FACTORS ASSOCIATED WITH INCOMPLETE IMMUNIZATION AMONG CHILDREN AGED 11-23 MONTHS IN SWAZILAND, 2014

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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 and Biostatistics**.

Supervisor: Professor Jonathan Levin

November 2020

DECLARATION

DECLARATION

I Lindiwe Bongisisile Skonela declare that this research report is my own work. It is submitted for the degree of Master of Science in Epidemiology in the field of Epidemiology and Biostatistics. In the University of the Witwatersrand Johannesburg. It has not been submitted before any degree or examination at this or any other University.

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ABSTRACT

Background

Incomplete immunization and non- immunization remain a global public health problem. Swaziland is not an exception and is also faced with challenges in achieving the WHO recommended routine immunization coverage target of 90%. The factors associated with incomplete immunization in Swaziland have never been explored. The reason for conducting this study is to determine the proportions of non - immunization, incomplete immunization and complete immunization and to investigate the factors associated with incomplete immunization among children aged 11- 23 months.

Objective

To determine predictors of incomplete immunization among children aged 11- 23 months in Swaziland during the period 2014.

Materials and methods

This study was a cross- sectional secondary data analysis from the Multiple Indicator Cluster Survey (MICS5) conducted in Swaziland in 2014. Data were collected on socio-demographics of mothers and childhood immunization using structured questionnaires. Children were classified as incompletely immunized if they have missed at least one of the recommended antigens (BCG, OPV, DPT and MCV1). A multivariable logistic regression model was selected to identify the predictors of incomplete immunization among children aged 11- 23 months.

Results

A total number of 520 mother- baby pairs aged between 11- 23 months old were included in this analysis. The majority 468 (90.4%) had immunization cards that were seen. The proportion of incomplete immunization was 24%. BCG had the lowest percent (1.7%) of incomplete immunization and DPT2 had the highest percentage (11.4%). Seven factors (hospital delivery, unavailability of immunization card, religion, postnatal care, antenatal care, exposure to media and birthweight) were associated with incomplete immunization in the univariable analysis. In the multivariable logistic regression, it was found that children with immunization cards that were not available at the first visit were 7.1 times (Adjusted Odds Ratio [AOR] = 7.11; 95% CI= 3.19, 15.86) more likely to be incompletely immunized compared to children for whom the immunization cards were available and seen. Children not having an immunization card were 15.3 times (AOR = 15.32; 95% CI= 1.89, 124.17) more likely not to be immunized compared to children with available and seen immunization cards. Children who were delivered at home were 3.4 times (AOR= 3.46; 95% CI= 0.92, 12.92) more likely to be incompletely immunized compared to children who were delivered in health facilities. Children of mothers who attended the traditionalist or other religions were 14.1 times (AOR=14.09; 95% CI= 0.76, 260.96) more likely to be incompletely immunized compared to children of mothers who were in the Christian religion.

Conclusion

Despite the EPI's efforts to increase the immunization coverage in Swaziland the proportions of incomplete immunization still remain high. Targeted interventions are needed to increase immunization coverage. These interventions need to be given to all women of childbearing age, and should especially emphasize the importance of utilizing the health facilities during pregnancy,

delivery and for postnatal care. These factors have been found to play an important role in childhood immunization.

DEDICATION

This research is dedicated to my family for their untiring support and prayer throughout my studies. Special thanks to my husband for his encouragement and moral support even when the journey seemed so impossible. This project would have not been successful without the encouragements from my family who have always motivated me to work harder despite the challenges. Lastly, I dedicate this piece of work to my husband (Thubelihle) and sons (Siwakhile, Wandisiwe and Sandziso) and hope one day you will take it from here onwards to greater heights.

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Abbreviations

AEFI	Adverse Events Following Immunization
ANC	Antenatal Care
BCG	Bacillus Calmette Guerin
CMIS	Client Management Information System
DPT	Diphtheria, Pertussis, Tetanus Vaccine
EPI	Expanded Programme on Immunization
HBV	Hepatitis B Vaccine
Hib	Haemophilus Influenza Type b
MCV	Measles Containing Vaccine
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Survey
OPV	Oral Polio Vaccine
PCV	Pneumococcal Vaccine
PNC	Postnatal Care
RED	Reaching Every District
ROTA	Rotarix
SDG	Sustainable Development Goals
TT	Tetanus Toxoid Vaccine
UNICEF	United Nations Children's Fund
VPD	Vaccine Preventable Disease
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

Childhood immunization helps protect children from a number of deadly diseases such as diphtheria, tetanus, haemophilus influenza type b (Hib), pertussis, rotavirus diarrhoea, pneumonia, measles, poliomyelitis, hepatitis B and tuberculosis through vaccinations which may be given by injection or orally (1). Receiving immunization at different stages in life improves a child's health, increasing their life expectancy. When children do not receive immunization, they are susceptible to potentially deadly diseases at a very young age. It is estimated that 1.5 million children die every year due to Vaccine Preventable Diseases (VPDs) (2), whilst, it is estimated that the use of vaccines have prevented 2 -3 million childhood deaths annually (3).

According to the WHO guidelines, children are considered fully immunized when they have received one dose of Bacillus Calmette-Guerin (BCG), three doses of diphtheria, pertussis and tetanus (DPT) vaccine and oral polio vaccine (OPV) and one dose of measles vaccine before their second birthday (4). It is important for children to receive all the doses of the different vaccines for effective immunization as in some cases incomplete immunization may lead to a complete ineffectiveness of the vaccinations. In 2016, it was estimated that there were 12.9 million infants who did not receive immunizations, whereas 6.6 million received the first dose of DPT vaccine but did not complete the full three doses of the vaccine (2).

This issue needs to be addressed effectively as immunization is key to attaining Sustainable Development Goal 3 (SDG 3), which aims at reducing under- five mortality to less than 25 per 1000 live births by 2030 (5).

The global immunization coverage has stalled at 86% (116.5 million children) and it is estimated that 19.5 million children are still missing out on the recommended basic vaccinations (6). This situation results in the rise of Vaccine Preventable Diseases, disability and deaths of children around the world. The global immunization coverage is still short of the 2010 target of 90% which was set by WHO / UNICEF who developed the Global Immunization Vision and Strategy for 2006-2015 (7).

This is especially true of the immunization coverage in the African region which has remained below the expected targets of 90%, although it has increased from 57% in 2000 to 77% in 2015 (8). The African region has been faced with a number of challenges such as sustainable funding for immunization, vaccine stock outs and data issues. These have made it difficult to improve the immunization coverage (9). That is why the coverage in the region has been stagnant at around 70% for quite a long time (9). In 2014, 19 million children in the world were unimmunized worldwide and 7.4 million are from the African continent. After countries failed to achieve the 90% target, the Global Vaccine Action Plan (GVAP) 2011-2020 was developed with the aim of preventing millions of deaths through more equitable access to vaccines by the year 2020 (10).

The Swaziland Multiple Indicator Cluster Survey (MICS5) conducted in 2014 indicated that neonatal mortality in the five years preceding this survey was 20 deaths per 1000 live births, infant mortality 50 deaths per 1000 live births while under- five mortality was 67 deaths per 1000 live births. These results show a decline of mortality among children in the last 15 years. Under –five's mortality in Swaziland remains high regardless of the strategies to reduce mortality by two thirds between 1990 and 2015. Immunization is one of the recommended

primary health interventions and a crucial strategy in the reduction of under- five mortality. The MICS5 results further indicated that the proportion of fully immunized children was 71% (11). The results show a decline in routine immunization coverage compared to results that were obtained in 2010 from a comprehensive EPI review which estimated the national immunization coverage to be 75% for DPT 3 (12). Both results fall far below the Global Immunization Vision Strategy of 2015-2020 of a 90% national target (12) .

