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Factors influencing vaccine coverage in Tshwane district, Gauteng, South Africa

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FACTORS INFLUENCING VACCINE COVERAGE IN TSHWANE DISTRICT, GAUTENG, SOUTH AFRICA

Heather Lynne Fraser

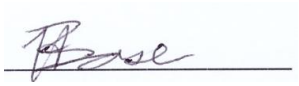
A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Epidemiology (Implementation Science)

September, 2019

Declaration

I, Heather Lynne Fraser, declare that this Research Report is my own, personal work. It is being submitted for the Degree of Master of Science in Epidemiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Signed,

 Miss HL Fraser

On this 12th day of September 2019, in Johannesburg

Dedication

To my family, without whom I would never have made it this far.

Presentation arising from this research project

Fraser HL, Ntombizodwa Ndlovu, Makwela Mashaole, Rohit Ramaswamy, Latifat Ibisomi. Factors influencing vaccine coverage in Tshwane District, South Africa: An application of the Consolidated Framework for Implementation Research. 11th Annual Conference on the Science of Dissemination and Implementation in Health, 3 – 5 December 2018, Washington D.C., United States of America (Oral presentation).

Abstract

Background:

It has been well established that immunisation is essential in preventing illnesses and reducing childhood mortality. Vaccine coverage refers to the percentage of people in a defined population that has received a particular dose of a vaccine, or schedule of vaccine doses. Improving coverage of vaccination is instrumental in preventing additional deaths and reaching targets that have been set for the elimination of vaccine-preventable diseases. In Tshwane District, South Africa, vaccine coverage for the population under one year is not optimal, with some areas reporting coverage levels as low as 44%, and others reporting coverage levels well over 100%. There has been no systematic exploration of the issues that have led to these estimates.

Aim:

To explore the factors that influence vaccine coverage in children under the age of one year, both in terms of the implementation of the vaccine programme and the process by which vaccine coverage is calculated, in Tshwane District, Gauteng, South Africa.

Methods:

A cross-sectional exploratory qualitative study design was used to achieve the objectives, through in-depth interviews with key-informants involved in vaccine programme implementation and coverage estimation, including nurses; managers at the facility, sub-district, district and provincial levels; and information system managers. Additionally, a focus group discussion was conducted with a ward-based outreach team. Transcripts were inductively coded and analysed, and the Consolidated Framework for Implementation Research was used to interpret the themes, in order to identify the barriers and facilitators to vaccine coverage in Tshwane.

Results:

Factors emerged both in terms of facilitators and barriers to vaccine coverage in Tshwane. Key facilitators were found to be: perceptions of success in the supply chain of vaccines, and high levels of engagement in achieving vaccine coverage. Key barriers were found to be: lack of mobile clinics, hindering access to services; a hierarchical, top-down approach to decision-making in removing defaulter-tracing registers; the complex process of deriving population estimates for calculating coverage rates; inefficient and ineffective data collection processes; sub-optimal data quality, and inadequate representation of the private sector.

Discussion:

There was a perception of high-level commitment to the success of EPI in Tshwane. The barriers to implementation of EPI are multifactorial, at all levels of the healthcare system. Coverage estimates for individual sub-districts may not be an accurate depiction of the true performance of EPI, due to inaccuracies in both the estimation of the denominator (population estimates) and the numerator (number of doses administered) of the vaccine coverage indicator. There is an opportunity for policy-makers to address highlighted issues, for example by re-instating defaulter-tracing registers and conducting an immunisation survey.

Acknowledgements

To the Lord God Almighty, “You discern my thoughts from afar, You search out my path” (Psalm 139). Thank You for holding me in the palm of Your Hand, always.

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To my parents, without your constant support, this would not have been possible – thank you for encouraging me always to take the next step.

To my wonderful siblings and their wonderful spouses, thank you for providing listening ears and a good laugh when I needed it most.

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List of Abbreviations

CFIR	Consolidated Framework for Implementation Research
CHC	Community Health Centre
DHIS	District Health Information System
DHS	Demographic and Health Survey
DTP3 Vaccine	Diphtheria-Tetanus-Pertussis Vaccine
EPI	Expanded Programme for Immunisation
FGD	Focus Group Discussion
GAVI	Global Alliance for Vaccines and Immunisation
GDoH	Gauteng Department of Health
GVAP	Global Vaccine Action Plan (2011-2020)
HAST	HIV/AIDS, Sexually Transmitted Diseases and Tuberculosis
HISP	Health Information Systems Programme
HIV	Human Immunodeficiency Virus
HPV	Human Papillomavirus
HREC Wits	Human Research Ethics Committee, University of the Witwatersrand
IMCI	Integrated Management of Childhood Illnesses
IT	Information Technology
LMIC	Low- and middle-income countries
MOU	Memorandum of Understanding
NDoH	National Department of Health
NGO	Non-Governmental Organisation
PHC	Primary Health Care
PMTCT	Prevention of Mother to Child Transmission of HIV
Stats-SA	Statistics South Africa
UNICEF	United Nations International Children's Emergency Fund
USA	United States of America
WBOT	Ward Based Outreach Team
WHO	World Health Organization

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List of Key Concepts and Terms

Vaccination:

The process by which a vaccine is administered to a person, predominantly through the use of injection (1).

Immunisation:

The process after receiving a vaccine, whereby a person becomes immune to the pathogen targeted by the vaccine (1).

Roles of study participants in the EPI programme

WBOT:

The Ward-Based Outreach Team (WBOT) consists of community healthcare workers, tasked with going out into the community and conducting door-to-door visits with community members. During these visits, if it is noted that there is a child in the household, the WBOT member will ask to check the Road to Health Card, on which all immunisations are recorded. If the WBOT member notes that the child has not been immunised according to the schedule, they encourage the child's caregiver to take the child to the clinic to for the required vaccine doses, according to the schedule. The WBOT is not permitted to administer vaccines in the community, as only registered or enrolled nurses are able to administer this intervention. Thus, the WBOT's role is largely to detect missed opportunities for immunisation, and to facilitate the completion of the schedule for these individuals.

EPI Nurses:

These are registered or professional nurses who are employed to work at a healthcare facility. They administer vaccines to children who present to the facility; record the doses that have been administered in the Comprehensive Tick Register, and monitor for adverse events. According to the integration of services, and the Integrated Management of Childhood Illnesses policy, these nurses are required to also attend to any other healthcare needs of the child – including HIV testing and malnutrition management.

Facility Manager:

This is the manager for all health programmes that are offered at the healthcare facility – including the EPI service. The facility manager is charged with monitoring the staffing levels of the programmes; monitoring the data collection and reporting, and handling any complaints arising from staff or patients

Sub-District EPI Coordinators:

The sub-district coordinators work under the supervision and direction of the District EPI Coordinator. They are charged with conducting support visits to all facilities within their sub-district, to ensure that stock levels are sufficient and that the cold chain is being maintained adequately; and to provide support in situations which may require specific EPI expertise – for example, the administration of catch-up doses of the immunisation schedule. Additionally, the coordinators receive reports from all facilities in their sub-district and compile these into a sub-district report for the District Managers.

Area Managers:

These are managers are tasked with monitoring and providing support for all Primary Healthcare facilities in their jurisdiction, which is usually two to three sub-districts. Thus, there are multiple area managers in Tshwane District. The EPI programme comprises one of several programmes for which they provide support and supervision.

District EPI Coordinator:

This is the senior manager for all EPI activities in the district. This manager is required to co-ordinate all activities among all the sub-districts, with the support of the sub-district coordinators. They are required to report to the District Health Programmes Manager, as well as the Provincial EPI Manager. These activities include surveillance for vaccine-preventable diseases; monitoring the supply chain; monitoring and maintaining the cold chain; monitoring vaccine coverage and compiling district reports.

District Health Programmes Manager:

This is the manager for all programmes delivered at Primary Healthcare facilities in the district – of which EPI is one programme. They provide senior managerial support to the District EPI Coordinator.

District Data Manager:

This is the manager of all data that is collected at public healthcare facilities in the district. Once data is captured into the District Health Information System (DHIS) by data capturers, the District Data Manager has to monitor for discrepancies and checks the quality of the data collected, as far as possible. This manager ensures that data pertaining to all indicators required by the National Indicator Dataset (NIDS) are being collected and reported on, by facilities. The indicators for the EPI programme and vaccine coverage fall under the requirements of the NIDS.

District Monitoring and Evaluations Officer:

This is the manager responsible for planning, monitoring and reporting, particularly with regards to the clinical performance of healthcare workers in the district. This includes interrogation of the data, analysis of the data, and making decisions (on strategies to improve performance) based on the analysis of the data. Performance of clinics in terms of achieving their vaccine coverage targets is one of the areas under the purview of the District Monitoring and Evaluations Officer.

Provincial EPI Coordinator:

This is the senior manager for all EPI activities in the province. This manager is required to co-ordinate all activities among all the districts within the province, with the support of the district coordinators, as well as the provincial cold chain manager, and provincial surveillance officer. They are required to report to the Provincial Health Programmes Manager. These activities include surveillance for vaccine-preventable diseases; monitoring the supply chain; monitoring and maintaining the cold chain; monitoring vaccine coverage and compiling district reports.

Provincial Health Programmes Manager:

This is the manager for all programmes delivered at Primary Healthcare facilities in the Province – of which EPI is one programme. They provide senior managerial support to the Provincial EPI Coordinator.

Senior Manager at HISP:

The Health Information Systems Programme (HISP) supports local management in terms of the flow of information and the delivery of healthcare services. They capture and perform analysis of data, to provide support to people at all levels of the healthcare system, including information managers and decision/policymakers at health district and national levels. A Senior Manager at HISP, a computer scientist, is involved in helping to develop the health information system, in order to estimate population sizes, using projections of census data, and using these estimates to capture sub-district population sizes, and facility-level population allocation (which are not captured by the census).

Chapter 1. Introduction

In order to introduce the reader to the study, this chapter first provides an overview of the setting in which the study took place and the intervention that was explored. This is followed by a problem statement, leading to the research question; the research objectives, and the justification for the study; followed by a review of the relevant literature. This entails a review of literature pertaining to what has been established regarding factors influencing vaccine coverage; the framework used to guide the study, the Consolidated Framework for Implementation Research (CFIR); the applicability of the CFIR to vaccine coverage, and previous applications of the CFIR.

1.1 The setting: South Africa, Gauteng and Tshwane

In order to contextualise the barriers and facilitators of vaccine coverage in Tshwane District, it is important to understand the unique attributes of the setting. For instance, the high levels of private sector healthcare utilisation in Tshwane may increase the impact of the private sector on vaccine coverage. Thus, the division of the healthcare system into the private and public sectors may be a factor that influences vaccine coverage in Tshwane.

South Africa is classified as a middle-income country according to the World bank [2, 3]. The health system is comprised of the public sector and the private sector, with access to the private sector largely through medical insurance. The end of Apartheid in 1994 brought about a transformation of the public sector into an integrated, comprehensive national service [2]. This service has adopted a Primary Health Care (PHC) approach, as a means of providing cost-effective care to the population (4). The public health care sector still faces significant challenges, however, with staff shortages being one of the critical issues (2). There is also a high level of variability in terms of provision of services across the nine provinces of South Africa (2). The majority of the South African population receive healthcare services, including routine immunisations, through PHC for no charge, while a small proportion of the population access the private sector, where they pay for this service (5).

Gauteng Province is the smallest province geographically, but has the largest population, with an estimated 14,278,700 people living in the province according to the mid-year population

estimates of 2017 (6). Tshwane District is one of five districts in Gauteng Province and is situated in the northern part of the province. The Tshwane Health District has the same geographical boundaries as the metropolitan municipality, which is known as the City of Tshwane. Tshwane District is demarcated further into seven health sub-districts, which are also aligned with the administrative demarcation of the metropolitan municipality (7).

The City of Tshwane is one of eight metropolitan municipalities in South Africa and is South Africa's administrative capital (8). Despite Gauteng being the most urbanised of South Africa's nine provinces, there are important factors to note when looking at the context of Tshwane District (9). The General Household Survey of 2017 presented information on some of these key factors, including housing; access to piped water; sanitation; educational status, and medical insurance coverage. In terms of housing, 17.6% of Tshwane's population resided in informal dwellings, defined as "makeshift structure(s) not erected according to approved architectural plans for example shacks or shanties" (10). Access to piped or tap water in Tshwane was the lowest among all metropolitan areas, with 94.8% of households having had piped water in the dwelling, or access to a tap on-site, in comparison to the average across all metros of 97.7%. Additionally, among the metropolitan municipalities, Tshwane had the lowest percentage of households with access to "improved sanitation", with this indicator being defined as "flush toilets connected to a public sewerage system or a septic tank, and a pit toilet with a ventilation pipe" (10). In terms of educational status, Gauteng Province had an adult literacy rate of 97.8% compared to 93.3% nationally, with Tshwane achieving a rate of 97.1%. In terms of access to health insurance, Tshwane had medical aid coverage of 29.1% which was higher than the average in Gauteng of 25%, and significantly higher than the national average of 16.9% (10).

Thus, despite a high level of urbanisation, high literacy rates and a large proportion of the population of Tshwane having access to private health care services, there was still a significant section of the population living in informal dwellings, without access to piped water or adequate sanitation. This demonstrates some of the inequities that existed in the context of Tshwane, and these may have played a role in the challenges involved in service provision in general, and healthcare service provision in particular.

1.2 The intervention: The Expanded Programme for Immunisation (EPI)

Immunisation is an important public health intervention for the prevention of illness, disability and death resulting from vaccine-preventable diseases (11). It is estimated that, globally, immunisation prevents between two and three million deaths annually from diphtheria, tetanus, pertussis and measles alone, which demonstrates the necessity of this intervention (11). Vaccine coverage refers to the percentage of people in a defined population that has received a particular dose of a vaccine, or schedule of vaccine doses(12). Improving vaccine coverage is instrumental in preventing additional deaths and reaching targets that have been set for the elimination of vaccine-preventable diseases (13). The EPI was launched in 1974 by the World Health Organization (WHO), targeting diphtheria, tetanus, pertussis, poliomyelitis, measles and tuberculosis and has produced remarkable gains (14). By 1990, the global coverage of vaccines against tuberculosis, poliomyelitis and measles had reached 80% for children under the age of 13 months; however, coverage rates varied widely within and between countries (14).

Targets for vaccine coverage are based on pathogen characteristics, particularly transmissibility (15). Pathogens with higher transmission rates, require greater proportions of the population to be immunised to achieve the elimination of that pathogen (15, 16). Herd immunity results from the indirect protection that immunised individuals provide to those they encounter who are not immunised. Hence, disease transmission is hindered by individuals no longer being susceptible to infection and thus unable to transmit the disease to others in the population(15). Furthermore, as a result of immunisation of individuals in the population, the population density of potential hosts is reduced, which lowers the transmission rate of the pathogen. As a result, 100% vaccine coverage is not required in order to eliminate a vaccine-preventable disease (16).

The Global Vaccine Action Plan (2011-2020) (GVAP) has set national targets of above 90% for coverage of scheduled childhood vaccines for all countries to reach by 2020 (17, 18). Vaccine coverage estimates are derived by dividing the number of children vaccinated (the numerator of the indicator) by the estimated target population for vaccination (the denominator of the indicator).

Achieving the vaccine coverage targets set by the GVAP is integral to achieving the Sustainable Development Goal of bringing to an end preventable deaths of children under the age of five years by 2030 (18). The coverage rates of the measles vaccine and the third diphtheria-tetanus-pertussis vaccine dose (DTP3) are used as indicators of the performance of

a given health system with regards to the immunisation programme, partly due to data relating to coverage of these vaccines being readily available in the majority of countries (19, 20). The Global Routine Vaccination Coverage report of 2015 found the global coverage of DTP3 to be 86%, with the African region achieving 76% coverage (21). With measles being considered one of the most highly transmissible diseases, and being one of the top causes of mortality among young children, it is essential to obtain high coverage of this vaccine in particular, and so this is a particularly important indicator of the performance of an immunisation programme (22-24). In 2015, only 50% of upper-middle-income countries reached the 90% coverage target for the second dose of the measles vaccine, with noted variation among and within WHO Regions and countries (21).

The South African EPI was initiated in 1995, and the schedule initially covered the six diseases included in the original global EPI (25). However, it has been adapted to include vaccines that have since become available, and which have the potential to have a significant public health impact in South Africa (25). The schedule now stipulates that children under the age of one year should receive vaccinations for the following 10 conditions: tuberculosis, poliomyelitis, rotavirus, diphtheria, tetanus, pertussis (also known as whooping cough), Haemophilus influenza type B, hepatitis B, pneumococcus and measles (26). Vaccination is free of charge at government-run clinics and community health centres, while the private sector provides the service for a fee (27). As South Africa is a middle-income country, it is not eligible for support from the Global Alliance for Vaccines and Immunisation (GAVI) (28). The GAVI Alliance has a mission of leveraging support from a wide range of private and public sector agencies, to increase access to vaccines, particularly in lower-income countries (29). This support includes the provision of vaccines and the strengthening of national immunisation programmes (29).

1.3 Problem statement

In 2016, the WHO and the United Nations International Children's Emergency Fund (UNICEF) estimated that South African DTP3 vaccine coverage was 66% and measles first and second dose coverage was 75% and 70% respectively – demonstrating vaccine coverage rates well below the national targets of 90%, set by the GVAP (30).

According to unpublished records provided by the Gauteng Department of Health (GDoH), vaccine coverage estimates for children under the age of one year in Tshwane District were not optimal at the sub-district level. A representation of these unpublished records dating back

to 2013, is presented in Figure 1.1, and in Appendix II. This figure shows that while some sub-districts reported vaccine coverage indicators over 100% (dashed line), others consistently reported coverage indicators below the target of 90% (solid line). Sub-districts four and six had not reached the 90% target once in the period between 2013 and 2017, with only sub-districts three and five having consistently achieved the target. The estimates for sub-districts three and five were not without concern, however. These two sub-districts had estimates consistently over the 100% mark, which is not a rational figure. This figure demonstrates the high level of variability that existed between the seven sub-districts in Tshwane and indicates that there may have been challenges in the delivery of the EPI programme and in the process of vaccine coverage estimation in Tshwane District. The GDoH expressed concern about the vaccine coverage estimates for Tshwane not being optimal and approached the School of Public Health at the University of the Witwatersrand to assist with conducting research, with a meeting being held on 7 August 2017 at the School of Public Health (31).

