - ☐ Fertility-enhancing drugs, Artificial insemination or Intrauterine insemination
  - ☐ Assisted reproductive technology (e.g., in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT))
- ☐ Mother had a previous cesarean delivery
  If yes, how many ________
- ☐ None of the above

42. INFECTIONS PRESENT AND/OR TREATED DURING THIS PREGNANCY (Check all that apply)
- ☐ Gonorrhea
- ☐ Syphilis
- ☐ Chlamydia
- ☐ Hepatitis B
- ☐ Hepatitis C
- ☐ None of the above

43. OBSTETRIC PROCEDURES (Check all that apply)
- ☐ Cervical cerclage
- ☐ Tocolysis

External cephalic version:
- ☐ Successful
- ☐ Failed

- ☐ None of the above

44. ONSET OF LABOR (Check all that apply)
- ☐ Premature Rupture of the Membranes (prolonged, ∃12 hrs.)
- ☐ Precipitous Labor (<3 hrs.)
- ☐ Prolonged Labor (∃ 20 hrs.)
- ☐ None of the above

45. CHARACTERISTICS OF LABOR AND DELIVERY (Check all that apply)
- ☐ Induction of labor
- ☐ Augmentation of labor
- ☐ Non-vertex presentation
- ☐ Steroids (glucocorticoids) for fetal lung maturation received by the mother prior to delivery
- ☐ Antibiotics received by the mother during labor
- ☐ Clinical chorioamnionitis diagnosed during labor or maternal temperature ≥38°C (100.4°F)
- ☐ Moderate/heavy meconium staining of the amniotic fluid
- ☐ Fetal intolerance of labor such that one or more of the following actions was taken: in-utero resuscitative measures, further fetal assessment, or operative delivery
- ☐ Epidural or spinal anesthesia during labor
- ☐ None of the above

46. METHOD OF DELIVERY

A. Was delivery with forceps attempted but unsuccessful?
☐ Yes ☐ No

B. Was delivery with vacuum extraction attempted but unsuccessful?
☐ Yes ☐ No

C. Fetal presentation at birth
- ☐ Cephalic
- ☐ Breech
- ☐ Other

D. Final route and method of delivery (Check one)
- ☐ Vaginal/Spontaneous
- ☐ Vaginal/Forceps
- ☐ Vaginal/Vacuum
- ☐ Cesarean
  If cesarean, was a trial of labor attempted?
  - ☐ Yes
  - ☐ No

47. MATERNAL MORBIDITY (Check all that apply) (Complications associated with labor and delivery)
- ☐ Maternal transfusion
- ☐ Third or fourth degree perineal laceration
- ☐ Ruptured uterus
- ☐ Unplanned hysterectomy
- ☐ Admission to intensive care unit
- ☐ Unplanned operating room procedure following delivery
- ☐ None of the above

NEWBORN INFORMATION

NEWBORN

48. NEWBORN MEDICAL RECORD NUMBER

49. BIRTHWEIGHT (grams preferred, specify unit)
____
9 grams 9 lb/oz

50. OBSTETRIC ESTIMATE OF GESTATION:
____________ (completed weeks)

51. APGAR SCORE:
Score at 5 minutes: ____________
If 5 minute score is less than 6,
Score at 10 minutes: ____________

52. PLURALITY - Single, Twin, Triplet, etc.
(Specify) ____________

53. IF NOT SINGLE BIRTH - Born First, Second, Third, etc. (Specify) ____________

54. ABNORMAL CONDITIONS OF THE NEWBORN (Check all that apply)
- ☐ Assisted ventilation required immediately following delivery
- ☐ Assisted ventilation required for more than six hours
- ☐ NICU admission
- ☐ Newborn given surfactant replacement therapy
- ☐ Antibiotics received by the newborn for suspected neonatal sepsis
- ☐ Seizure or serious neurologic dysfunction
- ☐ Significant birth injury (skeletal fracture(s), peripheral nerve injury, and/or soft tissue/solid organ hemorrhage which requires intervention)

9 None of the above

55. CONGENITAL ANOMALIES OF THE NEWBORN (Check all that apply)
- ☐ Anencephaly
- ☐ Meningomyelocele/Spina bifida
- ☐ Cyanotic congenital heart disease
- ☐ Congenital diaphragmatic hernia
- ☐ Omphalocele
- ☐ Gastroschisis
- ☐ Limb reduction defect (excluding congenital amputation and dwarfing syndromes)
- ☐ Cleft Lip with or without Cleft Palate
- ☐ Cleft Palate alone
- ☐ Down Syndrome
  - ☐ Karyotype confirmed
  - ☐ Karyotype pending
- ☐ Suspected chromosomal disorder
  - ☐ Karyotype confirmed
  - ☐ Karyotype pending
- ☐ Hypospadias
- ☐ None of the anomalies listed above