1.1.1 History of Vaccinations

The practice of immunization dates back to over two hundred years ago (13). In 1796, Edward Jenner discovered the smallpox vaccine. Smallpox existed for more than 3000 years, it was a highly virulent, contagious, horrifying and disfiguring disease caused by the variola virus. Smallpox killed millions of people with an estimated case fatality rate of around 30%, while thousands were left disfigured (13) (14). In order to deal with the disease Edward Jenner inoculated a young boy with vaccinia virus (cowpox), and through this process called "vaccination" he demonstrated immunity to smallpox. Edward Jenner later named that vaccine 'smallpox vaccine' and it was the first vaccine that was developed in 1798 (15).

In 1959, WHO started a campaign to eradicate smallpox, unfortunately the campaign encountered some challenges that initially prevented its successful implementation (16). However, they managed to make steady progress and in 1980, following a global campaign of vaccinations and surveillance, the 33rd World Health Assembly made an official declaration that the world was free of smallpox. Up to that time, the eradication was considered the biggest achievement in international public health. Following these achievements, WHO then

established the Expanded Programme on Immunization (EPI) in 1974 to develop and expand immunization programmes through the world. The programme was developed to ensure that children and mothers have access to vaccines.

1.1.2 The Expanded Programme on Immunization (EPI)

The World Health Organization (WHO) established the Expanded Programme on Immunization (EPI) in 1974 through a World Health Assembly resolution to develop and expand immunization programmes across the world (17). The main goal of the programme that was established in 1977 was to provide universal immunization for all children by the year 1990 (18) (19). This goal was said to be an important strategy for WHO to achieve health for all by the year 2000 (19). In fact, a healthy society begins with healthy children. The Expanded Programme on Immunization remains committed to its goal of universal access to all vaccines to all populations at risk. Also, the programme aims at expanding the targeted groups to older children, adolescents and adults and to work in collaboration with other public health programmes to control diseases and achieve better health for all populations, particularly the underprivileged populations (19).

The EPI first targeted six major diseases that could be prevented by vaccines namely tuberculosis, diphtheria, whooping cough, tetanus, polio and measles. As years went by, the EPI added a number of vaccines to the original six that were recommended in 1974 (19). The immunization schedule may differ across different regions due to a number of factors. For instance, a number of countries around the world and those in the sub-Saharan region have added hepatitis B vaccine, rotavirus vaccine, pneumococcal vaccine and haemophilus influenza type B vaccine into their routine immunization schedule (20).

The EPI has greatly improved in the African region since its inception in 1974. However, there are some inter-and intra-country differences that exist; a large portion of children in Africa who are unreached, unvaccinated, under-vaccinated and still dying from vaccine preventable diseases (8). The immunization system needs to be strengthened as most health facilities in Africa are under-staffed with minimal resources to function effectively (8). Also, some issues of vaccine supply need urgent attention. Moreover, there is a need for increased political and financial commitment from governments as well as coordination of national and continental evidence - informed efforts which involve all immunization stakeholders to maintain achievements and make additional progress for EPI in Africa (21). The success of an immunization programme solely depends on high rates of acceptance and immunization coverage (22).

In Swaziland, the EPI was introduced in 1980 as one of the components of primary health care. The need for the programme arose following high prevalence and incidence of VPDs, which significantly contributed to the high rates of infant and child disability, morbidity and mortality (12). The main goal of the programme is to reduce morbidity, disability and mortality due to vaccine preventable diseases. Over the years, EPI has managed to improve the quality of life of the under-five population in the country (12). Different countries have different immunization schedules (23). The national immunization schedule for Swaziland is displayed in table 1.1 showing the recommended vaccines for children under the age of one year. All vaccinations are free of charge and they are offered in all public clinics and in some private clinics around the country. Initially, the programme was doing well with the coverage of routine immunization

showing a steady increase, but between 2005 and 2010 the increase dropped gradually and finally the coverage stopped increasing (12).

Table 1.1: Immunization Schedule for children under 1 year in Swaziland

Age	Antigen
Birth / First contact	BCG, OPV 0
6 weeks	OPV1, DPT1-Hip 1-HBV 1 (PENTA1), PCV1, ROTA1
10 weeks	OPV2, DPT2- Hib2- HBV2 (PENTA2), PCV2, ROTA2
14 weeks	OPV3. DPT3-Hip3- HBV3 (PENTA3), PCV3
9 months	Measles and Rubella (MR)

*BCG: Bacillus Calmette-Guerin Vaccine; OPV: Oral Polio Vaccine DPT: Diphtheria Pertussis Tetanus Vaccine; Hip: Haemophilus Influenza Type B Vaccine; HBV: Hepatitis B Vaccine; PCV: Pneumococcal Vaccine; ROTA: Rotarix Vaccine

1.1.3 Burden of Vaccine Preventable Diseases (VPD)

WHO (24) estimated that 19.5 million children worldwide are still at risk of developing Vaccine Preventable Diseases (VPDs) because they missed out on basic vaccinations. Even though, 85% of all children received their first dose of DPT, this proportion dropped to 64% for the third dose. This is an issue that needs to be addressed as vaccinations are necessary to interrupt the transmission of infectious diseases and therefore prevent deaths due to these diseases (25). Furthermore, vaccination against a particular disease does not only reduce the incidence, it also reduces the social and economic burden of disease in the community/ population. High immunization coverage may lead to complete blocking of transmission for many VPDs (26).

WHO provides protocols and guidelines on assessing disease burden by using a variety of methods such as population based studies and disease surveillance (27). Through the use of these protocols, there was a significant reduction globally in morbidity and mortality attributable

to VPDs by 2008 (28). The number of children dying from neonatal tetanus was reduced from 198 000 to 59 000, pertussis deaths decreased from 294 000 to 195 000, haemophilus influenza type B deaths decreased from 386 000 to 199 000 and deaths from measles decreased from 540 000 to 118 000. Pneumococcal deaths decreased from 716 000 in 2000 to 476 000 deaths in 2008, however rotavirus infection deaths increased from 402 000 to 453 000 among children below the age of 5 years (27).

DPT-3 coverage indicates that vaccines are not used to their fullest potential. Deaths among children worldwide are caused by diseases that could be prevented by vaccines which are currently available (2). Nonetheless, these deaths could be prevented through the optimal use of currently existing vaccines (25). A number of VPDs are making a resurgence either because children are not vaccinated at all, some are incompletely vaccinated or because of waning immunity. Evidence of this comes from a study that was conducted in 2017 which showed that low immunization coverage, incomplete immunization coverage and no immunization was positively associated with VPDs (29). The authors found that out of the total number of children 264 (66%) children had suffered from a VPD. The most prevalent VPD was found to be measles (55%) followed by pertussis (21%), with hepatitis B having the least number of cases (0.3%)(29).

1.1.4 Burden of vaccine preventable diseases in Swaziland

According to Swaziland MICS5 (2014) under-five mortality is estimated to be 67 deaths per 1000 live birth (11). Diarrhoea is the second leading cause of death in the country in children

under five years with, 44 deaths recorded in 2017. Pneumonia is also a cause for concern in the country as it caused 19 deaths in 2017 (30).