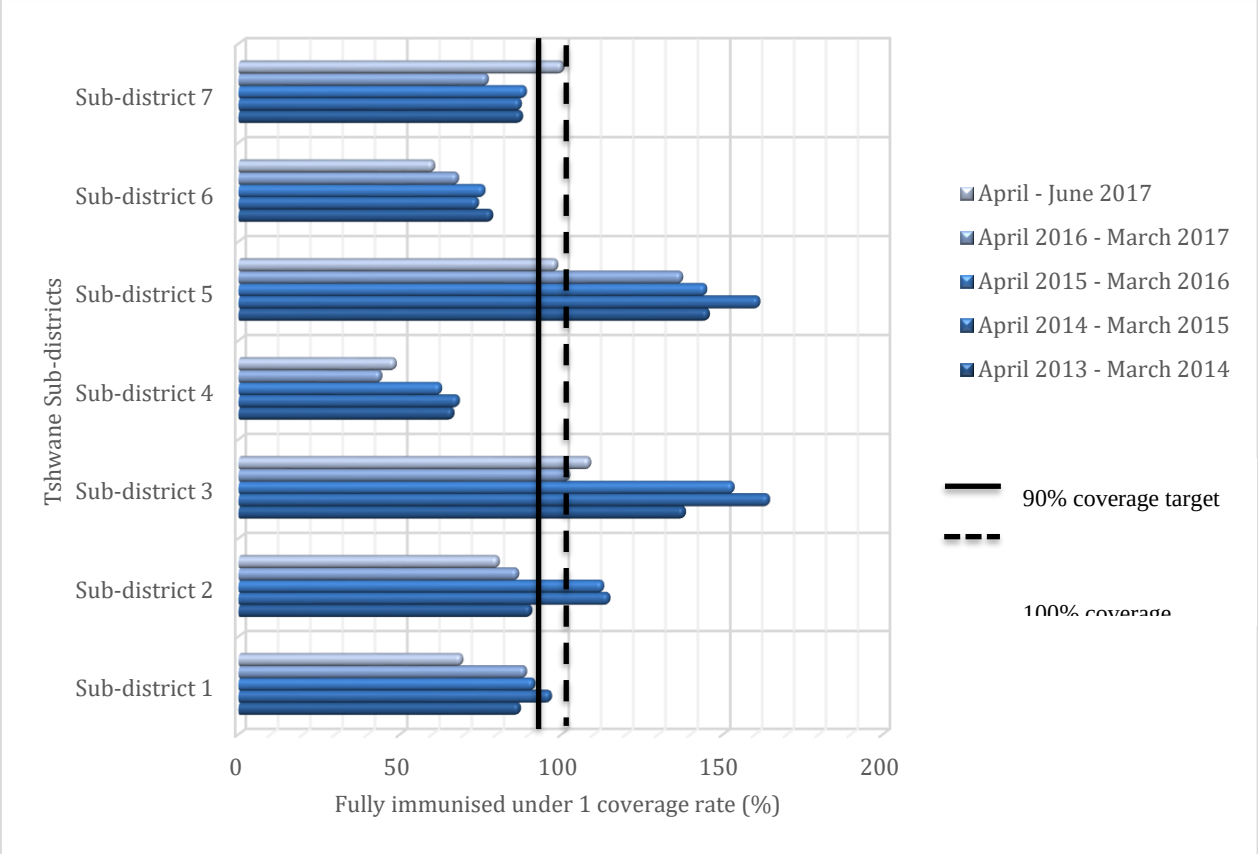


Figure 1.1 Bar chart showing vaccine coverage in Tshwane, by sub-district

1.4 Research question

What factors influence vaccine coverage in Tshwane District, Gauteng?

1.5 Aim

To explore the factors that influence vaccine coverage in children under the age of one year, in Tshwane District, Gauteng, South Africa.

1.6 Objectives

The objectives of the study were:

1. To explore the perceptions of EPI nurses, Ward-based Outreach Teams (WBOTs), facility managers and sub-district, district and provincial managers on the barriers and facilitators of vaccine coverage for children under one year, in Tshwane District.
2. To investigate how vaccine coverage estimates are derived for the sub-districts within Tshwane District.

1.7 Justification

Immunisation is an important public healthcare intervention. It is, therefore, crucial to ensure that coverage of the EPI programme meets the target of 90% set, to prevent outbreaks of vaccine-preventable diseases. In South Africa, optimal vaccine coverage is particularly important, in the context of the Human Immunodeficiency Virus (HIV) epidemic in the country. As Obaro et al noted, individuals with HIV may be more vulnerable to vaccine-preventable illnesses. However, protection can be attained through high immunisation rates in the population (32). According to Statistics South Africa (Stats-SA), an estimated 13.1% of the South African population was living with the disease in 2018 (33). It has been shown that vaccination of HIV positive children results in reduced levels of the desired immune response compared with sero-negative children (32). High prevalence of HIV may, therefore, result in reduced efficacy of vaccines and resultant lower population immunity to a pathogen (34).

Thus, given the sub-optimal rates achieved for vaccine coverage in Tshwane District, there was a need to investigate the barriers and facilitators to achieving the set targets. There had been no formal or systematic investigation into the factors that influence vaccine coverage in the context of Tshwane District, which would be required prior to developing strategies to improve vaccine coverage in the district.

The information resulting from the study was directly related to the two objectives. The systematic exploration of the factors that influence vaccine coverage in Tshwane, and the investigation into the methods used in the derivation of the vaccine coverage estimate, provided insight into the coverage indicators that were being obtained in Tshwane at the sub-district level. Using these results, recommendations to improve vaccine coverage in Tshwane were then made, which were expected to be of value to the GDoH.

1.8 Literature review

1.8.1 Factors influencing vaccination coverage

The Global Routine Vaccination Coverage (2015) Report stated that commitment from governments, as well as collaboration with multiple immunisation partners globally, was a major factor in reducing the number of children that were not fully immunised to an all-time low of 19.4 million (21). In a report of the status of the world's vaccines and immunisation, the WHO cited the weakness of health systems to be a major contributing factor of sub-optimal vaccine coverage in many developing countries (35). This was particularly apparent in sub-Saharan Africa, with weak monitoring and information systems, shortage of skilled healthcare workers, as well as variability in coverage of healthcare services found to be features of a weak health system, which impact vaccine coverage (35). Additional factors that influence vaccine coverage cited in this report included the logistics of the delivery of vaccines, in terms of stock management and infrastructure; the understanding of the importance of immunisation by both the healthcare workers and the community being served, and the need to secure additional funding to increase coverage in order to meet the targets (35).

Favin et al conducted a review of literature relating to reasons for under-immunisation in low- to middle-income countries. This review included a total of 126 studies and reports, conducted at national, sub-national and district levels, with the majority (53.9%) from the African region (36). It noted high variability in the factors determining the vaccination-status of a child, depending on location and setting, with a lack of generalizability of these factors from one country to another (36). This was confirmed by the WHO, with the 2017 Assessment Report of the Global Vaccine Action Plan recognising that a customised approach to the assessment of factors influencing the performance of immunisation programmes is required, due to variability from country to country with regards to reasons for low vaccine coverage (37). This

provided substantiation for the study as a contextual investigation was required to establish the factors that influence vaccine coverage in a given setting.

A case study in Uganda, by Rwashana et al, used systems dynamics and a mixed methods approach to analyse the immunisation system (38). Causal loop diagrams were developed to facilitate understanding of factors that influence vaccine coverage, using data collected from staff involved in the national immunisation programme; from staff at the district level; and from caregivers accessing the service (38). Much of the analysis focused on demand-side challenges, exploring reasons why the community may or may not choose to access the immunisation service. Issues that were highlighted included the 'level of immunisation awareness'; 'level of safety of health workers' that influenced caregivers' trust in the intervention (38). While this analysis highlighted the need to explore issues that affect the uptake of and access to EPI services, it did not provide explore factors that influence vaccine coverage from the health system perspective, as the present study aimed to do. Uptake issues were nevertheless explored in the present study, from the perspective of those delivering the intervention.

An audit of EPI programme managers' views on the key challenges facing the programme, as well as their recommended solutions, was conducted in South Africa, with data collected between 2009 and 2010 (39). The key challenges highlighted were linked to insufficient knowledge of vaccines and immunisation among healthcare workers; insufficient human and financial resources; and demand-side issues relating to vaccine hesitancy (39). A systematic review was conducted for the solutions that participants had recommended, to augment the study findings. The purpose of the audit was initially for programme evaluation and management, with the researchers identifying the utility of publishing their results after data collection had taken place (39). This may be the reason that the study sample was limited to EPI programme managers at the national and provincial levels. The implication of this limitation is that perspectives from other personnel involved in the EPI programme, such as data managers and those involved in service delivery at the facility level, were omitted. Focusing on the national and provincial levels provides useful evidence on challenges faced broadly in the country. However, challenges specific to Tshwane, which have led to the sub-optimal sub-district vaccine coverage levels, could not be identified from this study. Additionally, the study focused on the challenges faced in the EPI programme, with no identification of facilitators of the programme, which could be built on and replicated in the areas of the programme facing challenges.

1.8.2 Vaccine coverage estimation

There have been numerous evaluations of the quality and validity of vaccine coverage data in low- and middle-income countries – with some of these evaluations placing a focus on African countries. These evaluations have found vaccine coverage monitoring systems to be weak in most African countries (40-42).

Cutts et al noted that the quality of local vaccination data was low in many countries, adding that the variability of reporting by private practitioners may have played a role in the quality of the data included in the numerator of the estimate (43). Importantly, it was found that the population estimates that form the denominator of the coverage estimates are often inaccurate, as they frequently fail to accurately account for factors such as migration (41, 43, 44). It was acknowledged that inaccuracy in target population estimations, resulting in over- and under-estimation of administrative coverage, was a limitation to the findings of the Global Routine Vaccination Coverage (2015) Report (21). Thus, the derivation of population estimates for children under one was a factor explored in the context of vaccine coverage in Tshwane.

An assessment of the validity of reported vaccine coverage in 45 countries, not including South Africa, compared vaccination data from Demographic and Health Surveys (DHS) to the officially reported national data (45). This study found that officially reported rates of vaccine coverage were higher than those estimated using DHS data, with the discrepancy increasing with higher reported coverage rates (45). This led to the conclusion that officially reported data may not be able to accurately reflect changes in vaccine coverage rates over time. One of the key factors, leading to this uncertainty in officially reported data, was the weakness found in health information systems, that resulted in the poor quality of the data that is transmitted from the points of service delivery, to the central data management systems (45). This study called for further exploration into factors that explain discrepancies in official data, including the management of immunisation programmes and health information systems, which is a gap that this study aimed to address, in the context of Tshwane District (45).

Dietz et al. described several factors to consider when using the ‘doses administered’ method to assess vaccine coverage, as was the case in routine monitoring of coverage in the South African setting (44). These factors included the possibility of children over the age of one year receiving a vaccination and being included in the numerator of the coverage estimate incorrectly. Additionally, it was found that errors in coverage estimation may arise from children accessing vaccination services outside of their area of residence (44). Thus, the ‘doses

administered' method requires an emphasis on data management – with a high quality of local information on vaccine doses administered being necessary to achieve accurate vaccine coverage estimates (44). Thus, data management was a relevant factor to consider in the exploration of the context of vaccine coverage in Tshwane District.

Reviews of the South African health information system have been reported in the South African Health Review of 2011, as well as in the Health Information Audit Report. Both of these reports found that there were insufficient human resources for adequate functioning of the system (46, 47). Persistent policy and leadership challenges were noted in the Health Review, with poor alignment between key indicators that were being measured, and the health sector objectives (47). Additionally, the Health Information Audit found that while most staff had access to computers, many of these computers did not have the requisite hardware or software to perform the tasks required for the health information system (46).

1.8.3 The Consolidated Framework for Implementation Research (CFIR)

The CFIR, first described by Damschroder et al in 2009, is useful in the exploration of the barriers and facilitators of the implementation of an intervention (48). Broadly, the framework relates to characteristics of the intervention; how the intervention has been implemented and by whom; and the setting in which it is implemented, both within and outside of the organisation charged with implementation (48). The five domains of the CFIR, as well as the constructs within the domains, were used to structure the investigation and analysis of themes emerging of barriers and facilitators to vaccine coverage in Tshwane District. The CFIR Research Team has provided tools to facilitate research using the CFIR. One of these tools is a table with all of the constructs within the five domains of the CFIR, along with a description, which is presented in Appendix III. (49). A summary of the aspects relating to each of the five domains are presented in Figure 1.2, and this summary is expanded upon in the rest of this section.

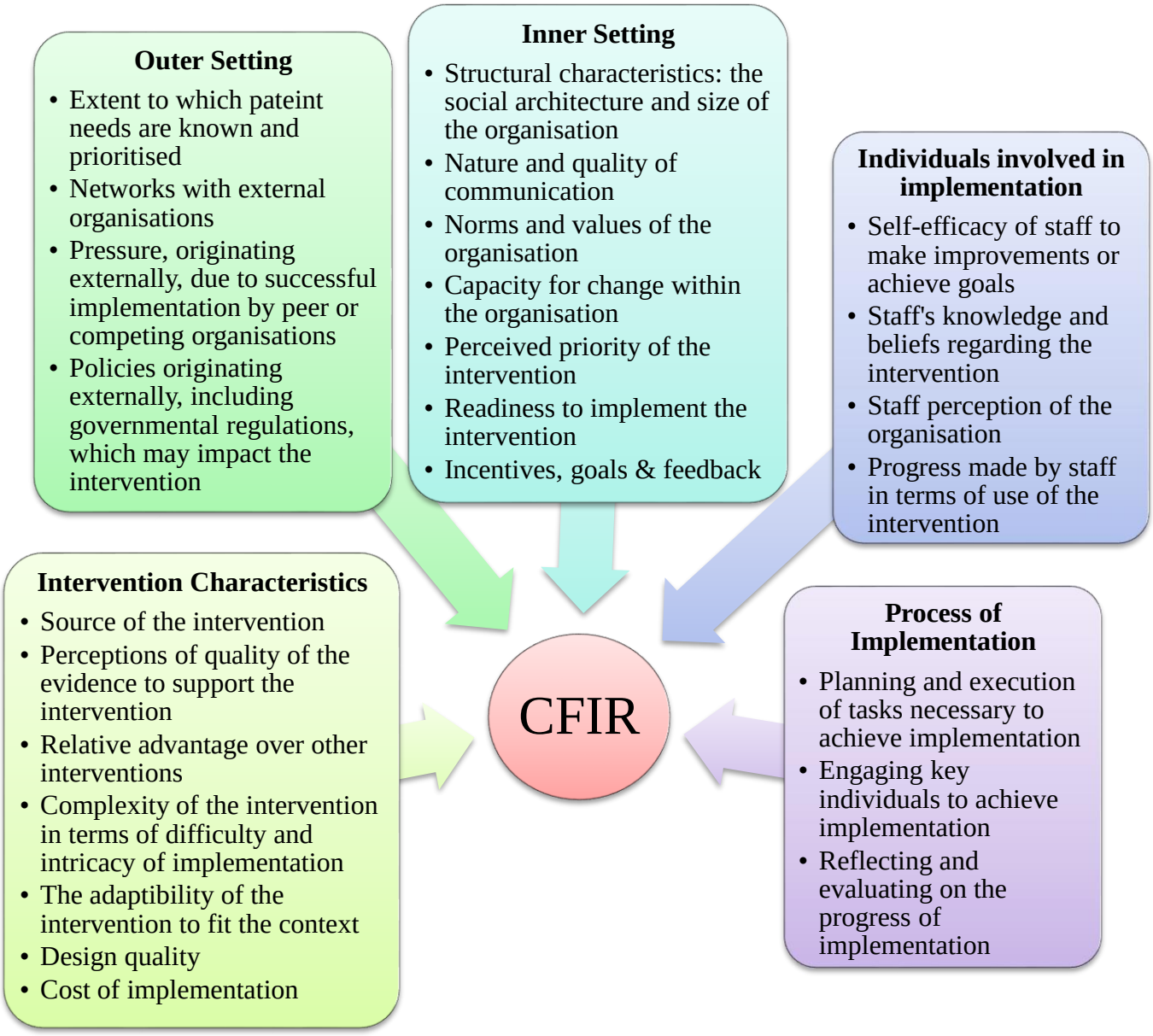


Figure 1.2 The five domains of the CFIR (48, 49)

The first domain described in the CFIR is the intervention characteristics (48). This domain explores the core components required for achieving vaccine coverage targets. It also explores aspects of the EPI programme that have been tailored successfully for the local context, and which aspects do not fit well with the context of Tshwane District.

The second domain described in the CFIR is the outer setting; which pertains to the economic, political and social context in which an intervention situated (48). This is further unpacked by exploring the policies that originate from an external source that affect the implementation of

the EPI programme, and the derivation of vaccine coverage rates. Additionally, the consideration of patient needs and resources in the way in which the EPI services are delivered will be important to explore (49).

The third domain laid out by the CFIR is the inner setting, which has a dynamic relationship with the outer setting (48). Structural characteristics of the organisation, which is charged with implementing the intervention, includes the social architecture, maturity and size of the organisation, and is a key construct of the inner setting (48, 49). The nature and quality of communication within and between facilities delivering the EPI service, the Tshwane District Department of Health, and the GDoH would also be important factors to explore in the inner setting domain (49). Also included in this domain are the implementation climate and tension for change of the organisation; these would be explored in terms of the extent to which the achievement of optimal vaccine coverage is expected, supported and rewarded within the organisation (49).

The fourth domain in this framework is the characteristics of the individuals involved in implementing the intervention, in this case, those involved in the EPI programme and those involved in estimating vaccine coverage rates (48). The level of agency of those involved in implementation as well as how meaningful the desired outcome of the intervention is to these individuals provides context to the performance of individuals in the implementation of the intervention.

The fifth and last domain is the process of implementation (48). In order to unpack this, the different components of the intervention, as well as the different levels of the organisation at which they occurred, would need to be studied. This will include the aspects that pertain to the completeness of reporting of vaccine coverage, such as the capturing of all vaccinations administered at a facility. Constructs such as execution; engaging the relevant stakeholders both within and outside of the organisation, as well as evaluation of implementation are relevant to explore as part of this domain (49). Thus, this framework would facilitate a comprehensive exploration of the barriers and facilitators to obtaining optimal vaccine coverage in Tshwane District.

1.8.4 Application of the CFIR in previous studies

The CFIR has been applied previously to the exploration of several healthcare interventions in various settings. Multiple studies have shown the applicability of this framework in guiding qualitative data collection and analysis in order to identify barriers and facilitators to an intervention (50-52). The CFIR has been found to provide structure and scientific rigour to a qualitative research project, in order to produce results that can be translated into actions to increase the effectiveness of the implementation of a healthcare programme (50, 52, 53).

The interventions that have been explored using the CFIR in this way include: the Comprehensive Primary Care initiative in the United States of America (USA); data quality improvement strategies in three sub-Saharan African countries; a health coaching intervention in the United Kingdom and a falls prevention strategy in Austria (50-53). In evaluating the implementation of electronic consults as an alternative to in-person appointments for speciality care in the USA, Haverhals et al noted an additional use of the CFIR – to enable synthesis with the findings of other studies, which allows for common patterns of the determinants of implementation to be identified (54).