56. WAS INFANT TRANSFERRED WITHIN 24 HOURS OF DELIVERY? 9 Yes 9 No

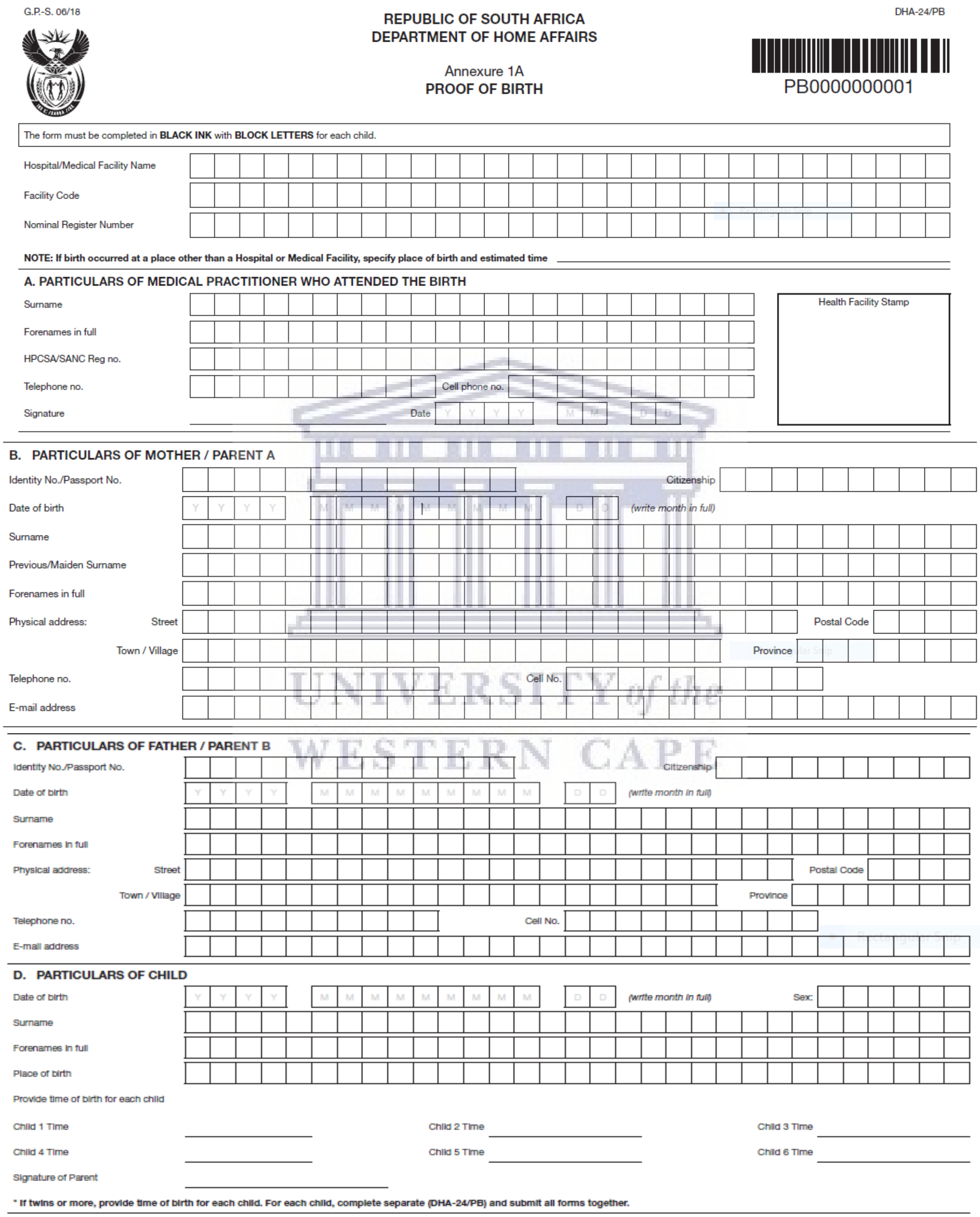
57. IS INFANT LIVING AT TIME OF REPORT?

58. IS THE INFANT BEING

ther's Name ____________

ther's Medical Record ____________

APPENDIX F: DHA-24/PB



G.P.-S. 06/18

DHA-24/PB

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF HOME AFFAIRS

Annexure 1A
PROOF OF BIRTH

PB0000000001

The form must be completed in **BLACK INK** with **BLOCK LETTERS** for each child.

Hospital/Medical Facility Name

Facility Code

Nominal Register Number

NOTE: If birth occurred at a place other than a Hospital or Medical Facility, specify place of birth and estimated time ________

A. PARTICULARS OF MEDICAL PRACTITIONER WHO ATTENDED THE BIRTH

Surname

Forenames in full

HPCSA/SANC Reg no.

Telephone no. Cell phone no.

Signature ________ Date Y Y Y Y M M D D

Health Facility Stamp

B. PARTICULARS OF MOTHER / PARENT A

Identity No./Passport No. Citizenship

Date of birth Y Y Y Y M M M M M M M M M D D *(write month in full)*

Surname

Previous/Maiden Surname

Forenames in full

Physical address: Street Postal Code

Town / Village Province

Telephone no. Cell No.

E-mail address

C. PARTICULARS OF FATHER / PARENT B

Identity No./Passport No. Citizenship

Date of birth Y Y Y Y M M M M M M M M M D D *(write month in full)*

Surname

Forenames in full

Physical address: Street Postal Code

Town / Village Province

Telephone no. Cell No.

E-mail address

D. PARTICULARS OF CHILD

Date of birth Y Y Y Y M M M M M M M M M D D *(write month in full)* Sex:

Surname

Forenames in full

Place of birth

Provide time of birth for each child

Child 1 Time ________ Child 2 Time ________ Child 3 Time ________

Child 4 Time ________ Child 5 Time ________ Child 6 Time ________

Signature of Parent ________

*** If twins or more, provide time of birth for each child. For each child, complete separate (DHA-24/PB) and submit all forms together.**