In 2009, Swaziland experienced a measles outbreak, which affected children from 9 months to 14 years, there were 94 confirmed cases of measles. The outbreak persisted up to 2010 with 448 confirmed cases. The epidemic of measles has been attributed to the low immunization coverage the country has been experiencing over the years (31). To prevent further re-emergence of other VPDs there is a need to increase the immunization coverage, thus the herd immunity of children in the country will be increased and they will be protected from future disease outbreaks. Increasing immunization coverage does not only prevent deaths from VPDs but transmission of infectious diseases can also be interrupted (32).

1.2 Literature Review

Immunization is the cornerstone of primary health care efforts and has proven to be one of the most cost–effective interventions for reducing and controlling childhood illnesses and mortality. This has been shown by the eradication of smallpox and the elimination of measles and poliomyelitis in some parts of the world. The Centre for Disease Control and prevention (CDC) ranked immunization first out of ten public health interventions in the past 100 years (33). Routine immunization of children is an important tool for the control of these infections and improvement of child health (33).

1.2.1 Immunization Coverage

WHO and UNICEF recommend that all children receive one dose of BCG, three doses of OPV, three doses of DPT vaccine, three doses of PCV and one dose of measles vaccine (34) so that children will be fully immunized and be protected from infectious diseases. Global immunization coverage has been increasing over the years from less than 5% in 1974 to approximately 84% in 2013 (35). Routine immunization coverage has been measured by the vaccine coverage of DPT-3 among children aged between 11-23 months old. DPT 3 is widely used in monitoring immunization coverage worldwide and it is also used as the key indicator of the immunization programme (35). However, coverage for each antigen is also monitored, this includes the third dose of OPV, BCG dose and the first dose of measles. WHO (2017) has indicated that the proportion of children receiving vaccination around the world has remained unchanged over the past few years (6). In 2017, about 85% children worldwide (116.2 million) received 3 doses of DPT while an estimated 19.9 million children around the world had not completed the three doses of DPT. Approximately, 60% of these children live in Angola, Afghanistan, Democratic Republic of Congo, Ethiopia, India, Indonesia, Nigeria, Pakistan, Iraq and South Africa (6).

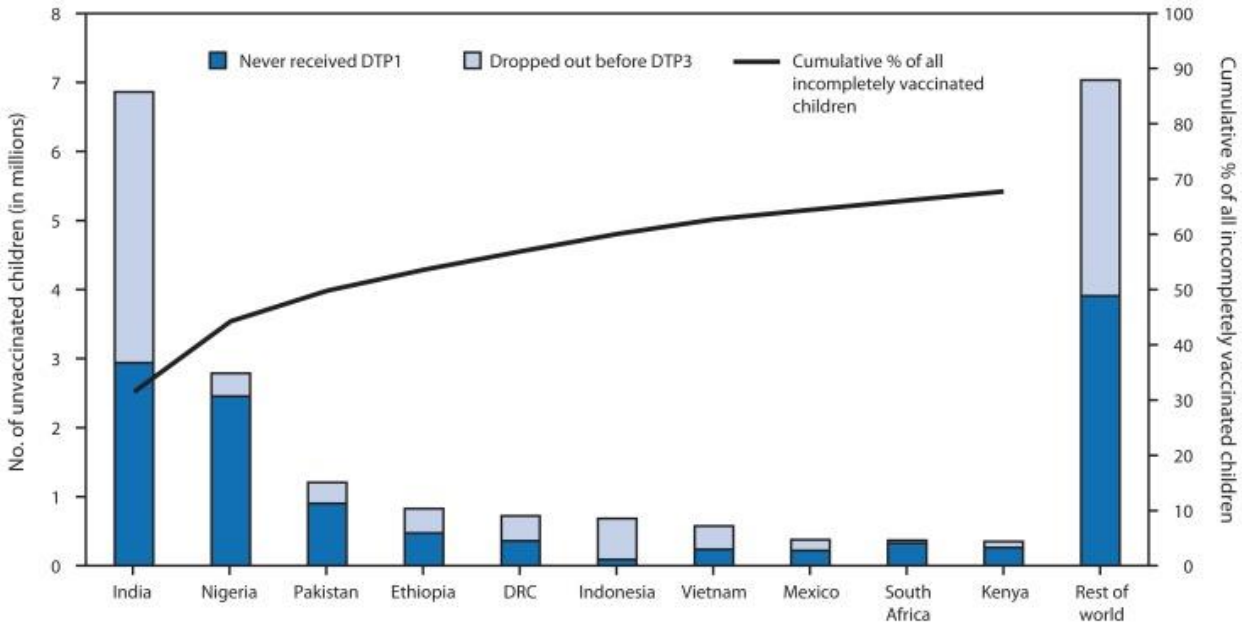
Achieving high immunization coverage has remained a challenge; as the number of children increases, there is an increased need to find effective ways to reach all of them through immunization. Reaching these children requires constant, rigorous, and persistent efforts. If the efforts are not rigorous, vaccine coverage will decline and this will lead to the re-emergence of Vaccine Preventable Diseases (VPDs) (21).

Incomplete immunization remains a challenge in sub-Saharan Africa where 25% of deaths in children are due to VPDs (25). In 2014, the number of children who did not receive the third dose of DPT was estimated to be 7.4 million. Despite all the strategies that have been put in place to improve vaccination coverage, the immunization coverage has been raised from 57% in 2000 to around 76% in 2015 which is below the WHO target of 90% especially for measles, DPT and OPV (21).

A number of studies have documented immunization challenges and incomplete immunization coverage in the sub Saharan African countries. A study by Mihigo et al (2017) (9) has indicated that immunization coverage in the African region has remained stagnant for a very long time. The study has explored the different challenges to immunization. The challenges identified by the authors that have contributed to the low immunization coverage are sustainable funding and resources for immunization, vaccine stock outs and procurement and logistical problems (9).

The Atlas for Health in Africa has indicated a wide difference when it comes to complete immunization coverage in the different African countries. For instance, Rwanda had a coverage of 98% while Equatorial Guinea had 19% coverage (36). DPT- 3 coverage in 2016 was 90% or more in 14 countries: Namibia, Lesotho, Botswana, Zimbabwe, Zambia, United Republic of Tanzania, Burundi, Rwanda, Eritrea, Ghana, Burkina Faso, Senegal and Algeria. Five countries had DPT-3 coverage less than 50%: Nigeria, Equatorial Guinea, Central African Republic, Chad and South Sudan. The other 12 had DPT-3 coverage between 50% – 79.9%: South Africa, Madagascar, Angola, Democratic Republic of Congo (DRC), Uganda, Ethiopia, Gabon, Guinea, Liberia Mali, Niger, and Mauritania (36).

The bar graph below shows the number of unvaccinated children in millions and a percentage of incompletely vaccinated children in ten countries in 2013.



Source: http://www.euro.who.int/vaccine

Figure 1.1: Comparison of immunization dropouts before dpt3 for selected countries in 2012

The accumulation of incompletely vaccinated and unvaccinated children has led to outbreaks of vaccine preventable diseases worldwide. Evidence of this is given by the outbreak of measles in the WHO European region, where there were 41 000 children who were infected with measles in early 2018 (37). The outbreak has been attributed to incomplete vaccination and the number of unvaccinated children (38). According to WHO, measles outbreaks can be prevented by achieving immunization coverage of more than 95% (38).