In terms of the application of the CFIR to the implementation of immunisation interventions, Selove et al used this framework to conduct a qualitative analysis of interviews with community healthcare providers regarding the implementation of the Human Papillomavirus (HPV) vaccine programme (55). This analysis involved the coding of barriers and facilitators of HPV vaccination implementation, and the results suggest that the CFIR can assist in planning the implementation of strategies to increase vaccine coverage, and once again showed the applicability of the CFIR to qualitative research (55). The HPV vaccine is not administered to children under the age of one year (26), thus this intervention is different to the one being explored in the present study, however, Selove et al demonstrate the applicability of the CFIR to an intervention with the complexity of immunisation programmes. It must be noted that this study was conducted in the USA, which is likely to have different contextual and systems-level factors compared to South Africa (55). This is largely due to the disparity in the economic development of the two countries, and the differences in the two healthcare systems. Thus, the application of the CFIR to achieve the aim of the study and explore the factors that influence vaccine coverage in Tshwane, South Africa was novel.

Chapter 2. Methods

This chapter describes the methodology employed in achieving the objectives of the study. It presents the study design used; how the study was carried out; the management of the data; the measurement limitations of the study, and the analysis methods applied. Lastly, the ethical considerations of the study are discussed.

2.1 Study Design

A cross-sectional exploratory qualitative study design was used to achieve the objectives. Exploratory study designs can contribute to the understanding of complex relationships and phenomena that are not well understood, such as the implementation of the EPI in a given context (56).

2.2 Study site

Tshwane District is one of five districts in Gauteng Province and is situated in the northern part of the province. It is demarcated further into seven health sub-districts, each of which provides estimates of vaccine coverage to the District and Provincial Offices (7). The study was conducted at the places of work of all participants and at the facility that was identified, in consultation with a district manager. The offices of managers and sub-district coordinators involved in the EPI programme in Tshwane District were located at the Tshwane District office, with the exception of the area managers, whose offices were located within their sub-districts, according to personal communication via telephone on 31 August 2017 with M. Moshime in the Tshwane District Department of Health. The provincial managers' offices were located at the GDoH Provincial Office. Thus, one healthcare facility; the Tshwane District office; the offices of the area managers, and the GDoH Provincial Office comprised the study sites.

2.3 Study population

Personnel involved in the implementation of the EPI programme in Tshwane District, including those at the facility, district and provincial level, comprised the study population to address Objective 1. Staff involved in the estimation of vaccine coverage indicators at the district, provincial and national level comprised the study population to address Objective 2. Personnel at the national, provincial, district and sub-district level who had been employed in their position for a minimum of one year as of January 2018 were considered as eligible for

the study. This was to ensure that the personnel included in the study had had sufficient exposure to the process of vaccine coverage estimation and thus ensure they were able to provide appropriate insight into the areas of interest of the study. At the facility level, due to the routine rotation of clinical staff, those involved in the EPI programme at the time of data collection were eligible. In order to preserve the anonymity of the participants, particularly for those with unique roles in the health system, the participants were grouped according to their designation regarding their involvement in the EPI programme: Senior Managers, Managers, Implementers, and Implementers who participated in the Focus Group Discussion (FGD). A description of the roles of the key-informants, as related to vaccine coverage in Tshwane, can be found in Appendix III.

2.4 Sampling

Table 2.1 displays the structure of the study population, that is, staff involved in the management and delivery of vaccine services and data management in Tshwane District.

In total 15 staff were purposively sampled as key informants based on their expertise and insights into factors that could influence vaccine coverage among children, and eight WBOT members were recruited for a Focus Group Discussion (FGD). Potential participants were sent invitations to participate via email, and appointments were made to conduct the interviews in the same manner. For the FGD, potential participants were approached at the facility to participate in the FGD. The details on the sampling strategy for each objective are laid out in sections 2.4.1 and 2.4.2.

2.4.1 Sampling strategy for Objective 1

After discussion with managers from the GDoH and the Tshwane District Department of Health, personnel with the requisite insight and experience were identified, to address the implementation gaps identified by the GDoH. The sampling was thus purposive, with a view of obtaining as broad a perspective as possible, within the time frame of the study. At the provincial and district levels, there was only one occupant of the positions specified, thus there was no sampling, and the EPI Managers and Health Programmes Managers at these levels were recruited. At the sub-district level, two EPI programme coordinators were selected: the coordinator for Sub-District 1, one of the higher-performing sub-districts, with an average vaccine coverage under one-year coverage rate of 89% between 2013 and 2017, and the coordinator for Sub-District 6, one of the lower performing sub-districts in Tshwane, with an

average vaccine coverage under one-year coverage rate of 78% during the same time period. The area managers for these two sub-districts were also selected to be participants.

Table 1.1 Structure of the study sample

Level of the health system	Role of Participant	Designation of participants
National Level	Senior Manager at HISP* (n=1)	Senior Managers (n=8)
Provincial Level	Provincial EPI Manager (n=1)	
	Provincial Cold Chain Manager (n=1)	
	Provincial Health Programmes Manager (n=1)	
District Level	District Health Programmes Manager (n=1)	
	EPI Programme Manager (n=1)	
	Monitoring and Evaluation Officer (n=1)	
	Data Manager (n=1)	
Sub-district Level	EPI Programme Co-coordinators (n=2)	Managers (n=5)
	Area Managers (n=2)	
Facility Level	Facility Manager (n=1)	
	EPI Nurses (n=2)	Implementers (n=2)
	WBOT** (focus group, n=8)	Implementers (FGD Participants) (n=8)

* Health Information Systems Programme

** Ward Based Outreach Team

At the facility level, one clinic was purposively selected, in consultation with a district manager. This facility was located in Sub-District 6, a low performing sub-district. Including an additional facility, in a higher-performing sub-district would have improved the information collected, and improved the transferability of the results, however, this was not feasible within the time constraints. This is because it would have entailed another layer of three interviews and an additional FGD. The facility in Sub-District 6 was selected as a site where key-informants would likely have knowledge as to the factors contributing to the low coverage rates in this sub-district. The Facility Manager and two EPI nurses were recruited at

this facility to be interviewed, and eight members of the WBOT were recruited to participate in an FGD in consultation with the Facility Manager.

2.4.2 Sampling strategy for Objective 2

Vaccine coverage is calculated using a numerator of the recorded number of fully immunised children under the age of one year, divided by the denominator of the population estimate for children under the age of one year. In order to address the second objective, the derivation of both the denominator and numerator was investigated. To explore how the denominators of vaccine coverage estimates are derived, purposive sampling of staff members within the Health Information Systems Programme (HISP) was done to identify one key-informant. In consultation with the Data Manager of the Gauteng Province, one of the three senior managers at HISP was selected as the appropriate key-informant on the topic of population estimation. To explore the derivation of the numerators of vaccine coverage estimates, the District Data Manager and Monitoring and Evaluation Officer were recruited.

2.5 Data Collection

This study was carried out from March to May 2018. In order to collect the data from the participants, key-informant interviews were conducted. The CFIR was used in the development of the interview guides to ensure a systematic approach to data collection. This ensured that the five domains of the framework were accounted for in terms of eliciting the participants' perceptions of barriers and facilitators of vaccine coverage. *A priori* knowledge on the numerators and denominators of the vaccine coverage estimates informed the questions pertaining to the derivation of the coverage indicators. The questions were structured so as to be open, reducing the risk of introducing bias in the responses, and allowing for participants to answer as they saw fit, to facilitate the emergence of their perceptions as key-informants. Probes were included to encourage greater detail in responses from participants.

Different interview guides were used for the different staffing levels, in order to elicit information most pertinent to each role (Appendix IV – IX). The FGD guide and the guide for the interviews with the EPI nurses differed only in that questions were not posed to the WBOT that pertained to data collection and the role of the private sector. The guides used for managers at the facility, sub-district, district and provincial levels were the same in substance, with only minor changes in wording. The guides for the interviews with the Data Manager, Monitoring and Evaluation Officer and the Senior Manager at HISP were structured to focus on aspects

relating to the derivation of the vaccine coverage indicators. Although key-informants were selected to participate in the study based on their familiarity with the topic covered by either the first or the second objective; questions pertaining to the delivery of the EPI service to achieve vaccine coverage, as well as questions pertaining to the process of the derivation of vaccine coverage estimates, were directed to all participants in order to obtain as broad a perspective as possible on all issues. Additionally, recommendations for improvement were solicited from each participant. Table 2.2 summarises the data collection methods, by objective and participant.

A pilot test of the interview guide for the district and provincial managers was carried out with a staff member in Tshwane District Department of Health, involved in the EPI programme, but not selected as a participant for the study. Thus, this respondent had the requisite knowledge of the EPI programme to appropriately pilot-test the questions in the interview guide, but the process of conducting the pilot test would not impact the results of the study. This process allowed the primary researcher to practice suitable interview techniques and ensure that the questions in the interview guide were clear, with no ambiguity. Based on reflections of the pilot test, as well as some recommendations from the respondent, some minor modifications were made to the interview guides – predominantly to the probing questions.

The interviews varied in length. The longest interview was conducted over approximately 100 minutes, while the shortest interview lasted approximately 25 minutes, with a mean length of 47 minutes and 37 seconds. The FGD lasted approximately 32 minutes.

The two EPI nurses declined to have their interviews recorded, and thus a scribe was used to capture as much accurate information as possible. For the rest of the interviews, a digital audio recorder was used, and the recordings were transcribed in full.

The FGD and interviews were all conducted in English, with no translator required. Much was observed during the conduction of the interviews and the FGD. The researcher was conscious of the need to maintain open body language, and to maintain neutral facial expressions throughout the interviews, so as to have a minimal effect on the responses of the participants. Participants differed in terms of demeanour and enthusiasm during the interviews. Some participants readily offered detailed answers and even discussed topics not directly enquired into. Where these topics were relevant to the research question, probes were made in order to

elicit further information. This led to these interviews being of significantly longer duration than expected. Through recognition of relevant information brought up by participants, which had not been accounted for in the interview guides, the interview guides were adapted for subsequent interviews.

Table 2.2 Summary of data collection

Objective	Method of Interview	Participants	Interview Theme
1. To explore the perceptions of key-informants of the barriers and facilitators to vaccine coverage	FGD	WBOT	Barriers and facilitators of vaccine coverage
	Key-informant interviews	EPI Nurses	
		• Facility manager • Sub-district EPI managers • Area Managers	
		• District EPI manager and Health Programmes manager • Provincial EPI manager and Health Programmes manager	
2. To investigate the derivation of vaccine coverage estimates	Key-informant interviews	• District Data Manager • Monitoring and Evaluation Officer	• Process of deriving denominators • Process of deriving numerators
		Senior Manager at HISP	

The differences in length of interviews may be explained by the differing levels of engagement of the various participants. Some participants showed a high level of engagement in the interviews, while other participants were more reticent, offering one-worded answers, and showing some reluctance to explain further when probed. This led to these interviews being somewhat shorter than expected. In particular, the nurses were more reluctant to engage in the research process, compared to other participants. From the first contact with these participants to invite them to participate in the study, through to their actual interviews, they appeared unenthusiastic and somewhat apprehensive of the research process. The FGD likewise showed variability in the engagement of the participants. There were three participants who spoke readily, while others required some encouragement. This may be due to the researcher-participant dynamic in this context, with both nurses and WBOT team members potentially

having an impression of the researcher having the ability to exert influence or power over them, potentially leading to reticence. The implication for the findings is that this may increase the risk of social desirability bias, and thus the responses from the FGD should not be considered to be necessarily transferable to other settings.

2.6 Data Management

For all audio recordings, the files were used to produce full transcripts of the interviews. The use of scribes in the interviews with the two EPI nurses optimised the quality of data obtained, as it allowed the primary researcher to focus on the interview, without compromising the ability to note the responses of the participants. Computer-assisted qualitative data analysis was conducted using the NVivo software package. This has added rigour to the analysis of the data, as an audit trail of the process used to code the interview transcripts was produced (57). Additionally, it reduced human error through the use of the search and matrix coding features of the software (57).

2.7 Analysis

2.7.1 Methodological approach

A combination of inductive and deductive techniques was used in the analysis of the transcripts. Pope, Ziebland and Mays (2000) describe inductive analysis as a process of "identifying analytical categories as they emerge from the data", rather than defining the themes using *a priori* knowledge (58). Deductive methodology was described by Kenneth Hyde (2000) as a process whereby the researcher starts with established theory and explores the extent to which that theory applies to a particular context of interest (59).

The influence of the CFIR in the development of the interview guides would be considered deductive, as an established theory was used. Additionally, *a priori* knowledge regarding the importance of investigating the process of the derivation of the vaccine coverage estimates influenced the development of the interview guides, in that questions pertaining to this process were included in the guides.

Deep reading of the transcripts and the use of open coding allowed for the codes and themes to emerge from the data, without a preconceived codebook or set of themes, which is thus inductive analysis (58). This facilitated the inductive development of the analytical

framework, allowing the themes to emerge gradually from the data. Once the themes and sub-themes had emerged, the domains and constructs of the CFIR were applied to the analytical framework, in order to explore the barriers and facilitators to vaccine coverage that had emerged, which once again utilised deductive methods.

The particular approach taken in the analysis was the Framework Method. Gale et al described this approach as a method to systematically organise qualitative data, which can be adapted to utilise inductive analysis, deductive analysis, or a combination of the two, depending on the research question (60). Pope et al described five stages involved in this approach: familiarisation; identifying a thematic framework; indexing; charting, and mapping and interpretation (58).

2.7.2 Analysis process

Familiarisation was done during the transcription process. A research assistant scribed two of the key-informant interviews that were not recorded, with the primary researcher, who was conducting the interview, also taking notes. Immediately after these interviews, the primary researcher then used the notes from the scribe, as well as their own notes, to transcribe the full interview as accurately as possible. Of the remaining 13 key-informant interviews, which were digitally recorded, one was transcribed by the primary researcher. The recording of the FGD was also transcribed by the primary researcher. A research assistant was employed for the task of transcribing the other 12 recorded key-informant interviews. The transcripts completed by the research assistant were audited for errors by the researcher, who read the transcripts while listening to the audio recordings, and made corrections as required. This facilitated familiarisation with all of the transcripts.

Identifying a thematic framework, described as the analytical framework by Gale et al, involved "identifying all the key issues, concepts, and themes by which the data can be examined and referenced" (58, 60). Two analysts, the principal researcher and an independent researcher experienced in qualitative methodology, coded the first three transcripts, independently of one another. The analysts then met to compare and discuss the codes applied to the transcripts and agreed on the set of codes to apply to the subsequent transcripts, known as the codebook. The codes were then categorised with clear definitions of the categories. These categories were then grouped into four themes (with the categories becoming the sub-

themes) and these themes, together with the codebook, became the working analytical framework.

The next step, indexing, involved applying the codebook to all transcripts (58). This was done using NVivo software, reading through the text of each transcript, and assigning relevant codes to each appropriate section of text (61). In many instances, more than one code was relevant to a particular section of the text, in which case, all relevant codes were assigned. The codebook remained flexible and adaptive throughout this process, as new codes emerged.

Once all the transcripts had been coded, and all new codes added to the codebook, the analytical framework was finalised as part of the stage of charting. This stage involved summarizing the data by category from each transcript, and ensuring the codes were systematically allocated to the relevant sub-theme and theme of the analytical framework (60). Where a code was relevant to more than one theme, it was allocated to all relevant themes. This stage was facilitated through the 'matrix coding' function of NVivo, which is a function that allowed the researcher to extract data coded by multiple codes, or attributes, within each transcript.

The fifth stage of the framework method, mapping and interpretation, is described as the process of defining concepts, drawing out the range of the phenomena that have emerged, and finding associations between the themes of the analytical framework, all with the purpose of postulating explanations for the findings and influenced by the original research objectives(58). This was done through the application of the domains and constructs of the CFIR to the themes and subthemes of the analytical framework. A table with a description of the constructs within the five domains of the CFIR, provided by the CFIR Research Team, is presented in Appendix III (49). This process of mapping and interpretation allowed the identification of the barriers and facilitators of vaccine coverage in Tshwane, based both on the CFIR and the themes that had emerged from the data. This then facilitated the conceptualisation of policy recommendations that may improve vaccine coverage in Tshwane.

2.8 Ethical Considerations

Ethical approval for this study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (HREC Wits), the certificate for which is in Appendix X.

Permission letters from the GDoH Research Office (Appendix XI), the Tshwane District Research Office (Appendix XII), as well as from the facility (Appendix XIII) were also obtained. Written informed consent was obtained from all participants in the study; participation in the study was voluntary, and participants were free to withdraw from the study at any time. The request not to record the interview by two participants was respected, in line with the principles of HREC Wits. All other participants consented to the recording of the interviews. All interviews were made anonymous at the stage of transcription in order to ensure confidentiality. Additionally, during transcription identifying information, such as names, was removed, so as to maintain the confidentiality of all involved.

Information sheets (Appendix XIV and Appendix XV) detailing the purpose of the study; how data will be used; how long the data will be kept for, and contact details to be used in the case of the participant requiring further information, were provided to all participants. A separate information sheet for the FGD was required, as the risk of confidentiality being breached by other participants in the FGD needed to be stated. There were two consent forms, one for participation in the study (Appendix XVI) and one for the interviews to be recorded on tape (Appendix XVII).

Chapter 3. Results

This chapter presents key findings regarding the factors that influence vaccine coverage in Tshwane District. The study explored the perceptions of key informants involved in the EPI programme about the barriers and facilitators of vaccine coverage for children less than one year, as well as the derivation of the vaccine coverage estimates, in Tshwane during 2018. Thus, through the use of key-informant interviews and an FGD, the objectives of the study were addressed. The results are presented in terms of the four themes that emerged through the inductive coding and analysis of the interview and FGD transcripts.

Table 3.1 presents descriptions of the study participants as they relate to the level of the organisation that they worked in, and their designation in terms of how their statements will be presented in the results, so as to maintain anonymity.

Table 2.1 Description of study participants

Level of the healthcare structure	Study participants	Designation of participant
Facility level A community healthcare centre in sub-district 6	WBOT	Implementers (FGD Participants) (n=8)
	EPI Nurses: 1 Professional Nurse and 1 Enrolled Nurse	Implementers (n=2)
	Facility Manager	Managers (n=5)
Sub-district level Sub-district 1 and sub-district 6 of Tshwane District	EPI Coordinators: Sub-district 1 and 6	
	Area Managers: Sub-district 1and 6	
District level Tshwane Health District, in Gauteng Province	EPI Manager	Senior Managers (n=8)
	Health programmes manager	
	Data manager	
	Monitoring and Evaluation officer	
Provincial level Gauteng Province	EPI manager	
	Cold chain manager	
	Health programmes manager	
National Level	Senior Manager at HISP	

Study participants for the exploration of perceptions of the barriers and facilitators of vaccine coverage comprised of personnel involved in the implementation of the EPI programme in Tshwane District. This included a WBOT, EPI nurses and a facility manager at the facility level; EPI coordinators and area managers at the sub-district level; the EPI manager, and health programmes manager at the district level; and the EPI manager, cold chain manager and health programmes manager at the provincial level. Study participants for the investigation of the derivation of the vaccine coverage estimates included the monitoring and evaluation officer and the data manager at the district level; and a senior manager of the health information systems programme at the national level.