A number of studies have been conducted in different countries to measure the immunization coverage and factors that influence full immunization coverage. A study conducted in Ethiopia

in 2011 aimed at identifying factors associated with full immunization coverage among children aged 12- 23 months. A sample of 1927 mothers with children aged 12- 23 months was extracted from the 2011 national demographic and health survey data and analysed. The prevalence of full immunization coverage was 24.3% and the predictors of full immunization were: women in the rich wealth index, women's awareness of community conversation programs, postnatal attendance within two months after birth and children with immunization cards (39).

A cross- sectional study was conducted in Atakumosa- west district, Osun State Nigeria (2016) which assessed routine immunization and its determinants. The study enrolled 750 mothers of children aged 12- 23 months. the findings of the study revealed that the children whose mothers attended ANC, received maternal TT immunization and mothers having knowledge on immunization were more likely to be fully immunized compared to their counterparts (40).

A number of studies conducted by several authors in different countries in the African region have revealed that predictors of full immunization coverage among children aged 12- 23 months are: first born child is likely to be fully immunized, children who were delivered in hospital, mothers who attended antenatal care, availability of immunization card, immunization knowledge and high educational level of the mother (41) (42)(43) (44) (45) (46).

1.2.2 Immunization Coverage in Swaziland

In Swaziland, the Comprehensive Swaziland EPI Review Report in 2011 indicated that the immunization coverage has been increasing steadily since the establishment of the EPI programme in 1980. The statistics indicated that between 2001- 2004 the coverage of DPT- 3 increased from 77% to 83%, measles from 72% to 79% and BCG has been at 90%. From 2005

to 2010, the rate of increase in coverage has been declining and overall coverage stopped increasing, with some variations in some of the antigens. In 2005 DPT-3 coverage was 71% and increased to 75% in 2010, measles coverage was 60% in 2005 and increased to 77% in 2010, whereas for BCG the coverage dropped from 84% to 57% (12). The Multiple Indicator Cluster Survey conducted in 2014 has indicated an overall immunization coverage of 70.7% (11) which does not show an improvement compared to previous immunization coverage.

1.2.3 Factors Associated with Incomplete Immunization Coverage

A study conducted by Favin et al in 2012 (47) in collaboration with WHO to investigate the reasons why children are unvaccinated globally showed that the reasons for under-immunization were related to immunization services, parental knowledge and attitudes. The most frequently cited factors were health staff attitudes, reliability of immunization services, parent's knowledge of vaccines, conflicting priorities and parent's beliefs, fear of side effects, and access to health facilities (47).

Analysed data from a number of DHS surveys has shown that immunization coverage is consistently higher among the wealthier populations than in the poorer populations (48)(49)(50). There are also direct and indirect contributing factors to low immunization coverage that include ethnicity, maternal education level, high birth order, and geographic access to health facilities (51). Other factors cited by Mworozi et al (2018) include inadequate and poorly motivated health care workers, negative messaging and the anti-vaccine lobby and inadequate social mobilization (52).

Several authors conducted a systematic review to assess the reasons related to non- vaccination and under-five vaccination of children in low and middle income countries in 2011 (53). Among the articles they reviewed they discovered a number of reasons associated with under-five vaccination. They categorized the reasons into different categories; immunization system (poor access and distance from vaccination services, shortage of vaccine supplies, health worker availability and knowledge, lack of integration of services and missing immunization card), family characteristics (literacy level of caregiver, low socio-economic status, family size, age, marital status of mother and religion), parental attitudes and knowledge (lack of knowledge pertaining to vaccinations and disease prevention, fear of adverse events following immunization (AEFI), and being a girl child) and limitation in immunization-related communication and information (inaccurate delivery of information from health care workers, and lack of social mobilization). They further abstracted 11 reasons from 19 articles describing the non- vaccinated children: 6 (32%) were related to immunization system, 8 (42%) to parental attitudes and knowledge, 4 (21%) to family characteristics and 1 (5%) to communication and information (53).

A cross- sectional study conducted in Togo in 2016, which assessed the predictors of incomplete immunization in 2067 children aged between 1- 5years found that the prevalence of incomplete immunization was 36.2% (54). The authors carried out a multivariable analysis and they found that children of illiterate mothers were more likely to be poorly vaccinated compared to those with secondary education, children from poor families were more likely to be poorly vaccinated compared to children from rich families. Place of residence, religion and the gender of the household head were also found to be predictors of incomplete immunization (54). A study that

was conducted in Nigeria in 2016 had similar results that children born from uneducated mothers are more likely to be unvaccinated compared to children of educated mothers (55).

A study conducted in Pakistan in 2015 to assess the factors associated with non-utilization of child immunization in the 2006-2007 periods, enrolled 2435 children aged between 12-23 months (53). The prevalence of incomplete immunization was 66% and significantly associated with the father's occupation and delivering at home (53). Another study carried out by Assegid et al in East Gojjam (Northern Ethiopia) in 2015 found that home delivery, mother who did not attend ANC, mothers with misconception on vaccine contra- indications and children born from mothers who had no PNC were factors associated with incomplete immunization. (56).

A case- control study was conducted in the slums of Kathmandu Valley in Nepal in 2015 assessing the predictors of incomplete immunization among children aged 12- 23 months residing in slums (57). The authors randomly selected 22 slums, 59 cases of incomplete immunized children and 177 children who were fully immunized. The factors that they found to be associated with incomplete immunization were poor knowledge on immunization schedule and negative perceptions towards vaccinating a sick child, conflicting priorities, AEFI, home deliveries and families residing in rented house (57).

In Brazil, a study was conducted in 2011 to describe the risk- factors for incomplete vaccination in children less than 18 months attending nurseries of day care centres (58). The authors conducted a cross-sectional study in which they enrolled 258 children and found that malnourished children, children born prematurely and those living in inadequate houses were more likely to be unvaccinated (58).

Another study was conducted in Malaysia (2017) to identify children at risk of incomplete immunization and their associated factors. They enrolled 10140 children aged between 12- 23 months of age (59). The prevalence of incomplete immunization was 45% and they found that children who were at risk of not being immunized were girls residing in urban areas having mothers who do not believe that vaccination can prevent the spread of diseases and their mothers had their ANC in a private healthcare facility. Other reasons that were found to contribute to incomplete immunization were vaccine shortages, child not due for vaccination yet or mother did not have time to take child for vaccinations, parent refused vaccine and mothers would say they forgot to take child for vaccination (59).

An unmatched case- control study was conducted in Arbegona district (Southern Ethiopia) in 2016 to identify determinant factors of incomplete childhood immunization. The authors identified 183 cases (children aged 12 to 23 months with incomplete childhood immunization) and then randomly sampled 365 controls (children aged 12 to 23 months with complete childhood immunization). Factors that were found to be significantly associated with incomplete immunization were: being born second to fourth and being born fifth or later, young mothers, lack of knowledge on the benefits of immunization, mothers' negative perception of vaccine side effects. Their qualitative findings revealed that migration of mothers and unavailability of vaccines on appointed immunization dates were the major reasons for incomplete immunization of children (4).

A study was conducted in Canada in 2016 to identify the sociodemographic determinants of non- vaccination and incomplete immunization. A sample of 5477 children aged 2 years old were included in the analysis. Overall, 2.7% of children (95% CI =2.0- 3.3) had no vaccination.

Lower parental education was associated with total non-vaccination and children from a household with a low income of $40,000 compared to children from a household with an income of $80 000 (60).