No socio-demographic characteristics were recorded, as they may have been considered identifiable characteristics, given the limited amount of staff employed in these positions in the district, and were not considered pertinent to the objectives of the study.

The analytical framework, comprising the four themes that emerged, along with the sub-themes of each, are presented in Table 3.2. In broad terms, the first three themes speak to the first objective (the exploration of perceptions of key-informants as to the barriers and facilitators of vaccine coverage in Tshwane), while the fourth theme speaks to the second objective (the investigation of vaccine coverage estimation in Tshwane District).

Table 3.2 Themes and sub-themes of the analytical framework

Theme Name	Sub-themes
3.1 Health systems organisation barriers and facilitators	3.1.1 Engagement of the private sector as a systems-level factor 3.1.2 Communication and interaction 3.1.3 Support for adherence to programme guidelines 3.1.4 Programme priority setting 3.1.5 Mobile clinics
3.2 Human resources for health barriers	3.2.1 Freezing of posts 3.2.2 Integration of services 3.2.3 National campaigns
3.3 Health system infrastructure and equipment barriers	3.3.1 Finances 3.3.2 Equipment and computers 3.3.3 Physical space
3.4 Health information system factors	3.4.1 Routine data collection 3.4.1.1 Data capture, quality and verification 3.4.1.2 Reporting by Private Facilities 3.4.2 Electronic systems 3.4.2.1 Electronic medical records 3.4.2.2 Unique health identifier 3.4.3 Population estimates for vaccine coverage 3.4.3.1 Process of deriving the population estimates 3.4.3.2 Challenges in using census data projections 3.4.3.3 Challenges specific to Tshwane District 3.4.3.4 Challenges associated with migration 3.4.4 Defaulter tracing

3.1 Health systems organisation barriers and facilitators

The first major theme to be discussed is the organisation of the health system as it related to vaccine coverage as both a barrier and a facilitator. This speaks to the perceptions of key-informants regarding barriers and facilitators to vaccine coverage in the context of the organisation, and as such, addresses the first objective of the study.

3.1.1 Engagement of the private sector as a systems-level factor

In the public sector, routine EPI services are delivered at primary healthcare facilities, comprised of clinics and Community Healthcare Centres (CHCs). These services are offered

from Monday to Friday, usually between 8 am and 4 pm. Professional and enrolled nurses, working in the Integrated Management of Childhood Illnesses (IMCI) department within the facility, administer the vaccine doses to children, according to the EPI schedule set by the National Department of Health (NDoH). In the private sector, facilities that offer EPI services include pharmacies, general practitioners and 'baby wellness' clinics. These may offer weekend services or services outside of public clinic hours. These services are offered for a fee, and the schedule offered may differ slightly from the EPI schedule offered at primary healthcare facilities.

In the context of Tshwane District, participants noted that the contribution of private healthcare services may have a larger impact than in other regions of the country, both in terms of barriers and facilitators to vaccine coverage. This was due to a higher proportion of the population in the district making use of the private sector compared to other areas. It was estimated that approximately 30% of the population in Tshwane had medical insurance, compared to the nationwide average of 17%:

> *"It's something like 30%, I mean it's 17% generally speaking countrywide on average but Tshwane has a much larger population, a lot of government employees and a lot of wealthier people, so I think it's closer to 30%."* - Senior Manager 1

Participants engaged with political factors related to the role of the private sector in vaccine coverage. Senior Manager 6 explained that the NDoH had set a priority of working with private providers to deliver EPI services. This was further explained to be due to the role that private providers were seen to play in democracy by providing people with a choice as to where they seek healthcare, particularly in terms of accessing services with shorter queues and waiting times, if they were willing to pay. This consideration was reiterated by Manager 1:

> *"For those that feel that they can't queue, they can't go to the clinic because it's that full, they opt for private providers and for those, that can't, that don't get the days off or anything, they opt for private providers*" – Manager 1

Due to this priority being set at the national level, this participant perceived the role of private providers in vaccination services as a factor "*that we cannot change"* – Senior Manager 2. The role played by the private sector was seen to be a facilitator of vaccine coverage in the district, as it provided vaccination services to those who may otherwise have not accessed the

service. This positive perception of the private sector's influence on vaccine coverage in the district extended to the agreement between Tshwane District and some private providers in Tshwane to report data on vaccinations administered in exchange for free vaccine doses, according to the EPI schedule.

This agreement, as it pertains to data reporting, will be discussed in greater detail in the fourth theme, which refers to the health information system. In terms of the agreement itself, two senior managers described this private-public engagement as a symbiotic relationship, the first saying that the role that private providers play in vaccine coverage in Tshwane was important because of the data supplied by those providers to Tshwane District. However, one participant went on to say that this positive impact had been somewhat limited in Tshwane:

> *"The issue of finances is a problem, we have a lot of private providers who are willing, who are applying and willing to work with us so that we give them vaccines, and they give us the data but because of financial constraints, we can't approve"* – Senior Manager 5

Manager 1 agreed with the sentiment of the limited engagement of private providers proving a barrier for coverage, stating the intention to improve partnerships with private providers in order to improve vaccine coverage figures.

Senior Manager 2 provided some background to a possible reason that approval for engagement with further private facilities had not been approved: The Memorandum of Understanding (MOU) in Tshwane stated that the private facilities were to provide their data on vaccines administered to the District Office. This differed with the agreement in Ekurhuleni and City of Johannesburg Districts – where the private facilities received the vaccines from a facility in their catchment area, and in turn, provided their data to that same facility. This was done so that the data collected by the facilities could be allocated to the correct catchment area.

> *"Tshwane made that mistake; the control is weak with Tshwane. I think they need to change their control, they need to re-enforce the fact that a private provider must receive vaccines in a clinic, local clinic and vaccinate children within the local clinic and report the statistics to the local clinic where she or he received the vaccines… Tshwane differs from Johannesburg and Ekurhuleni with that"* – Senior Manager 2

There were some participants with reservations about the influence of the private sector, particularly in terms of the additional workload resulting from working with private facilities in addition to public facilities. Manager 3 reported that conducting support visits to private facilities, in addition to the public ones, added significantly to their workload:

> *"We are doing like 9 hospitals in Tshwane, yes and then we have private hospitals, all the private hospitals in Tshwane… our clinics which is about 74 clinics and we have got private providers… all these people need our support. Tell me, when do I even go there?"* – Manager 3

At the facility level, participants were of the opinion that patients should not access the private sector for immunisations but should rather make use of public sector healthcare facilities. When Implementer 1 was asked about his/her experience with the contribution of private facilities to the immunisation programme, the participant shook his/her head and said only: *"No."* – Implementer 1. When asked the same question, Implementer 2 also replied in the negative, shaking his/her head: *"No, they must come here"* – Implementer 2.

Thus, managers felt that there is potential for the private sector to make a positive contribution to vaccine coverage in Tshwane, however, this potential was not yet being realised due to the inconsistency of the public-private partnerships across Tshwane District. This was mentioned particularly in terms of provision of vaccines in exchange for data collection and reporting. Additionally, managers were of the opinion that the capacity to support the engagement of private facilities should be ensured.

3.1.2 Communication and interaction

The topic of communication and interaction between staff members involved in the EPI service, at different levels of the health system, was one that participants engaged in readily. Due to the many staff members involved in the EPI service, at various levels, and the interactive nature of this programme, communication was thought to be an important factor in the delivery of the service. Throughout the data collection process the structure of the organisation, particularly relating to the various levels of staff involved in the EPI programme, was observed to be hierarchical in nature. This hierarchy was noted to be accompanied by a

fair amount of emphasis placed on support from the higher managerial levels to the lower ones, through to the implementers of the programme.

Participants reported that their experiences with communication within the organisation were generally as a facilitator for the programme; there were open lines of communication, and multiple methods were employed in communicating with staff members both at a higher, and lower level of the organisation. Face-to-face meetings were often reported, particularly with regards to support visits made by EPI managers, to the facilities. Phone calls, emails, text messages, as well as WhatsApp group messages (a freeware, cross-platform internet messaging service, used on smartphones) were all methods mentioned by participants as useful means of communication. The general perception of communication amongst personnel involved in the programme is represented by a sentiment expressed by one of the Senior Manager 5:

> *"Even the facilities ya, we get along very well. We communicate, we have meetings. If there is a need, ya even at Province where I report, if there is a challenge, I would pick up the phone and call them and say I am having this challenge and please assist."* – Senior Manager 5

Despite this generally positive perception of the communication aspect of the organisation of the health service, there were some challenges that were cited. Participants at three different organisational levels, sub-district, district and provincial, brought up the challenge of decisions being communicated to them, without the opportunity for their input to be made.

In one such instance mentioned by a senior manager and two managers, a decision was taken by the NDoH to remove the defaulter tracing register. This instance was raised unprompted by participants. This register was explained by participants to have had the purpose of noting the names, addresses and contact details of infants who were due to receive a particular dose of the EPI schedule in a given week, but had failed to present to the clinic to receive the dose. This enabled community healthcare workers to follow up with the infants' caregivers, and encourage them to attend the clinic, or to note cases where the infant had received the dose in a different facility and was thus up to date with the schedule. The removal of this register was done as part of a broader process known as the "rationalisation of registers". This was a process of consolidating various individual registers in use at facilities, into one register, the

Comprehensive Tick Register, in order to simplify and reduce the administrative tasks of the nurses in the facilities. However, managers at the provincial and district levels were not afforded the opportunity to make known their opinions on the matter, resulting in the Comprehensive Tick Register not being structured to be able to accommodate the functions of the Defaulter Tracing Register:

> *"Maybe if programs could have been consulted so that I come and I say… can we not lose the EPI register and the defaulter tracing register, it would have been easier. But now we were just told "we are rationalizing the registers", so no other register is allowed, only the tick-sheet is allowed."* – Manager 3

Senior Manager 3 felt that a barrier to improved interaction between the implementers of the EPI programme was the fact that WBOTs were not fully incorporated into the health system, and were instead paid stipends, and thus seen as functioning outside of the health system. This was perceived as a barrier to the WBOTs being able to function optimally, as the integration of these teams into full-time work would better enable them to find missed opportunities for immunisation in the community:

> *"Let's use the WBOTs maximally… WBOTs must not be paid stipends, they must form part of the mainstream... if they can be fulltime integrated into primary healthcare and be able to access the benefits as well, that will also help. Then they are able to go out there, you know, and find these children for us."* – Senior Manager 3

3.1.3 Support for adherence to programme guidelines

Support provided to EPI staff to facilitate adherence to the guidelines and protocols of the programme was another sub-theme of the organisation of the health system. Manager 4 drew the distinction between responsibility and support provision when speaking about their role:

> *"Everything, functionality of the facility, functionality of the programme… everything, that is all the systems that are there in the facility, I am not responsible, I am supporting... Because I can't do that on my own, I am supervising, supporting the functionality of the system in the department."* – Manager 4

This support was generally spoken about as a facilitator to the service and included support visits, directives, guidelines, training, as well as following up on problems with the health

information system. Data review processes in the district, discussed in more depth in the fourth theme, were also spoken about in terms of being part of the support structure for the EPI service, as they provided the forum to:

> *"…advise the facilities on how to do it better"* – Manager 1

The availability of support in the form of advice and consultation provided to EPI nurses when having to administer catch-up doses of the EPI schedule was also spoken of in a positive light. This support was seen as necessary due to the catch-up EPI schedule differing from the routine one, due to certain vaccines not being suitable for administration to children over a certain age.

The working relationship between the sub-district EPI coordinators and facilities was also described as an example of the functionality of the support system within the programme.

> *"For us, it's easy because we have got the support from the district, we have got a good relationship with local authority, we work together and then the district health system is there supporting us, we have got… they are following up with the indicators, the health information systems"* – Manager 1

However, some challenges were mentioned regarding this structure. Senior Manager 2 described non-adherence to guidelines and protocols as a barrier:

> *"We conduct monitoring and evaluations to see if there* (is) *adherence to the protocols, the guides and all that. It's just that people they tend to do what they want to do on their own, not following what they are being told"* – Senior Manager 2

Additionally, a senior manager reported having had to use national guidelines to develop standardised training manuals, to conduct training sessions with staff at the facilities on cold chain management, adverse events following immunisations and vaccine-preventable diseases. This is contrary to training for other health programmes, such as the Prevention of Mother to Child Transmission of HIV (PMTCT), where standardised training manuals were provided to the district managers by the provincial management structure. The annual EPI refresher course conducted by the province was deemed not to be good enough due to the high number of facilities:

"We are doing the training. Ourselves and my colleagues, the coordinators from this other district, we do our own training, we develop our own training material because the province doesn't have a standardized training material… once in a year they do provide (an) *EPI refresher course, for the district but it's not good enough because we are having a lot of facilities… PMTCT is well organized… There is a standardized PMTCT training manual"* – Senior Manager 5

3.1.4 EPI stakeholders

The organisation of the health system also included several other stakeholders involved in the EPI service, with the WHO and UNICEF being the most frequently mentioned. Most participants felt that overall, external stakeholders facilitate the service, particularly in terms of guidelines for the schedule; however, there were participants who felt that the WHO and UNICEF should have played a bigger role in the delivery of the EPI service, particularly with regards to funding.

"Even WHO, they just recommend, give you recommendations, give you advisory support you know those kind(s) *of system-support, but they don't come with monetary (support)"* – Senior Manager 5

It was also mentioned that other Non-Governmental Organisations (NGOs) facilitated EPI services, particularly in the vaccination campaigns. Some participants regarded the pharmacies as important stakeholders in the EPI programme, with these participants having generally favourable opinions of the impact of pharmacies on the programme. Traditional leaders were mentioned as stakeholders by two managers that were interviewed, as they were seen to have influence in the community:

"If the traditional leaders can advocate for EPI as well, that can help because remember the traditional leaders they have the consultations with the community… and when they talk, they have that influence" – Manager 1

Similarly, clinic committees were mentioned as a stakeholder in the EPI service, within the community. Senior Manager 3 described clinic committees as the people selected to serve in the clinic as representatives of the community. They were a medium through which messages could be sent to the community. This participant felt that this opportunity was not being used to its full potential:

"*Those are some of the resources that we need to tap in to, to help us as a stakeholder."* – Senior Manager 3

Thus, both the traditional leaders and the clinic committees were not perceived to be facilitators of the programme currently, but rather as having potential to be facilitators.

3.1.5 Programme priority setting

Priority setting of healthcare programmes was another sub-theme related to the organisation of the health system. The tension between prioritising patient management or data quality for the EPI nurses at the facilities was a concern among participants. The general perception was that the nurses place a higher priority on patient management, and thus may devote less time to administrative tasks, including recording the doses of vaccines administered correctly in the Comprehensive Tick Register.

> *"And anything that requires writing, they don't want it. And they tell you... we are here for the patient, not for your papers. So, they would rather prioritise seeing the patient and not ticking."* – Senior Manager 6

There were mixed perceptions among participants regarding whether there was enough priority placed on the EPI service as a whole. Some participants felt that the value placed on EPI was high, however, challenges such as staff shortages, and competing priorities due to the integration of services, remain. Staff shortages and resource constraints were reported to be reasons behind senior managers having to spend a disproportionate amount of time on the EPI service, particularly in responding to complaints.

> *"In terms of value, and importance, it's high in the hierarchy, but in terms of staffing, it is the least staffed... Let me say about 5 or 6 of the complaints that we receive… are EPI-related but at the same time, the staffing is poor. You could see the programs that I handle, most of the time… because of the resource constraints… I spend my time with EPI."* – Senior Manager 4

Others, at various levels of the organisation, from the facility level up to the provincial management level, felt that more value should be placed on EPI. Implementer 2 said that this would be required in order to reach the vaccine coverage targets. Several other participants felt that other health programmes received the bulk of the Department of Health's priority,

based on funding. This was particularly true of the HIV/AIDS, Sexually Transmitted Diseases and Tuberculosis (HAST) programme:

> *"Not valued enough. Not valued enough. You know I think everywhere now HIV is taking priority… I think from national level… if the way they advertise HIV, they could advertise immunisations, the importance of immunisations then that would be something. I mean everything is about HIV and circumcision now… where is EPI now?"* – Manager 1

Senior Manager 5, however, noted the potential for the facilitation of the service through priority-setting, as there were discussions on diverting some of the resources away from HAST and towards maternal and child health programme, of which the EPI service forms part.

> *"I think as a department we focus on HAST and other programs suffered like your non-communicable is suffering… but last week at the district management reviews, there was this, uh, discussion that let's re-channel the resources to maternal and child health… it's at a discussion level"* – Senior Manager 5

Thus, in general, participants felt that the EPI service would benefit from being seen as a higher priority programme, particularly with regards to funding and staffing levels.

3.1.6 Mobile clinics

The final sub-theme related to the organisation of the health system was that of mobile clinics used for outreach services to the community as part of routine immunisation. This was predominantly discussed in the FGD with the WBOT. Participants explained that they conduct home visits to identify possible missed opportunities for immunisation. However, as they are not capacitated to administer vaccines, they have to refer the caregivers to the facility to access the EPI service. Multiple participants within the group expressed the opinion that if nurses were able to use mobile clinics to administer the vaccinations in the community for those referred to the mobile clinic by the WBOT, it would improve access to and uptake of the service. There were multiple reasons expressed by participants in the FGD, and by the EPI nurses in the interviews, for lack of access to facilities. These included financial barriers; apprehension regarding staff attitudes and foreign nationals' apprehension of being turned away.

> *"When they skip the date, they are afraid to come back to the clinic… I think… When they will give us, maybe, our sisters they will give them mobile clinic*(s)*. We will win*

with that in the community because we are entering the house, each and every house" – Implementer (FGD Participant) 4

3.2 Human resources for health barriers

The second theme related to the barriers to vaccine coverage in Tshwane associated with human resources for health shortages. This theme emerged as the challenges faced due to poor staffing levels, with regards to the managerial staff at the district and sub-district levels, as well as at service-delivery staff at the facility level. This speaks to the perceptions of key-informants regarding barriers to vaccine coverage in the context of human resources, and as such, addresses the first objective of the study.

Participants at all levels of the EPI service cited staffing levels as a significant challenge. Three policies originating externally of the Tshwane District Department of Health, from either the NDoH or the GDoH, emerged as human resource for health barriers, influencing vaccine coverage in the district: the freezing of posts for the GDoH; the IMCI policy; and national catch-up vaccination campaigns. The exception to the perception of human resource barriers came from the WBOT, with a participant in the FGD stating "*no, the staff, is I think we… we're fine"* – Implementer 3 (FGD Participant), with the general consensus among the other participants in the FGD.

3.2.1 Freezing of posts in the GDoH

A shortfall in the GDoH budget was perceived by several participants to be the reason for the freezing of posts at all levels in the provincial health system. This policy prohibited the opening of new posts, as well as the recruitment of staff into positions that had been vacated through resignation or retirement.

"You will find that a facility has a high level of either resignations or retirements, people going on retirement and when you try to motivate for replacements, there is the moratorium to say currently we don't have money" – Manager 5

Implementer 1 was frustrated by the lack of agency given to managers in Tshwane to reduce the impact of human resource barriers at the facility level.

"The numbers are quite huge (gesturing to the register on her desk), *you can see here, 156 in one day. But we are only two… We are tired and can even be depressed. But*

when we talk to managers, to say we are overworked, they say there is no staff…. And the problem isn't here, it's at National and Government. There are no finances." – Implementer 1

Of further significance with regards to this policy, was the resignation of sub-district EPI coordinators without replacement. In Tshwane, some coordinators had to cover more than one sub-district, as there were less than seven coordinators, having to cover seven sub-districts. Even personnel integral to the management of the EPI programme in Tshwane would not be replaced, should they resign:

"*They are not even hiring any new people, if I leave today, and get another job, they won't replace my post… so even posts are not replaced*…" – Senior Manager 5

3.2.2 Integration of services

Policies mandating the integration of services at the facility level, such as the IMCI, was cited as a reason for the increased workload at the facility level by Manager 5:

"S*o, more programs are added, or sub-programs are added to the existing programs and human resource is not considered"* – Manager 5

3.2.3 National Campaigns

These are outreach campaigns that are conducted in the community to supplement routine EPI services offered at the primary healthcare clinics. They consist of national campaigns conducted approximately every four years, as well as campaigns organised in response to outbreaks of vaccine-preventable diseases. Campaigns are conducted at crèches, pre-schools, primary schools and, occasionally, at high schools if deemed necessary. Participants, particularly in Tshwane Sub-District 6, reported that these vaccination campaigns exacerbated the existing staffing challenges, due to personnel delivering routine EPI services having to conduct the campaigns, thus placing strain on the routine EPI service delivery.

"The same staff that are supposed to be immunizing at the facilities they are now supposed to go out and do the campaigns because we don't get extra staff from anywhere" – Manager 4

3.3 Health system infrastructure and equipment barriers

The third theme to emerge from the analysis of the data was barriers related to health system infrastructure and equipment. The three sub-themes related to finances; equipment and computers; and physical space. This speaks to the perceptions of key-informants regarding barriers and facilitators to vaccine coverage in the context of infrastructure, and as such, addresses the first objective of the study.

3.3.1 Finances

Participants at all levels of the programme cited many challenges related to financial constraints. Senior Manager 1 indicated that an immunisation survey, to determine more accurate vaccine coverage estimations, was unlikely to be financed by the district, due to competing priorities. Senior Manager 2 also cited financial constraints as a limitation in conducting a study to obtain more accurate target population estimates. Additionally, it was mentioned that a constrained budget at the national level might delay the rollout of the electronic medical record systems, thus delaying potential improvements in the quality of data collected at the facility level:

> *"It's not obvious that there will be a lot of money, I think, for rolling out electronic medical records systems. I think we are most likely talking about a gradual roll-out and at the lowest cost possible if you see what I mean, that in practice that also limits, you know, what you get out of it in the short-term"* – Senior Manager 1

Participants also indicated that financial constraints limited the engagement of private sector healthcare providers in terms of delivering data on immunisations carried out, to the district, in exchange for vaccines provided to the private practitioners (as discussed under Sub-theme 3.1.1). Financial limitations were also considered in relation to the challenges of staff shortages, at all levels of the EPI service – as discussed in the theme of human resources for health barriers.

In contrast to these financial barriers, Senior Manager 2 cited the "*renewed budget"* allocated for cold chain management as a success for the EPI programme. This budget had allowed for the purchasing of fridges and cooler boxes for each facility.

3.3.2 Equipment and computers

Equipment, with particular mention of computers, at the facility level was a factor that was discussed as a barrier in the EPI service. Participants frequently cited the challenge of the data capturer being required to share a computer with the facility manager, as many facilities only had one computer. This lack of computer equipment limited the time that the data capturer had to enter the data from the comprehensive tick register, into the District Health Information System (DHIS). The data capturer only had access to the computer when the Facility Manager was out of the office, which could lead to incomplete data entry and compromised the quality of all indicators, including vaccine coverage. Participants felt that, in order for the data capturers to be effective, space and computers would be required:

> *"When a manager is there, (the) data-capturer is not working… When the manager is away maybe for some few minutes may be doing the rounds,* (the) *data-capturer must capture the data. That in itself is really a disadvantage for us. We need space and we need a computer for the data-capturer"* – Senior Manager 3

3.3.3 Physical space

The physical spaces in which the EPI services were rendered to patients were perceived to be a barrier to the delivery of the programme as they were reported to be inadequate for the purpose. Managers expressed the opinion that more physical space dedicated to the EPI service at the facilities would improve the service. According to these participants, more consulting rooms in which vaccines are being administered would reduce waiting times for the patients, and it would improve the ability of the nurse to attend to the child in totality. If there were more space dedicated to the EPI service within the facility, there would be the capacity to allocate more nurses to the EPI service,

> *"Our structure actually is constraining us… We only have 1 consultation room for EPI. If we had three, with three professional nurses in there, that would actually… reduce the long waiting time. But at the moment, even if I can take three professional nurses to the EPI consultation room, it won't serve any purpose because you will be having three professional nurses there attending to one patient at a time because they need to respect the privacy of the baby"* – Manager 2

3.4 Health information system factors

The theme of the health information system barriers emerged in relation to a number of factors, namely data collection; the use of electronic systems in relation to EPI services; population estimates as utilised in estimation of vaccine coverage; and defaulter tracing, which spoke to the mechanisms available to trace individuals who missed appointments for scheduled immunisations. All of these factors related to the ultimate derivation of the vaccine coverage indicator, and thus this theme primarily relates to the second objective of the study: to investigate how vaccine coverage estimates are derived for the sub-districts within Tshwane District. However, there was some overlap with the first objective, as the discussion of barriers to identifying and vaccinating children that had missed doses of the EPI schedule involves discussion of key-informants' perceptions of barriers to vaccine coverage. There were no facilitators that emerged under this theme

3.4.1 Routine data collection

According to Senior Manager 3, the vaccine coverage indicator was calculated within the DHIS. Vaccines administered by nurses were recorded in the Comprehensive Tick Register, from which the data was captured into the DHIS at the facility by data capturers. Doses administered served as the numerator for the indicator, with the population estimate (for children under one) of the catchment area of the facility serving as the denominator. These numerators and denominators were then aggregated across all facilities within a sub-district in order to obtain the vaccine coverage indicator for the sub-district. Similarly, aggregation was used to obtain the district and provincial coverage indicators.

3.4.1.1 Data capture, quality and verification

Routine data collection and capture at the healthcare facility and district levels were not always viewed as smooth. In particular, there were challenges noted with regards to data capturers at facility level, some of which have been mentioned in themes two and three: insufficient numbers of data capturers; data capturers not having had access to computers or internet connection reliably; high workload and competing priorities; nurses not completing the totals in the data collection tools, leading to poor quality data available to the capturers; and lack of clinical knowledge of data capturers leading to errors being made.

Multiple participants, particularly at the senior managerial level, noted that the quality of the data collected was a barrier to estimating vaccine coverage. Instances of observing practices

of sub-optimal recording in the data collection tools at facilities were reported by four of the senior managers interviewed. Examples were given of senior managers having observed nurses administering vaccinations and not ticking the appropriate boxes (or any boxes) in the Comprehensive Tick Register.

Competing priorities of the nurses administering the vaccines, mentioned in Sub-theme 3.1.5, were reported as a possible reason for this poor data quality. Due to high workload, the nurses were reluctant to perform administrative tasks, as their priority is on patient management, and the perception was that there was not sufficient capacity for nurses to perform both to an adequate degree of quality.

There were other instances mentioned by participants of data audits being performed and findings of records in patients' files that were not transcribed to the register. Additionally, it was reported that nurses did not write the totals of vaccines administered in the register as required, leaving it for the data capturers, who may not have time to count all doses administered for all vaccines and thus may fabricate the totals, leading to under-reporting. These challenges left Senior Manager 2 despondent:

> "*The story they told is very weak to an extent that I am tired of this EPI now, someone else must come with some strength and come work"* – Senior Manager 2

In an effort to address these challenges with data quality, a data verification system had been put in place. Manager 5 explained that each facility had a data team, of which the data capturer and the facility formed part. This team was supposed to monitor the capturing of data and verify the data at the facility level, weekly. At the sub-district level, there were monthly data review meetings, where the facility manager and data capturer accounted for any errors in calculations or abnormalities in the data. At the district level, there were quarterly review meetings, where the performance of the sub-districts was examined. The area manager reported the success of this process:

> *"At the beginning, there were so many mistakes, but these days each and every manager and data-capturer, they make it a point that the mistakes …the mistakes are eliminated."* – Manager 5

However, a number of senior managers reported challenges with data verification in that the quality of the verification itself is not adequate:

"With verification, I would say, you may find the facility says they have verified… When you really see they have not properly verified their data. They have sent in some garbage through… So, when I have also verified and sent it back for corrections, they delay to give us the corrections, sometimes… So, I find that I still have a(n) outstanding correction." – Senior Manager 6

Senior Manager 5 gave insight into these challenges in the verification process: data capturers were not able to update targets on a daily basis, waiting until month-end instead, leading to poor practices in the data verification process due to time pressures. These challenges were exacerbated by time constraints of facility managers, as they do not have time to inspect all of the gaps that they may find in the data collection and capturing tools, as required.

"*You know if we were having data capturers then they will make sure that their targets run on a daily basis not wait until month-end because now they want it,* (and) *now you are under pressure. The verification is not done properly, the analysis is not done properly, the facility manager will just sign off whereas there are gaps. So, it's a big challenge."* – Senior Manager 5

3.4.1.2 Reporting by Private Facilities

The next challenge that was mentioned with regards to data collection was the reporting of vaccines administered by private facilities. Facilities in the private sector were not required to provide data on services provided to the Department of Health. However, in an effort to improve the estimation of vaccine coverage, some private facilities had been engaged in a "*vaccines for data*" agreement. This entailed the private facility receiving the full schedule of vaccines, free of charge, from the regional pharmacy (administrated by the NDoH on the understanding that they would report the vaccines administered to the Tshwane District Office). However, not all private facilities in the district had been engaged in this agreement, and there were several challenges mentioned in relation to this process. Reporting of the data at irregular intervals, by some of the private facilities, made it difficult to integrate these data with those collected from government-run facilities. Furthermore, participants noted failure to report any data to the district by a portion of private facilities, despite having received the vaccines from Tshwane District pharmacy suppliers.

In terms of the agreement itself, the challenge of the private facilities reporting the vaccine administration data that they have collected directly to the district level, instead of to the

closest primary healthcare facility, which was mentioned in Sub-theme 3.1.1, affects the ability of a facility (and the sub-district in which it lies) to reach its target. This is due to the vaccines administered in a private facility not having been allocated to the catchment area of the facility most proximal to the private facility:

> *"Even if a private practice is within a catchment area for a particular facility, they don't submit to that particular facility but send their stats directly to the district. So, some facilities, when you look at their raw data, you will find that this facility does not reach its target, but at district level it's green"* – Manager 5

Thus, there was a general consensus from participants that challenges in data collection and capturing are proving to be a barrier to vaccine coverage, as uncertainty in the numerator of the vaccine coverage indicator led to uncertainty in the indicator itself.

3.4.2 Electronic systems

The next sub-theme that emerged under the theme of health information system barriers was the lack of electronic systems, such as an electronic medical record system and a unique health identifier. This was both in relation to estimating vaccine coverage accurately and being able to identify, follow up and vaccinate children who had missed doses in the immunisation schedule.

3.4.2.1 Electronic medical records system

An electronic medical records system refers to using a computer-based system to store and access patient medical records, as opposed to the current paper-based system. This would involve all government-run healthcare facilities using the same system, so that patient records can be traced to any facility utilised by the patient. This system was viewed as having the potential to improve data quality:

> *"A well-functioning electronic medical record system, a well-functioning one, would improve the quality of data particularly for longitudinal things like the primary course of vaccination"* – Senior Manager 1

However, this may be a long way off in terms of implementation, and there may be barriers in terms of computer literacy, internet connectivity and infrastructure.

> *"I prefer the paper-based because sometimes the computers don't have network."* – Implementer 2

3.4.2.2 Unique health identifier

When discussing methods for tracking children through the EPI schedule to reduce the number of children lost to follow-up, and the number of missed opportunities, Senior Manager 3 mentioned the use of unique identifiers. This would involve every child that is born receiving a unique identifier that is for the express purpose of access to healthcare services. It may form part of an electronic medical records system – where it would facilitate the tracking of medical records of patients across numerous facilities, districts, or even provinces – improving the accuracy of both the denominator and the numerator of the vaccine coverage indicator.

However, others expressed reservations about the use of unique identifiers in the EPI programme, due to financial constraints, on-going challenges with information technology services in the health system, as well as the training that would be required for healthcare providers. In particular, Senior Manager 4 reported that simpler things could be done to improve vaccine coverage, citing the successes of the immunisation programmes in Rwanda and Eritrea in achieving high vaccine coverage and preventing measles polio and Hepatitis B outbreaks, without the use of "*these fancy things you're talking about."* – Senior Manager 4.

3.4.3 Population estimates for vaccine coverage

A sub-theme of the health information systems barriers that emerged strongly was that of the estimation of population sizes for each district, sub-district and facility catchment area, in relation to vaccine coverage estimation. This is an important function of the health information system and may influence vaccine coverage, as the population estimate (of children under one) of a facility's catchment area serves as the denominator of the vaccine coverage indicator for that facility.

All participants were of the opinion that these estimates negatively influenced vaccine coverage rates in Tshwane. The principle concern among participants centred on the accuracy and validity of the population estimates. Challenges that were discussed in this regard included the effect of migration, both internal and international migration; the specific challenges relating to estimating the size of the population under one year; and the process of estimating population sizes at the sub-district and facility-level, using census data.

3.4.3.1 Process of deriving the population estimates

In terms of insight into this process, there was general consensus among participants at senior management levels as to the general process involved in the derivation of the estimates; however, they were unable to specify the exact methods used, with Senior Manager 6 stating, *"I am not so sure about those nitty-gritties around the actual calculation".* These participants explained that the population estimates from the previous census, along with headcounts from facilities, were used in the facility level population allocation.

In order to estimate the target population for a facility, the district mid-year estimates that were provided by Stats-SA were broken down per sub-district, while also incorporating data on the number of services provided by facilities within the sub-district (head-counts):

> "*Their method is basically like the national model, that can get, you know, adjusted, per province, per district and then now per local municipality so it's fundamentally an overarching model that they are then using at lower and lower levels. And that model is considering obviously the census data, it is considering community service data, it's considering births… and uhm, vital registration, so birth registrations and it's considering things like HIV rates and rates of people on antiretrovirals, and so forth, you know, it's a range of things, but it's still, as far as I know, reasonably simple model"* – Senior Manager 1

3.4.3.2 Challenges in using census data projections

Along with the insight into the methods involved in population estimation, Senior Manager 1 was able to provide the most insight into the challenges with the population estimates. These challenges were raised by the participant, unprompted by the researcher. This included perceptions of challenges with the census data, the estimation of the population under one (the target population for the 'fully immunised under one' indicator), and perceptions of instability with the modelling of the population by Stats-SA. In terms of the census data, this participant stated that there was "*there was quite a large under-count".* It was also explained that the estimation of the population under one year tends to be inaccurate – which is the case in other countries in Africa, for various reasons, including cultural and social reasons. An example of such a reason was given:

> *"Typical reasons that I have heard are that in some cultures you are supposed to sort of keep your new-borns… at home and sort of secluded for a couple of weeks… this is*

from all over Africa for various reasons, the estimation of the all under one particularly tends to be inaccurate and don't really ask me why, I think there are many cultural and social reasons for it, it just tends to be (a) *problematic group"* – Senior Manager 1

There was a perceived instability in the population under one estimation from the Stats-SA model that was noted by the participant:

"*For 2016 and 2017, there was actually about 30 000 more one-year-old children in the 2017 estimates than under one children in 2016"* – Senior Manager 1

In this participant's opinion, this indicated an inaccuracy, as he/she would have expected fewer one-year-olds in the 2017 estimation, compared to the under-one estimation for the preceding year, due to mortality.

"Now I have picked up with the mid-year estimates that we received last year that for the under1 and one year old, so the child populations, there is something funny in the data particularly from 2014 onwards… you're expecting a pyramid that is, a population pyramid, that is largest at the bottom and then it slowly becomes smaller right because over time people die… Now then from 2014, we see… we have seen that those numbers are actually flipping around uhm this is countrywide alright and I think for 2016 and 2017, there was actually about 30000 more one-year-old children in the 2017 estimates than under-one children in 2016 ok… So, to me here I suspect that this is a, shall we call it, an instability, or an inaccuracy or whatever you call it in the Stats-SA modelling" – Senior Manager 1

3.4.3.3 Challenges specific to Tshwane District

In terms of challenges specific to Tshwane, Senior Manager 1 had still further insight to give, this time prompted by the researcher. This participant noted that Sub-District 4 of Tshwane is a middle- or upper-class area, resulting in approximately 10 to 15 per cent of children in this sub-district utilising the private sector for immunisation services. The population estimates, and the facility-level allocation, in particular, did not account for the number of people in the district that are accessing private sector services for immunisation. This once again highlighted the challenge with the system of reporting for private facilities. By having private facilities report directly to the district level, there was no way for each facility to account for those accessing private facilities in the numerator of their vaccine coverage estimates. Senior

managers and managers interviewed noted this to be one reason that the target populations for vaccination within Tshwane were not realistic.

> *"With this thing of immunisation, it calculates everybody irrespective of whether they came to us or not, even those that went to the private, they are there as part of the denominator*." – Senior Manager 3

Additionally, managers and senior managers reported other challenges with the accuracy of population estimates, leading to vaccine administration targets that are not realistic at the sub-district and facility level. Senior managers and managers reported that the target population estimates had not accounted for the possibility of some of the sub-districts consisting of a large contingent of elderly people, who are no longer of childbearing age. In their view, this resulted in over-inflated estimates of the size of the population of children under one in these areas:

> *"It's just that, eh, well, sometimes you find that some of the sub-districts, the sub-districts are not the same… And then they do have reasons why they are performing under. For instance, you'll find that some of the places or areas are full of, eh, the elderly population"* – Senior Manager 6

In contrast, a manager spoke of other sub-districts that had informal settlements within their allocated areas, resulting in overpopulation and leading to their population estimates being lower than the true value. This resulted in vaccine coverage estimates in these areas being inflated, at times, to over 100%. This challenge was also apparent within the sub-districts, leading to some facilities having had unrealistically high population estimates allocated to them, with others having had population estimates lower than the true number.