1.2.4 Factors Associated with Incomplete Immunization in Swaziland

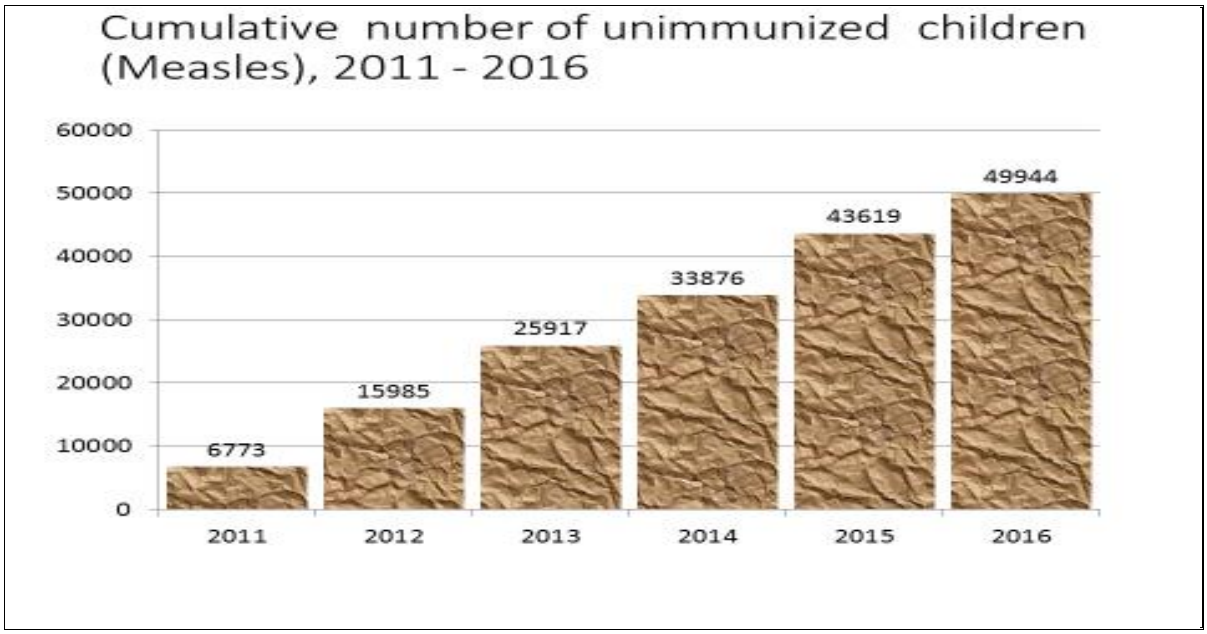
Analysed data from the Multiple Indicator Cluster Survey conducted in Swaziland in 2014 showed that only 70.7% children were fully immunized (11). Factors associated with incomplete immunization in Swaziland are not known, however administrative factors are suspected to affect the immunization coverage e.g. inadequate supportive supervision, incomplete data reporting by health workers and lack of transport for outreach services (12).

In summary, the literature reveals several factors contributing to incomplete immunization among children aged 12-23 months of age, the main demographic and socio- economic factors associated with incomplete immunization are: lack of education, which was found to be significantly associated with incomplete immunization by a majority of the researchers, home delivery and place of residence.

1.3 Problem statement

Incomplete immunization and non- immunization remain a global public health problem. Swaziland is not an exception and is also faced with challenges in achieving the WHO recommended routine immunization coverage target of 90%. Routine immunization coverage of OPV 3, DPT3 and measles in 2013 was 81.0%, 79.4% and 79.5% respectively. These figures are far below the EPI set target(31).

In Swaziland the EPI and the government have put in place a number of interventions to improve and strengthen routine immunization coverage through initiatives such as: the Reaching Every District (RED) intervention which aims to fully immunize children with all recommended vaccinations (12). Unfortunately, the strategy was never rolled out. Other strategies include the re-establishment of outreach services in hard to reach areas and the addition of supplementary immunization activities (12). The goal for the EPI programme is to reduce VPD related morbidity and mortality by increasing immunization coverage. However in 2010 the country experienced a huge measles outbreak which is attributable to the low immunization coverage and accumulation of unimmunized children (31). The number of unimmunized children in Swaziland was found to have increased from 6773 in 2011 to 49944 in 2016 (12). Figure 1.1 below shows the number of unimmunized children against measles in Swaziland. The possible known reasons that may have contributed to the escalating numbers could be the suspension of outreaches as some of these children reside in the hardest to reach areas of Swaziland (12).



Source: Comprehensive Swaziland EPI Review Report (2016).

Figure 1.2: Number of unimmunized children in Swaziland

1.4 Justification

In Swaziland, the routine immunization coverage had been increasing steadily over the years since its inception in 1980. The coverage in Swaziland is far below the target of 90% set by the EPI programme for routine immunization. Despite all the efforts, that the programme has put in place to increase and strengthen immunization coverage, the coverage still remains low. According to the MICS Report (2014) the overall full immunization coverage is 70.1% (51). In order to control (prevent) the re-emergence of VPD, a target of 95 % should be achieved especially for the coverage of measles because it is highly contagious (61). Vaccines reduce the risk of VPDs in children provided the children are fully immunized and they have acquired the maximum immunity threshold to be protected from VPDs. However, with the coverage the country has been achieving since 2010 the children are at risk of VPDs.

The factors associated with incomplete immunization in Swaziland have never been explored. The reason for conducting this study is to determine the proportions of non - immunization, incomplete immunization and complete immunization and to investigate the factors associated with incomplete immunization among children aged 11- 23 months.

1.5 Research Question

What are the proportions of non-immunization, incomplete immunization and complete immunization among children aged 11-23 months in Swaziland and what are the factors associated with incomplete and non-immunization?

1.6 Aim of the study

To determine the immunization status of children aged between 11-23 months in Swaziland and the factors associated with incomplete and non-immunization during the period 2014.

1.7 Objectives of the study

1. To determine the proportions with non- immunization, incomplete immunization and complete immunization overall and by antigen among children aged 11- 23 months in Swaziland during the period 2014.

2. To determine associations between maternal and child factors with incomplete immunization among children aged 11-23 months during the period 2014.

3. To determine predictors of incomplete immunization among children aged 11- 23 months in Swaziland during the period 2014.

4. To identify factors associated with no immunization among children aged 11-23 months in Swaziland during the period 2014.

CHAPTER 2: METHODOLOGY

2.1 Introduction

This chapter focuses on the methods that were used in undertaking this study. The sections of the chapter include study setting, study design, sampling procedure, study variables, data collection methods, data management, data analysis, ethical considerations and dissemination of results.

2.2 Study Design

This study was a cross- sectional secondary data analysis from the Multiple Indicator Cluster Survey conducted in Swaziland in 2014. The Multiple Indicator Cluster Survey (MICS) programme was developed by UNICEF in order to assist countries in collecting and analysing data for monitoring the situation of children and women through its international household survey. MICS makes available information that is up to date on maternal and child health and measures key indicators that allows countries to monitor progress towards MDGs. MICS is conducted after every three years (11).

The MICS5 was conducted in Swaziland in 2014 by the Central Statistics Office (CSO) in collaboration with UNICEF and it was the fifth round of MICS. The survey was a nationwide survey conducted in Swaziland across all the four administrative regions, Hhohho, Lubombo, Manzini and Shiselweni. The study was a cross-sectional survey and its main aim was to collect information for policy makers, researchers and programme managers that would be used in planning, monitoring and evaluation of population and health programmes (11).