3.4.3.4 Challenges associated with migration

According to participants, migration of patients was another challenge in population estimates, due to the use of headcounts as part of the process of estimating the target population for facilities. People in Gauteng Province were described by one participant as *"highly mobile"*, referring to people having accessed healthcare services within Gauteng, and thus being included in the headcount of that particular facility, but then having returned to another province, which may have been their province of origin. This affects the estimation of the population under one in the cases where mothers gave birth in a facility in Gauteng, and then returned to another province. Senior Manager 5 explained that:

> *"Gauteng is full of visitors that are part of our headcounts. Hence, you know… most of the population-based indicators they will suffer because of that."* – Senior Manager 5

In addition to migration after the birth of a child, the EPI programme was affected by internal migration when a child received one or more of the earlier doses of the schedule at a particular facility, but completed the schedule at another facility, leaving the first facility with reduced numbers of "fully immunised under one" compared to its target population:

> *"People in Gauteng are very mobile, highly mobile. You will find out that, uh, these people they come to this facility, they are counted… in the headcount of the facility but 3 months down the line they go back to Limpopo…"* – Manager 4

According to Senior Manager 1, these challenges in estimating the population under one may best be solved at the level of Stats-SA, by doing *"more accurate settlement estimates per sub-district"*. However, due to the nature of these challenges, this participant was of the opinion that an immunisation survey with a sufficiently high sample size may be the best way to determine an accurate estimate of vaccine coverage.

> *"Obviously if you want really accurate data on vaccination coverage, you do a high sampling intensity survey, an immunisation survey"* – Senior Manager 1

3.4.4 Defaulter tracing

Another barrier related to the health information system was the challenge in tracing patients that had defaulted on the EPI schedule. As discussed in Sub-theme 3.1.2, a decision was taken by the NDoH to remove the Defaulter Tracing Register, as part of the "rationalisation of registers" process. The removal of these registers had impeded the ability of nurses and community healthcare workers to contact caregivers of children who had missed a scheduled vaccine dose, as well as their ability to note when a child had received the required doses of the schedule elsewhere. This made it difficult to adjust the vaccine coverage indicator accordingly, either by removing that child from the denominator or adjusting the numerator to account for the child being fully immunised under one.

Chapter 4. Discussion

The aim of the study was to explore the factors that influence vaccine coverage in Tshwane District, Gauteng, with two objectives: to explore the perceptions of EPI nurses, WBOTs, facility managers and sub-district, district and provincial managers of the barriers and facilitators of vaccine coverage for children under one year, in Tshwane District in 2018; and to investigate how vaccine coverage estimates are derived for the sub-districts within Tshwane District.

This chapter first reflects briefly on the engagement of the various participants in the four themes presented in the results chapter. The second and third sections of this chapter (4.2 and 4.3) together address the first study objective. This is achieved through a discussion of the barriers and the facilitators of vaccine coverage in Tshwane District, respectively, as identified from the themes and sub-themes of the analytical framework, presented in the results chapter.

The fourth section of this chapter addresses the second study objective through the examination and interpretation of the results that emerged in relation to the derivation of the vaccine coverage indicator.

The next section of this chapter discusses the six main recommendations for improving vaccine coverage in Tshwane, in response to both the discussion of the intervention through the CFIR lens and the discussion of the estimation of the vaccine coverage indicator. The sixth section then discusses the applicability of the CFIR to the mapping and interpretation of the analytical framework that was presented in the results. The chapter goes on to discuss the need for further research based on the study findings; the limitations of the study; the contributions that this study makes; and the conclusion.

4.1 Engagement of participants in the four themes

Themes 3.1 (health systems organisation barriers and facilitators) and 3.3 (health system infrastructure and equipment barriers) were discussed by all participants. Two levels of participants were markedly different from the other participants in terms of what was discussed: The Implementers (FGD participants) and Senior Manager 1. In the FGD, neither human resources for health shortages nor health information systems barriers in terms of

vaccination coverage in Tshwane were discussed. This may be because the FGD participants were not involved in administering vaccines, collecting data or using the vaccine coverage data that has been collated, in their day-to-day jobs. Senior Manager 1 did not discuss human resources for health shortages or health system infrastructure and equipment barriers to vaccination coverage. A possible explanation could be that this participant's involvement in vaccine coverage is predominantly related to the derivation of the coverage estimates, rather than the specifics relating to the delivery of the service. There were no other clear distinctions to be made regarding engagement in particular themes by the various participants.

4.2 Objective 1: Barriers to vaccine coverage in Tshwane

Barriers that emerged to vaccine coverage in Tshwane included financial barriers; hierarchical decision-making; vaccination campaigns (otherwise known as supplementary immunisation activities); the division of the health system into private and public sectors; service access issues; and the lack of integration of the WBOTs into the healthcare system.

4.2.1 Financial barriers

Financial barriers led to a restriction on the resources available to the EPI programme. One of the perceived reasons for this was that the EPI programme received lower priority in relation to other health programmes – particularly the HAST programme. The financial barriers manifested in several ways.

The cost of conducting an immunisation survey was noted to be a barrier to obtaining a more accurate estimation of vaccine coverage in Tshwane District. Additionally, the cost of providing vaccines to private providers in exchange for data was perceived as a barrier to engaging the private providers in this agreement, thus limiting access to data that may contribute positively to vaccine coverage in the district.

The freezing of posts by the GDoH, due to financial constraints, was perceived to be a barrier to ensuring adequate human resources required for the EPI service. This was perceived to affect the delivery of the service as well as the coverage estimation, in that the numerator of the indicator was affected by poor data quality resulting from sub-optimal staffing levels from data capturers to programme managers. This is supported by previous literature, as shortage of staff was noted as one of the five key barriers to childhood immunisation in South Africa

in a study, by Wiysonge et al, which used evidence from systematic reviews, as well as the views of EPI Programme Managers, to assess challenges to the EPI programme (39).
The lack of resources to ensure that data capturers had access to computers was seen as a barrier to improving data quality.

4.2.2 Hierarchical decision-making

Hierarchical decision making within the organisation was also seen to be a barrier. This was particularly noted in relation to the decision to remove the defaulter tracing register from use in the facilities, without having given programme managers at the lower levels of the healthcare system's structure the opportunity to provide their insight into the potential negative effects of the decision.
In addition, the target population for vaccination was perceived as a target imposed on the facilities, sub-districts and district by Stats-SA, of which the participants felt they had no control. These population estimates were also widely perceived as being inaccurate by the key informants, and thus a significant barrier to achieving optimal vaccine coverage in Tshwane District.
The IMCI policy, mandated by the NDoH, was perceived to be increasing workload at the facility. This was because each nurse is required to deliver a higher number of services to each patient, however, the number of nurses employed is not increased accordingly. It thus emerged as a barrier to vaccine coverage, as the nurses involved in the EPI service have less time to conduct tasks such as recording of doses administered, and it also increases the waiting times for the patients at the clinic.

4.2.3 Vaccination campaigns

Participants noted vaccination campaigns as a barrier to vaccine coverage largely in relation to the reduction of staff available to conduct the routine immunisation services at the clinic, as the EPI nurses are drafted in to conduct the campaigns. The barrier to vaccine coverage posed by these campaigns, also known as supplemental immunisation activities, is well supported by previous literature. Hanvoravongchai et al noted that setting aside funds and setting up separate reporting and logistical systems in order to conduct these campaigns do not facilitate the long-term strengthening of routine immunisation services (62). This may be largely because supplemental immunisation services are conducted with the purpose of administering catch-up doses of a specific vaccine, rather than with a view of achieving

coverage of the full EPI schedule. A study of the impact of supplemental immunisation activity on health systems in South Africa found that the supplemental immunisation activities conducted in 2010 were associated with a significant reduction of children completing the full EPI schedule to be fully immunised (63).

4.2.4 Public-private sector divide

The limited engagement of the private sector was perceived to be a significant barrier to vaccine coverage, particularly in terms of data collection from private facilities. This barrier has been noted in previous literature, Wiysonge et al found that another of the five key challenges to the EPI service in South Africa was the "suboptimal collaboration between the public and private health sectors" (39).

4.2.5 Access to the EPI service

The limitation of services to weekdays, with no provision of services outside of working hours by government-run clinics was perceived as a barrier, in terms of access to the service, for caregivers that work. Additionally, the lack of mobile clinics to improve access to EPI services for the community was also perceived to be a barrier to vaccine coverage in Tshwane.

4.2.6 Lack of integration of WBOTs

The fact that the WBOTs were not fully integrated into primary healthcare as full-time staff was perceived as a barrier to finding missed opportunities for immunisation in the community, and thus a barrier to vaccine coverage in the community. The potential for inclusion of community healthcare workers such as WBOTs, in preventative interventions for maternal and child health, has been noted by previous researchers, as described in a systematic review by Gilmore et al (64).

4.3 Objective 1: Facilitators of vaccine coverage in Tshwane

The facilitators for vaccine coverage in Tshwane that emerged in this study related to the budget allocated for procurement and supply of the vaccine doses; engagement and communication among staff; monitoring and evaluation processes; and stakeholder support. Much of the previous literature that has sought to identify facilitators of vaccine coverage, has focused on demand-side issues rather than the healthcare system perspective. A case study in Uganda used a mixed methods approach to develop causal loop diagrams for demand-side

issues (38). Facilitators identified in the Ugandan study included the quality of the healthcare service provided, which did not emerge as a facilitator in the present study (38). This may be due to the study's focus on demand-side issues; however, it may also indicate participants' hesitancy to reflect on the quality of public healthcare services in Tshwane. It may also be an indication that participants did not perceive EPI service delivery in Tshwane to be of sufficient quality to facilitate improved vaccine coverage.

4.3.1 The supply chain of vaccines

The budget allocated to the supply and cold chain management of vaccines was seen as a facilitator for vaccine coverage in Gauteng Province, and thus in Tshwane District. Wiysonge et al noted in 2012 that priority should be placed on ensuring that sufficient funds are available for the procurement of vaccines and the purchasing of vaccine-related equipment (39). It is encouraging to note that, according to key-informants in this study, sufficient budget had been allocated to procure vaccines in Gauteng, and that sufficient vaccine refrigeration infrastructure was in place to maintain the cold chain. Work should continue to ensure that human resources and computers are included in budget priorities for addressing challenges in the EPI programme.

4.3.2 Engagement and Communication among staff

The concern demonstrated by participants at the district and provincial management levels with regards to investigating and addressing the challenges faced indicated that leaders within the organisation had a high level of commitment to improving vaccine coverage. This was further demonstrated by the involvement of these leaders in support visits to the facilities, as well as in the sub-district and district reviews – both attempts to increase vaccine coverage in Tshwane. Engagement of such leaders indicates an encouraging level of political will to address challenges to the EPI service. Political will was noted to be a key factor for the success of EPI programmes in an assessment of immunisation systems strengthening and EPI programmes across Africa (40).

Additionally, there was a consensus among participants that communication among the various members of staff functioned well. This was a facilitator in terms of enabling the staff to coordinate their roles in supporting or delivering the EPI service.

4.3.3 Monitoring and evaluation processes

The data review process that was set in place in Tshwane was perceived as a facilitator, as it provided a mechanism to have explicit goals to improve the quality of data collected and captured into the DHIS. Through this process, those responsible for data quality were able to receive feedback in terms of where to improve, and how. Introducing audit and feedback processes was one of the recommendations made by Wiysonge et al to address challenges in the EPI programme in South Africa, and so it is encouraging to see that it is being utilised in this aspect of the programme (39). Further processes that utilise this strategy may be appropriate to address other barriers related to non-adherence to EPI guidelines.

Based on monitoring and evaluation processes, the EPI schedule was adapted to minimise loss to follow-up. This was done through the delivery of both required measles doses within the first year of life, instead of at 9 months and then at 18 months, and was noted to be a facilitator for vaccine coverage.

4.3.4 Stakeholders in the EPI programme

Support provided by global organisations was perceived to be a facilitator of vaccine coverage in Tshwane. This was largely through the provision of guidelines and through the support of service delivery in the community – although this support was noted to be limited. The limitation of global support for EPI service delivery may be due to South African not being eligible for support from GAVI (28).

4.4 Objective 2: Derivation of vaccine coverage estimates in Tshwane

In the investigation of the derivation of the vaccine coverage estimates for the sub-districts and the district of Tshwane, numerous challenges emerged. These findings were predominantly linked with the fourth theme (health information system barriers) of the analytical framework and included aspects related to both the numerator and the denominator. Many of these are not unique to the South African setting but have been found to be challenging in other countries, particularly in countries with weak information systems (45).

4.4.1 Numerator challenges

The numerator of the vaccine coverage indicator is the number of fully immunised children under one. In particular, the quality of data collected and captured into the DHIS and the

difficulty of capturing data from vaccine doses administered in the private sector emerged as factors related to the numerator of the indicator.

Quality of numerator data collected, captured and transmitted to higher levels of the health information system was found to be a significant factor in the estimation of vaccine coverage in Tshwane. Similar challenges were found by Murray et al, to be the result of weak information systems (45). Human resources for health shortages, leading to poor data quality, is not a new finding: it was cited as major factor in the Health information Audit Report of 2006; in the chapter on health information systems in the South African Health Review of 2011; as well as in the South African Health Review of 2016 (46, 47, 65). What is perhaps a finding of interest, is that there has been little progress made in addressing this challenge, to the point that the participants in this study were still citing this issue as a concern in 2018.

While it was acknowledged that computers are required for data capturers to enter data recorded in the Comprehensive Tick Registers into the DHIS, participants were hesitant to rest their hopes in electronic systems to solve all challenges in collecting, capturing and improving quality of data. Additionally, Implementers were emphatic in their preference for paper-based methods, indicating low confidence in their ability to adapt to a computer-based system. This means that while the DHIS may be computer-based, implementers may prefer that collection of data on doses administered, at the point of care, remain paper-based. This finding is supported by the findings of research conducted both in South Africa and in other low-resource settings. These studies noted that holistic change management, including support and sufficient numbers of staff with the requisite skills, is required for sustainable success in implementing electronic health information systems and improving clinical outcomes (66, 67). This indicates the need for general system strengthening before strategies such as electronic medical records systems could be successfully implemented and fully utilised in South Africa.

The results of an assessment of the quality of vaccine coverage data in Uruguay, using a standardised assessment tool, indicated remarkable reliability of the immunisation registration system in that country (68). The study found that despite the use of paper forms to record data on vaccines administered, there was 100% match between these forms submitted by vaccination centres, and the number of children recorded on the electronic database at the

national level (68). This demonstrates the potential for improvement in the quality of vaccine coverage data, without the use of electronic databases at the point of service delivery.

The division between the private and public sectors was also found to have a negative impact on the ability to estimate the numerator of the vaccine coverage indicator, as doses administered in the private sector were not attributed to the sub-district in which the child lived. This was found to be the case in a study that assessed vaccination coverage levels in the Region of the Americas and in the study by Murray et al that assessed the validity of reported vaccinations in 45 countries, not including South Africa (44, 45). This indicates that the effect of this division of the healthcare system on vaccine coverage estimation is well-established and not unique to the setting of Tshwane District. Thus, efforts to reduce this impact through collaboration with the private sector should be considered.

4.4.2 Denominator challenges

The denominator of the vaccine coverage indicator is the population estimate for children under one. Challenges in obtaining accurate population estimates using projections of census data; high levels of internal and external migration, and the challenge of accounting for specific features of the population of a certain sub-district in the population estimate emerged in the results as major concerns of participants regarding the denominator of this indicator.

The instability of the modelling of Stats-SA to project the population estimate from the census, noted by one participant, is confirmed by work done by Dorrington, which compared the data produced from the 2011 census to the Stats-SA population estimate for 2011 – projected from the same model used for the Mid-Year Population Estimate for 2013 (69). This comparison found large discrepancies in the population estimates, particularly for the age-group of 0-5years, with a pronounced discrepancy modelled for Gauteng Province (69). Sandefur et al, in an analysis of African survey and administrative data, echoed the concerns of participants in this study, noting that migration and inaccurate census projections contribute significantly to inaccurate denominators (70). A key factor of success of Uruguay's immunisation registration system was the use of a cohort-based denominator, rather than an annual fixed target generated from census data (68). The cohort-based denominator takes into account all children born in the country, in order to produce a more accurate target, with the noted shortcoming of inability

to account for children born outside of the country (68). This method would thus require modification for the South African setting, due to high levels of international migration.

High levels of migration were also noted to be a factor in estimating population sized for the purpose of vaccine coverage calculation in the Region of the Americas, with a potential solution suggested of comparing the estimate for the population under one with the estimates of other healthcare interventions, such as prenatal programmes, for a specific region (44). This strategy has been put to good use by a region in southern Mexico, and the use of population estimates for prenatal programmes to adjust and validate population estimates for children under one may also reduce the challenge, reported by participants, of specific attributes of sub-districts not being accounted for, such as a high proportion of geriatric, non-childbearing citizens in an area. The use of this adjustment technique may result in a reduction in the variability of the vaccine coverage estimates that exists between the sub-districts of Tshwane District.

Based on these wide-spread, multi-faceted challenges with vaccine coverage estimation, the classification of healthcare facilities or sub-districts as having better, or worse coverage may not be a reliable measure. The coverage estimates for each sub-district may not be an accurate depiction of the true performance of the EPI programme in that area, which includes those sub-districts achieving over 100% vaccine coverage.

4.5 Recommendations

Thus, the factors that influence vaccine coverage in Tshwane have emerged, through the exploration of the perceptions of staff involved in the EPI service with regards to barriers and facilitators for vaccine coverage, as well as through the investigation of the process of deriving the vaccine coverage indicator. Based on these findings, six main recommendations to improve this coverage are apparent.

4.5.1 Re-introduction of defaulter tracing registers in facilities to facilitate the identification of missed opportunities for immunisation. These registers will enhance the ability of the staff of the facilities to follow up caregivers who have missed appointments and to make a record if the child has received the required dose at a different facility, allowing the facility to adjust their vaccine coverage targets as appropriate. This recommendation is

supported by previous literature: adequate follow-up of individuals was noted to be a key factor to ensuring high immunisation levels in the USA and in the Bedouin population in Israel; and the success of defaulter tracing in Uruguay was considered to be one of the main advantages of the immunisation registration system in that country (68, 71).

4.5.2 Further engagement and signed agreements with private facilities to provide vaccines in exchange for data, with the data to be reported to the facility most local to the private provider, instead of to the district office. This will improve the ability of the facility and sub-districts to meet their vaccine coverage targets. Engagement with a larger proportion of these providers will also improve the accuracy of the numerator of the vaccine coverage indicator.

4.5.3 Inclusion of outreach services as part of routine immunisation services, conducted by nurses qualified to administer vaccines in conjunction with the WBOTs. This will facilitate the work done by the WBOTs, as the missed opportunities for immunisation that have been identified in the community by the WBOTs will be able to receive the vaccination in the community, instead of being referred back to the clinic. Through improving access to services in this way, these services will reduce the need for the staff and resource-intensive vaccine campaigns, or supplemental immunisation activities, as discussed as a barrier in the domain of Process of Implementation.

4.5.4 Integration of WBOTs into full-time work as community healthcare workers in the healthcare system. This could improve the ability of the WBOTs to cover the full catchment area of the facility, which would optimise the efficiency and effectiveness of mobile clinics. This recommendation is supported by a systematic review, conducted by Gilmore et al, finding evidence to support the delivery of maternal and child health preventive health programmes by community healthcare workers in low- and middle-income countries (LMICs) (64). The inclusion of the WBOT in the healthcare system as full-time workers could increase their impact in delivering preventive health programmes, such as immunisation, in the community.

4.5.5 Provision of computers for data capturers to improve data quality at the facility level. These computers will not replace the use of paper-based methods, in the form of the Comprehensive Tick Register, to record doses administered at the point of care. They will be

only be used to capture this data into the existing DHIS system, which is computer-based. This will improve the quality of data from the facility level, as access to a computer will allow the data capturer to enter the information from the tick registers on a continuous basis throughout the month, instead of waiting until the end of the month when the reports are due, which leads to increased time pressure, and thus errors and inconsistencies. Given the financial challenges that have been noted in this study facing the health system, this recommendation may not be feasible. However, it may be worth bearing in mind in future budget allocation exercises.

4.5.6 A high sampling immunisation survey would facilitate more accurate estimation of vaccine coverage in the district; however, the resources required for this strategy prohibit this from being a long-term sustainable solution.

Other barriers to vaccine coverage in Tshwane noted in this study, such as staff shortages and population estimates, do not lend themselves to recommendations such as those made above, as they require strengthening of the health system. Work should nevertheless continue in order to address these concerns and reduce their impact on vaccine coverage in Tshwane.

4.6 Applicability of the CFIR to the analytical framework

While the CFIR served as a useful framework to interpret the themes of the analytical framework presented in the results, the themes that emerged did not fit neatly into the constructs and domains of the CFIR.

A finding of interest was the emergence of constructs that were relevant as both a barrier and a facilitator to vaccine coverage in Tshwane. These constructs were relevant to different aspects of the programme in the district, for example, under the domain of Intervention Characteristics, the construct of Cost was a barrier in terms of engagement of the private sector; however, it emerged as a facilitator with regards to the aspect of the budget allocated for supply and cold chain management of the vaccines.

In one domain, characteristics of individuals, no constructs emerged as facilitators for vaccine coverage in Tshwane. The CFIR, and thus its domains and constructs, was developed in the USA. There are naturally cultural and societal differences between the USA and South Africa, and this would explain the occurrence of a domain having higher relevance to healthcare

interventions in one country compared to another. It is further explained when looking at this specific domain. The USA is considered to emphasise individualism (72), whereas, in South Africa, there is a predominance of *Ubuntu*, described as an African value system with collective values such as communocracy, supportiveness and sharing, contrasting with individualism and the Euro-American philosophical theory of knowledge (73-76). It, therefore, follows that Characteristics of Individuals would be considered of higher relevance in the USA context, compared to the South African context. Thus, further work, utilising the CFIR in South Africa, could assist in improving the applicability of the CFIR to the South African context.

4.7 Limitations of the study

There may be social desirability bias present in the responses of participants during interviews. This limitation was managed by employing suitable interview techniques, such as: stating at the beginning of the interview that there are no correct answers; maintaining a neutral facial expression throughout the interview process and maintaining open body language throughout. This limitation may have had a larger impact in the FGD, where participants may have altered their input based on the presence of their colleagues and perceptions of their colleagues' opinions. This was managed by only including members of the WBOT in the FGD, who were all at the same level of the organisation, thus reducing the anxiety of reproach from a manager, and potentially improving the level of comfort within the group.

Time and resource constraints resulted in the limited number of sub-districts and facilities selected to participate in the study. Interviewing sub-district managers for all seven sub-districts in Tshwane, as well as interviewing EPI nurses and facility managers from facilities in all sub-districts in Tshwane may have led to further insight into the topic. In particular, the inclusion of only one facility, from the lower performing sub-district may have led to missed information. Adequate information was received from higher levels on the well-performing sub-district, but information may have been missed information pertaining to service delivery. However, participants were selected so as to gain as wide a perspective as possible, with the time and resources available.

A further limitation of the study is that the CFIR was developed in the context of the health system in the USA. As previously mentioned in section 4.6, there are cultural and health-

system differences between South Africa and the USA. This means that the use of this framework as a lens through which to design interview guides and interpret the results may have led to the omission of consideration of constructs unique to the South African context. This limitation was managed during the data collection phase, as well as the analysis phase of the study. During data collection, the interview guides were adaptive, and not followed in a rigid manner. Where participants discussed factors not included in the interview guide, the principal investigator probed, and allowed the discussion to be dictated by the key-informants' perceptions of important factors, rather than rigidly adhering to factors related to the domains and constructs of the CFIR. In the analysis phase, this limitation was managed through the use of inductive methods to code the transcripts and identify the themes and sub-themes emerging from participants' responses, rather than confining the analysis of the transcripts to the constructs of the CFIR.

4.8 Need for further research

A quality improvement project, to implement the policy recommendations made and evaluate their impact on vaccine coverage in Tshwane, may be of use to the Department of Health going forward.

In order to improve the utility of the CFIR in South Africa, further applications of the CFIR to South African settings, are required to increase the evidence base for the applicability of the CFIR in South Africa. Such studies, viewed in combination with this one, would facilitate the identification of domains and constructs unique to the South African health system and may allow for the adaptation of the framework for use specifically in this country.

Due to the nature of qualitative research, in exploring factors relevant to a specific setting, the results that emerged from this study are not generalizable to other settings. Thus, further research is required to assess the extent to which the factors that were identified in this study, which influence vaccine coverage in this setting, apply to other settings in South Africa. This need for further research extends to assessment of the appropriateness of the policy recommendations made in this study, to establish applicability in other districts and provinces.

4.9 Contribution of the study to the field

This study provides a context-specific exploration into factors that influence vaccine coverage in Tshwane District. The identification of the barriers and facilitators allow for recommendations, such as those above, to improve vaccine coverage in Tshwane District. Additionally, systems-level factors have been identified, providing evidence for decision-makers at the national level to consider the impact that health information systems barriers; resource shortages (human resource and otherwise) throughout the system, and the structure of the system (in terms of division into private and public sectors) have on the delivery of the EPI service as well as on the estimation of vaccine coverage indicators. The presentation of these factors in this way may help programme managers motivate for policy change as recommended.

This study also provides a useful demonstration of the application of an Implementation Science framework for the South African context. While the results produced are highly context-specific, the process and methodology of the study in using the CFIR to provide structure and a systematic approach to qualitative research may be replicated in other settings. Further, it demonstrates the use of Implementation Science to conduct research at multiple levels of the South African healthcare system and to answer questions that are relevant to policy-makers in South Africa. This may serve to build capacity for Implementation Science in South Africa.

4.10 Conclusion

The barriers that emerged to vaccine coverage in Tshwane District are multifactorial and occur at all levels of the healthcare system, and consideration should be taken by policy-makers to limit the influence that these have on vaccine coverage. The facilitators that emerged for vaccine coverage in Tshwane District should also be considered, as efforts should be made to replicate these successes in the system and enhance their influence on vaccine coverage.

The use of an Implementation Science framework to identify barriers and facilitators to an intervention in the South African healthcare setting was demonstrated. The CFIR provided a useful lens through which to view the themes and sub-themes that had emerged from participants, and facilitated a systematic approach to the mapping and interpretation step of the framework approach to the qualitative analysis.

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Appendices

Appendix I

Plagiarism Declaration



I, **Heather Lynne Fraser** (Student number: **307537**), am a student registered for the degree of **MSc Epidemiology in Implementation Science** in the academic year 2019.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Signature: _____ Date: 12/09/2019_____

Appendix II

Unpublished records of vaccine coverage in Tshwane sub-districts

From April 2013 to June 2017, provided by the Gauteng Department of Health

Sub District (SD)	Indicator Name	Annualised Coverage Rate (%)				
		April 2013-March 2014	April 2014-March 2015	April 2015-March 2016	April 2016-March 2017	April to Jun 2017
Tshwane 1 SD	Vaccine coverage under 1 year	86.7	96.3	91.3	88.6	68.9
	Measles 1st dose	89.9	102.4	106.8	95.7	83.5
	Measles 2nd dose	67.9	89.8	92.4	91.4	63
	PCV 1st dose	95.8	97.0	93.2	106.7	104.9
	PCV 2nd dose	95.5	101.8	88.8	97.5	78.6
	PCV 3rd dose	88.5	98.0	93.3	91.5	117.7
Tshwane 2 SD	Vaccine coverage under 1 year	90.3	114.4	112.5	86.2	80.2
	Measles 1st dose	91.8	120.0	123.9	95.3	74.8
	Measles 2nd dose	65.0	98.2	88.4	92.7	64.7
	PCV 1st dose	94.5	105.9	102.0	103.6	88.8
	PCV 2nd dose	90.2	102.0	90.3	98.9	81.3
	PCV 3rd dose	88.3	112.6	111.7	87.8	101.1
Tshwane 3 SD	Vaccine coverage under 1 year	137.8	164.0	152.9	102.0	108.5
	Measles 1st dose	140.7	166.2	158.3	114.7	110.4
	Measles 2nd dose	112.9	121.5	122.5	102.4	104
	PCV 1st dose	169.6	181.8	178.8	133.8	152.7
	PCV 2nd dose	150.6	164.0	160.4	126.3	119.6
	PCV 3rd dose	139.2	163.1	152.9	103.3	173.1
Tshwane 4 SD	Vaccine coverage under 1 year	66.1	67.8	62.3	43.8	48.3
	Measles 1st dose	65.6	66.9	59.3	44.1	51.2
	Measles 2nd dose	50.0	59.2	42.9	38.9	56.7
	PCV 1st dose	67.5	64.6	76.8	55.1	67
	PCV 2nd dose	67.4	66.2	71.8	51.1	51
	PCV 3rd dose	64.6	67.0	62.4	45.1	66.1
Tshwane 5 SD	Vaccine coverage under 1 year	145.2	160.9	144.4	137.0	98.3
	Measles 1st dose	149.5	164.5	148.4	171.2	119
	Measles 2nd dose	129.9	148.5	132.1	170.4	93.7
	PCV 1st dose	166.8	161.5	157.0	152.8	147.3
	PCV 2nd dose	167.2	162.1	151.1	148.1	99.5
	PCV 3rd dose	149.5	163.0	146.4	142.2	173.3
Tshwane 6 SD	Vaccine coverage under 1 year	78.2	73.8	75.8	67.6	60.2

	Measles 1st dose	67.6	74.3	76.4	76.3	54.6
	Measles 2nd dose	53.8	68.8	56.7	70.2	51.6
	PCV 1st dose	69.0	77.8	78.2	72.9	67.7
	PCV 2nd dose	69.3	74.3	75.1	70.1	62.6
	PCV 3rd dose	66.0	74.0	75.0	69.1	74.6
Tshwane 7 SD	Vaccine coverage under 1 year	87.4	87.0	88.6	76.8	100.2
	Measles 1st dose	159.2	89.3	98.0	103.7	101.9
	Measles 2nd dose	132.9	71.3	77.1	78.7	91.1
	PCV 1st dose	104.2	109.3	114.9	106.8	112.3
	PCV 2nd dose	100.1	95.6	94.4	98.6	110.5
	PCV 3rd dose	90.4	88.9	89.9	84.8	124.9

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Appendix III

The domains and constructs of the CFIR (49)

Construct		Short Description
I. INTERVENTION CHARACTERISTICS		
A	Intervention Source	"Perception of key stakeholders about whether the intervention is externally or internally developed."
B	Evidence Strength & Quality	"Stakeholders' perceptions of the quality and validity of evidence supporting the belief that the intervention will have desired outcomes."
C	Relative Advantage	"Stakeholders' perception of the advantage of implementing the intervention versus an alternative solution."
D	Adaptability	"The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs."
E	Trialability	"The ability to test the intervention on a small scale in the organization, and to be able to reverse course (undo implementation) if warranted."
F	Complexity	"Perceived difficulty of implementation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement."
G	Design Quality & Packaging	"Perceived excellence in how the intervention is bundled, presented, and assembled."
H	Cost	"Costs of the intervention and costs associated with implementing the intervention including investment, supply, and opportunity costs."
II. OUTER SETTING		
A	Patient Needs & Resources	"The extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization."
B	Cosmopolitanism	"The degree to which an organization is networked with other external organizations."
C	Peer Pressure	"Mimetic or competitive pressure to implement an intervention; typically, because most or other key peer or competing organizations have already implemented or are in a bid for a competitive edge."

D	External Policy & Incentives	"A broad construct that includes external strategies to spread interventions, including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting."
III. INNER SETTING		
A	Structural Characteristics	"The social architecture, age, maturity, and size of an organization."
B	Networks & Communications	"The nature and quality of webs of social networks and the nature and quality of formal and informal communications within an organization."
C	Culture	"Norms, values, and basic assumptions of a given organization."
D	Implementation Climate	"The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organization."
1	Tension for Change	"The degree to which stakeholders perceive the current situation as intolerable or needing change."
2	Compatibility	"The degree of tangible fit between meaning and values attached to the intervention by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how the intervention fits with existing workflows and systems."
3	Relative Priority	"Individuals' shared perception of the importance of the implementation within the organization."
4	Organizational Incentives & Rewards	"Extrinsic incentives such as goal-sharing awards, performance reviews, promotions, and raises in salary, and less tangible incentives such as increased stature or respect."
5	Goals and Feedback	"The degree to which goals are clearly communicated, acted upon, and fed back to staff, and alignment of that feedback with goals."
6	Learning Climate	"A climate in which: a) leaders express their own fallibility and need for team members' assistance and input; b) team members feel that they are essential, valued, and knowledgeable partners in the change process; c) individuals feel psychologically safe to try new methods; and d) there is sufficient time and space for reflective thinking and evaluation."
E	Readiness for Implementation	"Tangible and immediate indicators of organizational commitment to its decision to implement an intervention."

1	Leadership Engagement	"Commitment, involvement, and accountability of leaders and managers with the implementation."
2	Available Resources	"The level of resources dedicated for implementation and on-going operations, including money, training, education, physical space, and time."
3	Access to Knowledge & Information	"Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks."
IV. CHARACTERISTICS OF INDIVIDUALS		
A	Knowledge & Beliefs about the Intervention	"Individuals' attitudes toward and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention."
B	Self-efficacy	"Individual belief in their own capabilities to execute courses of action to achieve implementation goals."
C	Individual Stage of Change	"Characterization of the phase an individual is in, as he or she progresses toward skilled, enthusiastic, and sustained use of the intervention."
D	Individual Identification with Organization	"A broad construct related to how individuals perceive the organization, and their relationship and degree of commitment with that organization."
E	Other Personal Attributes	"A broad construct to include other personal traits such as tolerance of ambiguity, intellectual ability, motivation, values, competence, capacity, and learning style."
V. PROCESS		
A	Planning	"The degree to which a scheme or method of behavior and tasks for implementing an intervention are developed in advance, and the quality of those schemes or methods."
B	Engaging	"Attracting and involving appropriate individuals in the implementation and use of the intervention through a combined strategy of social marketing, education, role modeling, training, and other similar activities."
1	Opinion Leaders	"Individuals in an organization who have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing the intervention."
2	Formally Appointed Internal Implementation Leaders	"Individuals from within the organization who have been formally appointed with responsibility for implementing an intervention as coordinator, project manager, team leader, or other similar role."
3	Champions	"'Individuals who dedicate themselves to supporting, marketing, and 'driving through' an [implementation]'

		[101] (p. 182), overcoming indifference or resistance that the intervention may provoke in an organization."
4	External Change Agents	"Individuals who are affiliated with an outside entity who formally influence or facilitate intervention decisions in a desirable direction."
C	Executing	"Carrying out or accomplishing the implementation according to plan."
D	Reflecting & Evaluating	"Quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience."

Appendix IV

Focus Group Discussion Guide: for Ward-based Outreach Team (WBOT)

Background information - All key-informants

1. Please describe your role, position and responsibility area within the catchment area.

Systems-related issues

2. How do EPI/vaccination services work in this catchment area?
    a. Probe: Which other stakeholders are linked to the EPI services?
    b. Is the service available on specific days / every day?
    c. Which providers do vaccinations? All / specific?

3. What is the role of the WBOT in delivering immunization?
    a. What do you do in the event of the road-to-health card is incomplete/not present?

4. What aspects of the EPI service are working well?
    a. To what extent are the successes that you experience similar or different to other sub-districts / facilities in Tshwane?

5. Describe how you work with the facility manager and EPI nurses. (*If WBOT team leader not present, then include team leader in question.)*
    a. How would you describe the relationships between different people involved in the programme?
    b. How do you communicate with the facility manager and EPI nurses?

6. In the context of all the services that need to be delivered at PHCs, like chronic diseases, antenatal care, TB services how is EPI valued (or prioritized)?

7. In your experience, what is the role of other stakeholders (within / outside of the Tshwane District Health Department)
    a. How do they influence vaccine coverage in Tshwane, if at all?

We've talked a lot about the programme, I would now like you to think about the communities that are served by your facility

8. In this community/district, what are the attitudes or perception towards vaccination?
    a. Any specific group of patients?
    b. Differences between the groups?
9. Which parents ask specifically for vaccination for their children if any?
    a. Which group?
    b. What reason?
    c. Proportions?
10. Which parents, if any, do not want to vaccinate, do not complete or delay vaccination for their children?
    a. Which group?
    b. What reason?
    c. Proportions?

11. What possible barriers to access to vaccination services are there?

12. What suggestions or recommendations for improvements to the EPI services do you have if any?

Appendix V

Interview Guide 1: for EPI Nurses

Background information - All key-informants

1. Please describe your role, position and responsibility area within the facility.

Systems-related issues

2. How do EPI/vaccination services work at this facility?
    a. Probe: Which other stakeholders are linked to the EPI services?
    b. Is the service available on specific days / every day?
    c. Which providers do vaccinations? All / specific?