It consisted of four questionnaires namely household questionnaire, under- fives questionnaire, women's and men's questionnaire. Information obtained from the women's questionnaire included background characteristics, birth history (including baby's birthweight), antenatal, delivery and postnatal care and health related issues. The under- five questionnaire contained immunization history, anthropometry and history of illnesses.

2.3 Study setting

The study was conducted in Swaziland, which is one of the countries in the sub- Saharan African region located in the Southern part of Africa; it is a small (17,364 km sq.) landlocked country. The country is almost surrounded by the Republic of South Africa. Administratively the Kingdom is divided into four regions namely Hhohho, Lubombo, Manzini and Shiselweni, with Manzini having the highest population of 340,251 people. Some rural areas in the country are hard to reach due to the mountainous nature of the country. Approximately 77% of the population live in rural areas and 23% live in cities and towns.

The 2014 MICS5 was conducted in the four administrative regions. According to the 2007 population count, the total population of Swaziland was estimated to be 1,018,449, comprising of 53% women, 47% men, with 44% of the population being under 15 years, 13% being under five years old, 2.9% aged under one year, while women of child bearing age (15- 49) constitute 27% of the total population.

2.4 Study Population

MICS had a target population of men aged 15- 59 years, women aged 15- 49 years and children under the age of five years. For this report, mother – baby pairs were included in the analysis, if the child was aged between 11- 23 months. In addition, if a mother had two babies e.g. twins in the age range 11- 23 months, data for only one twin, who was selected randomly was included in the secondary data analysis.

Immunization information of children who were aged between 11- 23 months was collected from their road to health cards. If the child had a missing immunization card or if the information was missing on the immunization card, the mother's recall on the vaccination was used. Children aged 11- 23 months were selected because they are the youngest cohort who had reached the age by which they should be fully immunized. The primary vaccinations in Swaziland are completed at the age of nine months. Additionally, most of the studies conducted previously have used the same age group for studying the uptake of vaccination (62).

2.5 Sampling

The primary study selected a nationally representative sample of 5211 households in 347 sample clusters (EAs) using a stratified multistage sampling method. The population was stratified by region and by urban and rural areas within each region. Within each stratum, a two-stage sample was selected, with a specified number of EAs selected with probability proportional to size at the first stage, and a systematic sample of 15 households was drawn from each sample EA. The

sample was stratified by region, urban and rural, and is not self- weighting. For reporting the survey results, sample weights were used (11).

From the total sample of 5211 households, 4762 contained at least one woman aged 15-49, and 2693 mothers/ caretakers of children under 5 years of age were interviewed.

No sampling was done for this study: all records of mother- baby pairs that qualify for inclusion as detailed above were used for analysis. Immunization status was established for every child based on the immunization card and mothers recall.

2.6 Sample Size Consideration

The sample included all children from the MICS report (11) out of the 2728 children under- five years. For this secondary data analysis, there were approximately 500 mother- baby pairs sample extracted from the MICS dataset, who satisfied the criteria of being included in the analysis (i.e. being a baby aged between 11- 23 months). The calculations below show that this sample size of approximately 500 mother- baby pairs is sufficient to estimate the proportion of babies with incomplete immunization and to have at least 80% power to detect large or moderate exposure effects. The calculations need to take into account the effect of clustering of mother-baby pairs within EAs. If we assume that this clustering results in a design effect (DEFF) of approximately 1.5, then the effective sample size will be:

Effective sample size is $\frac{500}{1.5}$ = 333.33 which is approximately 330.

- If the proportion of incomplete immunization is approximately 45% (59) this will be estimated with precision of 2* s. e (p) = 2* $\sqrt{\frac{(0.45)(0.55)}{330}}$ = 0.05478 = 0.05*100= 5%

- In order to show that the study has sufficient power to detect moderate to large effects, the following example can be considered: to compare the proportions with incomplete immunization between those who delivered in health facilities and those who delivered at home. Suppose 87% (11) of deliveries in Swaziland take place in health facilities and only 13% deliver at home, then in terms of the effective sample size, this would translate into 280 mothers who delivered in hospital and 50 who delivered at home. The study had 80% power to detect as statistically significant at 5% level a true absolute difference of 20% in the proportions of children with incomplete vaccinations between those who delivered at home and those who delivered in hospital. Similarly, the study had sufficient power to detect other large effects. The power calculations were carried out in Stata.

2.7 Data Collection

The primary study used validated questionnaires for data collection. There were four sets of questionnaires that were used in the survey. The first questionnaire was the household questionnaire which was used to collect basic demographics on all household members the household and dwelling. The second questionnaire was for women aged 15- 49 years, which was addressing the woman's socio-demographics, reproductive health and services use behaviours. The third questionnaire was for the men aged 15- 59 years also addressing health related information. Lastly the under –five questionnaires. Fieldworkers were trained for 19 days, training included lectures on interviewing techniques and contents of the questionnaire. Pretesting of the questionnaire was done for five days in neighbouring areas around Manzini.

Information on immunization status was collected from all children under the age of two years; the child immunization card was used. Information from the immunization card was copied onto the questionnaire. If the vaccination card was unavailable, the mothers were asked to recall the vaccines given to the child and the number of doses the child received. For this study, only information on children between the ages of 11- 23 months and information on the mothers' socio- demographics were used for the analysis.

2.8 Definition of key terms

Antenatal care – care given to a pregnant woman during pregnancy by skilled health- care professionals to ensure the best health conditions for both mother and baby. WHO recommends a minimum of four contacts for a low- risk and more than four visits for a high- risk pregnancy by any health care professional (11).

Immunization/vaccination **-** is the process of rendering protection to a child so that they can be protected from infectious diseases through administration of a vaccine

Fully immunized child – a child between the age of 12- 23 months who has been vaccinated with one dose of BCG, three doses of OPV and DPT and one dose of measles before reaching the age of one year (63).

Incomplete immunization – a child aged between 12- 23 months who has missed at least one of the recommended doses (4)

Unimmunized/unvaccinated – a child between 12- 23 months who has never received any of the recommended doses of the vaccines above (64).

Full immunization coverage – is the proportion of children who are aged between 11 – 23 months who have been vaccinated with all the recommended vaccines (one dose of BCG, three doses of OPV and DPT and one dose of measles) in the national immunization before they are one year old (11).

Immunization coverage – is the percentage of children aged fourteen weeks who have been vaccinated with DPT 3 over the total number of children under one year old in that period (6), it is mostly used as a key measurement for immunization system performance (65).

Immunization card: is an official document used to record all vaccinations that a child has received from birth till five years of age (66).

Postnatal care – care given to a woman and her newborn 2 – 7 days after delivery by a health professional (67).

2.9 Study variables

2.9.1 Outcome Variables

In this analysis, the outcome (dependent) variable is ***"immunization status"*** which is a binary variable, which takes the values 1 (for incomplete immunization) or 0 (for full immunization). Children who have received one shot of BCG (protecting them against tuberculosis), three shots of OPV (a vaccine to prevent polio) and DPT (for preventing diphtheria, pertussis and tetanus) and one shot of MCV1 (preventing them against measles) were considered to be fully immunized (68) (69). Those who missed at least one of the vaccines were said to be incompletely immunized. The outcome variable was computed using eight doses of four antigens e.g. BCG (1 shot), OPV (3 shots), DPT (3 shots) and measles (1 shot). The mothers

were asked whether the child had an immunization card, if the card was available dates of vaccinations were copied to the child questionnaire, if some dates were missing the mother was asked whether the child was vaccinated. In the case of children who did not have an immunization card, or in cases where the immunization card was not seen, the mothers would be asked to recall which vaccinations and the number of doses the child had received. If the number of doses were less than the required, they were categorized as incompletely immunized. Incomplete immunization in children is defined as having missed at least one dose in the immunization schedule up to 23 months of age (59).