3. What are the challenges, if any, in delivering immunization services?
    a. To what extent are the challenges that you experience similar or different to other sub-districts / facilities in Tshwane?
    b. How are you addressing these challenges, if at all (mention specific challenges)

4. What aspects of the EPI service are working well?
    a. To what extent are the successes that you experience similar or different to other sub-districts / facilities in Tshwane?

5. Describe how you work with the facility manager and WBOT
    a. How would you describe the relationships between different people involved in the programme?
    b. How do you communicate with the facility manager and WBOT

6. In the context of all the services that need to be delivered at PHCs, like chronic diseases, antenatal care, TB services how is EPI valued (or prioritized)?

7. In your experience, what is the role of other stakeholders (within / outside of the Tshwane District Health Department)
    a. How do they influence vaccine coverage in Tshwane, if at all?

8. How do you collect immunization data?
    a. Do you use registers?
    b. How does the information get from the register to the data manager?
    c. What are the challenges, if any?

9. What is the contribution, if at all, of the private sector or private health facilities to vaccine coverage?

10. Do you know about calculating vaccine coverage data? Mapping the catchment areas for immunisation? With community engagements around immunisation?

We've talked a lot about the programme and the coverage calculations, I would now like you to think about the communities that are served by your facility

11. In this community/district, what are the attitudes or perception towards vaccination?
    a. Any specific group of patients?
    b. Differences between the groups?

12. Which parents ask specifically for vaccination for their children if any?
    a. Which group?
    b. What reason?
    c. Proportions?

13. Which parents, if any, do not want to vaccinate, do not complete or delay vaccination for their children?
    a. Which group?
    b. What reason?
    c. Proportions?

14. What possible barriers to access to vaccination services are there?

15. What suggestions or recommendations for improvements to the EPI services do you have if any?

Appendix VI

Interview Guide 2: for Sub-district /facility managers

Background information - All key-informants

1. Please describe your role, position and responsibility area within the district.

Systems-related issues

2. How does EPI/vaccination services work in this sub-district / at this facility?
    a. Probe: Which other stakeholders are linked to the EPI services?
    b. Is the service available on specific days / every day?
    c. Which providers do vaccinations? All / specific?

3. What are the challenges if any in delivering immunization services?
    a. To what extent are the challenges that you experience similar or different to other sub-districts / facilities in Tshwane?
    b. How are you addressing these challenges, if at all (mention specific challenges)?

4. What aspects of the EPI service are working well?
    a. To what extent are the successes that you experience similar or different to other sub-districts / facilities in Tshwane?

5. Describe how you work with the EPI nurses sub-district manager and district manager (for facility manager) / district manager and facility (for sub-district manager)
    a. How would you describe the relationships between different people involved in the programme?
    b. How do you communicate with the EPI nurses, sub-district manager and district manager (for facility manager) / district manager and facility (for sub-district manager)?

6. In the context of all the services that need to be delivered at PHCs, like chronic diseases, antenatal care, TB services how is EPI valued (or prioritized)?

7. In your experience, what is the role of other stakeholders (within / outside of the Tshwane District Health Department)
    a. How do they influence vaccine coverage in Tshwane, if at all?

8. How do you collect immunization data?
    a. What are the challenges, if any?

9. What is the contribution of the private sector or private health facilities to vaccine coverage?

10. What have been your experiences, if any, with calculating vaccine coverage data? With mapping the catchment areas for immunisation? With community engagements around immunisation?

We've talked a lot about the programme and the coverage calculations I would now like to think about the communities that are served by the facilities (in this sub-district)

11. What possible barriers to access vaccination service are there?

12. What suggestions or recommendation for improvements to the EPI services do you have if any?

Appendix VII

Interview Guide 3: for Provincial/District managers

Background information - All key-informants

1. Please describe your role, position and responsibility area within the district.

Systems-related issues

2. How does EPI/vaccination services work in Tshwane District?
    a. Probe: Which other stakeholders are linked to the EPI services?
    b. Is the service available on specific days / every day?
    c. Which providers do vaccinations? All / specific?

3. What are the challenges if any in delivering immunization services?
    a. To what extent are the challenges that you experience similar or different to other districts?
    b. How are you addressing these challenges, if at all (mention specific challenges)?

4. What aspects of the EPI service are working well?
    a. To what extent are the successes that you experience similar or different to other districts?

5. Describe how you work with the sub-district manager and provincial manager (for district manager) / district manager and sub-district manager (for provincial manager)
    a. How would you describe the relationships between different people involved in the programme?
    b. How do you communicate with the sub-district manager and provincial manager (for district manager) / district manager and sub-district manager (for provincial manager)?

6. In the context of all the services that need to be delivered at PHCs, like chronic diseases, antenatal care, TB services how is EPI valued (or prioritized)?

7. In your experience, what is the role of other stakeholders (within / outside of the Tshwane District Health Department)
    a. How do they influence vaccine coverage in Tshwane, if at all?

8. How do you collect immunization data?
    a. What are the challenges, if any?

9. What is the contribution of the private sector or private health facilities to vaccine coverage?

10. What have been your experiences, if any, with calculating vaccine coverage data? With mapping the catchment areas for immunisation? With community engagements around immunisation?

We've talked a lot about the programme and the coverage calculations I would now like to think about the communities that are served by the facilities (in this sub-district)

11. What possible barriers to access vaccination service are there?

12. What suggestions or recommendation for improvements to the EPI services do you have if any?

Appendix VIII

Interview Guide 4: for Data Manager and Monitoring and Evaluation Officer

Background information - All key-informants

1. Please describe your role, position and responsibility area within the district.

2. How are immunization figures collected?
    a. What are the challenges, if any?
3. What have been your experiences, if any, with calculating vaccine coverage data?

4. How are the numerators and denominators of vaccine coverage indicators calculated?
    a. Where does the formula come from for this calculation?

5. What is the contribution of the private sector or private health facilities to vaccine coverage indicators?

6. What have been your experiences, if any, with mapping the catchment areas for immunisation?

7. In your experience, are there challenges in matching the numerator to the denominator of vaccine coverage in the sub-districts?
    a. What are the challenges specific to the numerators?
    b. What are the challenges specific to the denominators?

I also want to get your insight into the immunization services, and how they are delivered in the district. Please feel free to decline to answer any questions that you don't feel comfortable answering.

Systems-related issues

8. How does EPI/vaccination services work in Tshwane District?
    a. Probe: Which other stakeholders are linked to the EPI services?

9. What are the challenges if any in delivering immunization services?
    a. To what extent are the challenges that you experience similar or different to other districts?
    b. How are you addressing these challenges, if at all (mention specific challenges)?

10. What aspects of the EPI service are working well?
    a. To what extent are the successes that you experience similar or different to other districts?

11. Describe how you work with the district and provincial managers
    a. How would you describe the relationships between different people involved in the programme?
    b. How do you communicate with the district and provincial managers?

12. In the context of all the services that need to be delivered at PHCs, like chronic diseases, antenatal care, TB services how is EPI valued (or prioritized)?

13. In your experience, what is the role of other stakeholders in delivering immunization services (within / outside of the Tshwane District Health Department)?
    a. How do they influence vaccine coverage in Tshwane, if at all?

We've talked a lot about the programme and the coverage calculations I would now like to think about the communities that are served by the facilities (in this sub-district)

14. What possible barriers to access vaccination service are there?

What suggestions or recommendation for improvements to the EPI services do you have if any?

Appendix IX

Interview Guide 5: for Senior manager of HISP

General questions on vaccine coverage estimators:

1. Can you tell me about the process of estimating vaccine coverage in Tshwane District?
2. In your experience, what are the challenges faced in estimating vaccine coverage in Tshwane?
    a. Are there challenges specific to certain sub-districts?
3. In your experience, what influences the completeness of reporting of vaccines administered to children under the age of one year?
    a. Is there a difference between how government-run facilities and private health facilities report the vaccinations that are administered?

Questions pertaining to the Derivation of the Denominator

4. How are the denominators for the vaccination coverage estimators for each sub-district in Tshwane calculated?
    a. Are there difficulties faced in arriving at accurate denominators for these estimators?
    b. Can you explain these difficulties?
5. Are these denominators adjusted for the monthly estimators?
    a. How is this adjustment done?

Questions pertaining to the Numerator and denominator

6. In your experience, are there challenges in getting the numerator and the denominator to represent information about the same geographical space?
7. Do you have any suggestions on how to improve the process of vaccine coverage estimation in the sub-districts in Tshwane?

Appendix X

Ethics Clearance from HREC Wits

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Miss Heather Fraser

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M171196

NAME: (Principal Investigator)	Miss Heather Fraser
DEPARTMENT:	School of Public Health Epidemiology and Biostatistics Tshwane District Health Department
PROJECT TITLE:	Factors Influencing vaccine coverage in Tshwane District, Gauteng, South Africa
DATE CONSIDERED:	24/11/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Latifat Ibisomi, Ntombizodwa Ndlovu and Mashaole Makwela
APPROVED BY:	Prof C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	16/02/2018

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

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third floor, Faculty of Health Sciences. Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in November and will therefore be due in the month of November each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

27/02/2018
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix XI

Clearance certificate from the GDoH Research Committee

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

OUTCOME OF PROVINCIAL PROTOCOL REVIEW COMMITTEE (PPRC)

Researcher's Name (Principal investigator)	Heather Lynne Fraser
Organization / Institution	Wits University
Research Title	Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa
Contact number	Heatherfraser10@gmail.com
NHRD Reference number	GP_201801_013
Date reviewed	2018/03/09
Sites	GDOH Provincial Office

Permission granted [X]

Permission denied [ ]

The Department request that you submit a report after completion of your study and present your findings to the Gauteng Health Department.

Dr. B. Ikalafeng
(On behalf of PPRC)

Date: 09/03/2018

Appendix XII

Clearance certificate from the Tshwane Research Committee

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Enquiries: Dr. Lufuno Razwiedani
Tel: +27 12 451 9036
E-mail: lufuno.razwiedani@gauteng.gov.za

TSHWANE RESEARCH COMMITTEE: CLEARANCE CERTIFICATE

MEETING: 11/2017
PROJECT NUMBER: 15/2018
NHRD REFERENCE NUMBER: GP_201801_013

TOPIC: Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa

Name of the Researcher:	Heather Lynne Fraser
Supervisor:	Latifat Ibisomi
	Ntombizodwa Ndlovu
	Mashaole Makwela
Facility:	*Stanza Bopape CHC*
Name of the Department:	University Witwatersrand

NB: THIS OFFICE REQUEST A FULL REPORT ON THE OUTCOME OF THE RESEARCH DONE AND

NOTE THAT RESUBMISSION OF THE PROTOCOL BY RESEARCHER(S) IS REQUIRED IF THERE IS DEPARTURE FROM THE PROTOCOL PROCEDURES AS APPROVED BY THE COMMITTEE.

DECISION OF THE COMMITTEE: APPROVED

.....
Dr. Robert Oyedipe
Acting Chairperson: Tshwane Research Committee
Date: 28/02/2018

.....
Mr. Pitsi Mothomone
Chief Director: Tshwane District Health
Date: 2018-03-07

Appendix XIII

Permission letter from the facility

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Annexure 1

Declaration of intent from the clinic manager or hospital CEO

I give preliminary permission Heather Fraser (name of researcher) to do his or her

research on Factors influencing vaccine coverage in Tshwane
(research topic) in District, Gauteng, South Africa

Stanza Community Health Centre (name of clinic) or

Stanza Community Health Centre (name of CHC) or

_____ (name of hospital).

I know that the final approval will be from the Tshwane/Metsweding Regional Research Ethics Committee and that this is only to indicate that the clinic/hospital is willing to assist.

Other comments or conditions prescribed by the clinic or CHC manager or hospital CEO:

Signature
Clinic Manager/CHC Manager/CEO

25/01/2018
Date

Appendix XIV

Information Document – key-informant interviews

Title:	Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa.
Name of investigator:	Heather Fraser
Dept:	School of Public Health
Phone Number:	0763350151

Dear Participant,

Introduction and invitation to participate

My name is Heather Fraser, and I am a master's student doing research on the factors that influence vaccine coverage in Tshwane District. I am inviting you to take part in this research study. You are being invited to take part in this research because you are a key-informant, with valuable knowledge of the implementation of vaccine coverage and of coverage estimation, in Tshwane District. I ask that you read this form and ask any questions that you may have before agreeing to be in the study.

Research is an important process to learn the answer to a question. In this study, I want to learn about the process involved in vaccine coverage and the factors that influence it, in order to make recommendations on how this process can be improved. Specifically, I want to know: what the barriers and facilitators are to vaccine coverage in Tshwane are, and how vaccine coverage estimates are derived for the sub-districts within Tshwane District. Ultimately, this research may be published in a journal and may be used to inform ideas for policy change to improve vaccination coverage in Tshwane District.

Description of the Study

If you agree to be in this study, you will be asked to attend a face-to-face interview of approximately one hour's duration in order to discuss your experience in vaccination coverage in your facility. The interview will be recorded to ensure that the interview is captured as accurately as possible. A separate consent form for the recording of the interviews will be provided to you.

Risks/Discomforts of Being in this Study

There are no reasonable foreseeable (or expected) risks. There may be unknown risks.

Benefits of Being in the Study

The benefits of participation are to contribute to research in this field to ultimately inform policy changes to improve vaccination coverage in Tshwane.

Confidentiality

The records of this study will be kept strictly confidential. Research records will be kept in a locked file, and all electronic information will be coded and secured using a password-protected file. I will not include any information in any report we may publish that would make it possible to identify you. Any information obtained during the course of this study will be stored and analysed for the purposes of this study for a period not exceeding two years if the research report is published and five years if no publications emanate.

Payments

There will be no payment for participation in this study.

Right to Refuse or Withdraw

The decision to participate in this study is entirely up to you. You may refuse to take part in the study *at any time* without affecting your relationship with the investigators of this study or with the Department of Health. Your decision will not result in any loss of benefits to which you are otherwise entitled. You have the right not to answer any single question, as well as to withdraw completely from the interview at any point during the process; additionally, you have the right to request that the interviewer not use any of your interview material.

Right to Ask Questions and Report Concerns

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have any further questions about the study, at any time feel free to contact me, Heather Fraser, at 307537@students.wits.ac.za or by telephone at 0763350151. If you like, a summary of the results of the study will be sent to you. If you have any problems or concerns that occur as a result of your participation, you can report them to the Chair of the Human Research Ethics Committee: Professor Peter Cleaton-Jones, by email at cleaton-jones1@wits.ac.za or by telephone at 011 717 2301.

Appendix XV

Information Document – Focus Group Discussion

Title:	Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa.
Name of investigator:	Heather Fraser
Dept:	School of Public Health
Phone Number:	0763350151

Dear Participant,

Introduction and invitation to participate

My name is Heather Fraser, and I am a master's student doing research on the factors that influence vaccine coverage in Tshwane District. I am inviting you to take part in this research study. You are being invited to take part in this research because you are a key-informant, with valuable knowledge of the implementation of vaccine coverage and of coverage estimation, in Tshwane District. I ask that you read this form and ask any questions that you may have before agreeing to be in the study.

Research is an important process to learn the answer to a question. In this study, I want to learn about the process involved in vaccine coverage and the factors that influence it, in order to make recommendations on how this process can be improved. Specifically, I want to know: what the barriers and facilitators are to vaccine coverage in Tshwane are, and how vaccine coverage estimates are derived for the sub-districts within Tshwane District. Ultimately, this research may be published in a journal and may be used to inform ideas for policy change to improve vaccination coverage in Tshwane District.

Description of the Study

If you agree to be in this study, you will be asked to attend a focus group discussion, with your colleagues, of approximately one hour's duration in order to discuss your experience in vaccination coverage in your facility. The focus group discussion will be recorded to ensure that the discussion is captured as accurately as possible. A separate consent form for the recording of the discussion will be provided to you.

Risks/Discomforts of Being in this Study

There are no reasonable foreseeable (or expected) risks. There may be unknown risks.

Benefits of Being in the Study

The benefits of participation are to contribute to research in this field to ultimately inform policy changes to improve vaccination coverage in Tshwane.

Confidentiality

The records of this study will be kept strictly confidential. Research records will be kept in a locked file, and all electronic information will be coded and secured using a password-protected file. I will not include any information in any report we may publish that would make it possible to identify you. Any information obtained during the course of this study will be stored and analysed for the purposes of this study for a period not exceeding two years if the research report is published and five years if no publications emanate. The information that you share in the focus group will be kept confidential by myself, and by all investigators involved in the study. However, due to the nature of the focus group, I cannot guarantee that other participants involved in the focus group will maintain full confidentiality. The importance of confidentiality will be stated at the beginning of the study, to encourage all participants to respect the confidentiality of the information shared.

Payments

There will be no payment for participation in this study.

Right to Refuse or Withdraw

The decision to participate in this study is entirely up to you. You may refuse to take part in the study *at any time* without affecting your relationship with the investigators of this study or with the Department of Health. Your decision will not result in any loss of benefits to which you are otherwise entitled. You have the right not to answer any single question, as well as to withdraw completely from the interview at any point during the process; additionally, you have the right to request that the interviewer not use any of your interview material.

Right to Ask Questions and Report Concerns

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have any further questions about the study, at any time feel free to contact me, Heather Fraser, at 307537@students.wits.ac.za or by telephone at 0763350151. If you like, a summary of the results of the study will be sent to you. If you have any problems or concerns that occur as a result of your participation, you can report them to the Chair of the Human Research Ethics Committee: Professor Peter Cleaton-Jones, by email at cleaton-jones1@wits.ac.za or by telephone at 011 717 2301.

Appendix XVI

Consent form for participation in the study

Title:	Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa.
Name of investigator:	Heather Fraser
Dept:	School of Public Health

Informed Consent

I hereby confirm that I have been informed by the study staff (_____) about the nature, conduct, benefits and risks of the Factors that influence vaccine coverage in Tshwane District Study.

- I have also received, read and understood the above-written information
- I am aware that the results of the study, including any personal details such as those regarding my age will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researchers or on their behalf.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

PARTICIPANT:

Name of Participant (print): _____

Signature of Participant: _____ Date: _____

STUDY STAFF:

I, _____, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Name of Investigator (print): _____

Signature of Investigator: _____ Date: _____

Appendix XVII

Consent Form for Tape Recording of the Interview

Title:	Factors influencing vaccine coverage in Tshwane District, Gauteng, South Africa.
Name of investigator:	Heather Fraser
Dept:	School of Public Health
Phone Number:	0763350151

Dear Participant

I would like to seek your kind permission to record the proceedings of the interview/discussion on tape. The recording is to ensure that all that is discussed during the session is captured. The tape will be kept strictly confidential. In accordance with study procedures, the recording will be stored and analysed for the purposes of this study for a period not exceeding two years if the research report is published and five years if no publications emanate. Is this acceptable to you?

Yes ___ No ___

Name of Participant: _____

Signature of Participant: _____Date: _____

Name of Interviewer: _____

Signature of Interviewer: _____ Date: _____