2.9.2 Exposure Variables

The exposure variables were based on available literature reviewed and available data within MICS5 (11). The exposure variables considered in this study were categorized into maternal and child factors. Potential confounders were also identified.

2.9.2.1 Maternal Factors

Exposures

Antenatal care: the variable in the MICS study asked the mother whether she saw someone for antenatal care during her pregnancy referring to either a doctor, nurse/midwife, traditional birth attendant, community health worker or other person. The responses were categorized into 'yes' or 'no', and for the current study it was adopted as it is.

Place of delivery: for the MICS study this was categorized into your home or other home, public health facility (government hospital, government health Centre, government clinic/PHU,

government outreach site or other public facility) or private medical facility (private hospital, private clinic or other private). For this analysis the variable was categorized as home delivery or health facility.

Post-natal care: During the primary study, the mother was asked whether her health was assessed after delivery. For the current study, the variable was adopted as it is (post-natal attended 'yes' or 'no').

Confounders

Education level: (level of education) from the MICS it had five categories. For this analysis it was categorized into four: no education, primary education, secondary education or higher and above.

Parity: this variable indicates the number of children ever born. In the MICS study, all births were recorded whether still alive or dead. For the current study, four categories were generated for this variable; first category was one child, the secondly was a mother with two children, thirdly were mothers with three to four children and the last one were mothers with five or more children.

Religion: in the primary study this was categorized into five categories namely Christianity, Islam, Judaism, Hinduism, Traditionalist. For this analysis the variable was classified into two categories namely Christianity versus traditionalist/ other, due to the small frequencies for the categories apart from Christianity.

Wealth index: this variable is derived from assets that the household owns to assess the household's cumulative standard of living. The primary study used five categories and for this study it was adopted as it is. The categories are; poorest, second, middle, fourth and richest.

Exposure to mass media: this variable was measured using the frequency of listening to the radio and watching television for the current study. Internet, newspapers, computers and social media were excluded in this analysis. The reasons for excluding these media are that they are expensive and not available in some parts of the country.

Marital status: there were four categories for this variable; living with a man, formally married, widowed, divorced and separated. For this analysis, it was categorized into 1. Married/ cohabiting. 2. Single and 3. Widowed/ divorced/ separated.

Place of residence: the variable was categorized into two: whether the mother resides in a rural setting or urban setting.

Region: this variable was adopted as it is from the MICS divided into four categories, which are Hhohho, Manzini, Shiselweni or Lubombo.

Age of mother: (age of the mother in years at the time of the primary study) the age of the mother was categorized into three categories (15-24, 25-34 and 35-49).

2.9.2.2 Child factors

Exposure

Birth weight: birth weight at delivery was used to categorize babies with a birth weight of less than 2.5 kg as low birth weight babies but for this analysis it is using the very low birth weight of less than 2 kg and those 2 kg or more were categorized as normal babies.

Immunization card: from the primary study the respondents were asked if child has an immunization card, it had three possible answers which were; yes, card was seen by the interviewer, the second answer was yes card was not seen and the last answer was no vaccination card. If card was available, vaccine dates were transferred to the MICS questionnaire and if the card was missing, the mother was asked on vaccination status of the child to recall whether received the antigen and how many doses the child on each antigen. For the current study, the variable was adopted as is from the primary study.

Confounders

Sex of child: was adopted, as it is from the MICS dataset with two categories of either male or female.

2.10 Data Management

For the primary study data, entry was done using the CSPro software, version 5.0. Seven data entry operators and one supervisor entered data on seven desktop computers. For quality assurance purposes, all questionnaires were double entered and consistency checks were performed to ensure accuracy and completeness of data. MICS data was analysed using the Statistical Package for Social Sciences (SPSS) software version 21. The data was weighted to account for non- response for household and individual interviews, selection probability and sampling variations between regions and to produce national estimates of the population that are representative.

Data was received in SPSS format and was imported to Stata version 15 for analysis. Data cleaning was performed, including consistency checks, there were no duplicates and participants' identifiers were already removed. Three datasets were merged (data from under-

five questionnaires, women's questionnaire and household questionnaire). Thereafter, recoding and generation of new variables was done. The independent variables such as the demographics and socioeconomic factors were extracted accordingly. Some variables had missing values e.g. those who received postnatal care were 377 and those who did not were 36 with 107 missing. In such cases new variables were generated by combining the missing and those who did not receive postnatal care. Child immunization information was also extracted. Information on pneumococcal vaccine (PCV) was not included for this analysis because the vaccine was introduced into the national EPI schedule in 2014. Thereafter, new variables such as the outcome variable was generated as "incomplete immunization" (yes = 1 and no = 0). The data was kept in a password-protected database.

2.11 Data Analysis

All data analysis took into account of the multistage survey design, in particular the clustering of observations and the differential weighting of observations, using the "svy" commands in Stata release 15. Descriptive analysis was performed to describe the socio-demographic characteristics of the study population. Since this was a descriptive analysis and all variables were categorical, frequencies and weighted percentages were reported.

For objective 1, the proportions (%) of incomplete vaccination and complete vaccination were reported. Prevalence of incomplete immunization was reported by region, antigens, and socio-demographic characteristics.

For objective 2 Firstly, a univariable analysis was conducted for each explanatory variable (exposures and confounders) to determine factors associated with incomplete immunization. Odds ratios (OR) with their corresponding 95% CI were reported.

For objective 3 the final multivariable logistic regression model was selected to identify the predictors of incomplete immunization among children aged 11- 23 months. The final model was selected using a backward elimination stepwise algorithm using a liberal 20% significance level. Factors associated with incomplete immunization at the 5% significance level that were found to be significant in the univariable analysis were included in the final model. Terms were also included in the model if they were of a priori importance or they were found to play a significant confounding role (i.e. changing the estimated ORs of important exposures by more than 10%). Such a variable was the age of the mother.

The results were reported as adjusted odds ratios (AOR) with 95% confidence intervals. A test for multicollinearity was carried out to check for multicollinearity and the mean variance Inflation factor (VIF) was reported (a VIF of less than 10 indicates that there is no multicollinearity) (70). The final model was checked for goodness of fit using Hosmer and Lemeshow test (p value above 0.05 shows that there is no evidence of lack of fit of the model)(71).

We could not carry out an analysis to meet objective 4 as there was only one child with no immunization.

2.12 Ethical consideration

The primary study received ethical clearance from Swaziland MOH REC and informed consent was obtained before data was collected. For this study the dataset is freely available on the internet on this web page; http://www.mics.unicef.org, for the public by request. After sending a brief description of the purpose of the study and objectives to the MICS team (UNICEF) permission to use the dataset was granted. Furthermore, permission was sought from the Central Statistics Office (CSO) in Swaziland as the gatekeepers of the data. For this secondary analysis, ethical clearance was obtained from the Human Research Ethics Committee (Medical), University of the Witwatersrand before the commencement of the study. The ethical clearance certificate number is M190219 (appendix 1). The Faculty of Health Services of the University approved the title of the study (appendix 2).

The data that were extracted was used strictly for the purposes of this study. De-identified data were used for the analysis to observe the principle of confidentiality.

2.13 Dissemination of Results

The findings of the study will be disseminated to the Ministry of Health in Swaziland through an oral presentation and a copy of the final research report will be shared with the EPI programme. Also, the results will be shared with the global MICS team - UNICEF as they also expressed interest on the findings of the study. In addition, copies of the final research report will be made available to the University's library, University of the Witwatersrand and to the supervisor. The results will also be published in a peer-reviewed journal.

CHAPTER 3: RESULTS

3.1 Introduction

This chapter presents the findings of the study. The explanatory variables are divided into maternal and child characteristics and the associations of these variables with incomplete immunization among children in Swaziland aged 11-23 months are presented. Since the analysis was on survey data, weighted percentages are reported.

3.2 Background characteristics of the study participants

A total number of 520 mother- baby pairs aged between 11- 23 months old are included in this analysis. It can be observed from Table 3.1, which presents frequencies and weighted percentages, a majority of participants 427 (74.3%) lived in the rural areas with only 93 (25.7%) from the urban areas.

The greatest proportion of the mothers were aged between 25 and 34 years, 211 (41.1%). The smallest proportion of the women have no education, 32 (4.8%) while the largest proportion of the mothers have secondary education, 175 (32.2%). The majority of the participants were single 285 (54.8%) and the smallest proportion are either divorced, widowed or separated, 46 (8.6%).

Table 3.1: Background Characteristics of Study Participants (N=520)

Characteristics	Level	Frequency	Weighted percentage (%)
Mothers' Age	15-24	198	38.9
	25-34	211	41.1
	35-49	111	20.1
Region	Hhohho	136	24.0
	Lubombo	115	21.3
	Manzini	137	37.3
	Shiselweni	132	17.4
Area	Rural	427	74.3
	Urban	93	25.7
Marital status	single	285	54.8
	Married/ cohab	189	36.6
	Widowed/divor/seper	46	8.6
Education Level	No education	32	4.8
	Primary	147	27.9
	secondary	175	32.2
	Higher +	166	35.2
Parity	1	148	29.4
	2	129	26.0
	3-4	148	26.9
	5+	95	17.7
Religion	Christianity	516	99.1
	Traditionalist/other	4	0.9
Wealth index	poorest	138	22.6
	Second	125	23.5
	Middle	114	19.0
	Fourth	72	15.2
	Richest	71	19.0
Exposure to media	Yes	418	81.7
	No	102	18.3

Table 3.2 presents frequencies and weighted percentages, on health facility utilization. The results indicate that a majority of women were utilizing health facilities, for those who attended antenatal care during pregnancy were 92.1%, those who delivered in a health facility were 81.4% and those who received postnatal care after delivery were 74.6%.

Table 3.2: Background characteristics by health facility utilization (N=520)

Factors	Level	Frequency	Weighted Percentage (%)
Place of delivery	Home/ elsewhere	103	18.6
	Health facility	417	81.4
Received antenatal care	Yes	473	92.1
	No	7	1.0
	Missing	40	6.9
Received Postnatal care	Yes	377	74.6
	No	36	6.1
	Missing	107	19.3

3.2.1 Background characteristics of the children

Children included in the analysis were aged between 11- 23 months. Table 3.3 presents the results on the background characteristics and weighted percentages are reported. The mean age was 16.8 months (95% CI= 16.47- 17.13). The proportion of females was slightly higher than that of males, 261 (58.9%). The majority 468 (90.4%) had immunization cards that were seen, those who reported to have immunization cards but were not seen, 45 (8.5%), and only seven (1.1%) did not have immunization cards and 421 (79.1%) had normal birthweight. It is worth

noting that there were only 28 children with low birth weight and only 7 without immunization cards.

Table 3.3: Background characteristics of children

Factor	Level	Frequency	Weighted Percentage (%)
Sex of child	Male	259	49.1
	Female	261	50.9
Birth weight	Low birth weight	28	5.4
	Normal birth weight	402	79.1
	Missing	90	15.5
Vaccination Card	Yes seen	468	90.4
	Yes, not seen	45	8.5
	No	7	1.1

3.3 Immunization Status of children aged 11- 23 months

Figure 3.1 shows the immunization status of children aged 11- 23 months old, it is indicated that out of the 520 children included in the analysis, 123 (23.7%; 95%CI= 0.20.1%,27.5%) were incompletely immunized.

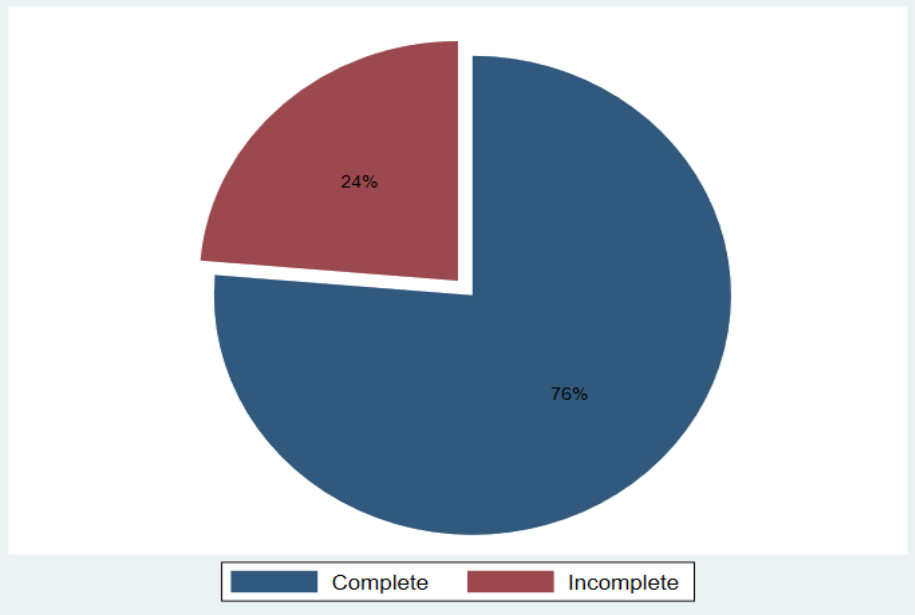


Figure 3.1: Immunization status of children aged 11- 23 months in Swaziland, 2014

3.3.1 Immunization status by specific antigen

Figure 3.2 shows that 98.2%; 95%CI= 96.7%,99.2% children were immunized with BCG vaccine, the antigen with the lowest proportion of incomplete immunization. A relatively higher percentage of children received the first dose of DPT (93.3%; 95% CI= 89.9%,94.6%). However, 89.2%; 95% CI= 89.0%,94.0% received the third dose of DPT, which is almost similar with the second dose (88.6%; 95%CI= 89.2%,94.1%). The first dose of OPV on the other hand, had 92.5%; 95% CI = 90.8%,95.3% who were vaccinated and the third dose, 91.7%; 95%CI=86.2%,92.8% were vaccinated. OPV and DPT vaccines are often routinely administered at the same time. These results displayed in Table 3.4 are puzzling. The proportion of children who received measles vaccine was 89.6%; 95%CI=86.7%,92.1%).

Table 3.4: Incomplete Immunization of DPT versus OPV

DOSES	DPT (%)	OPV (%)
1	6.7	7.5
2	11.4	8.1
3	10.8	8.3

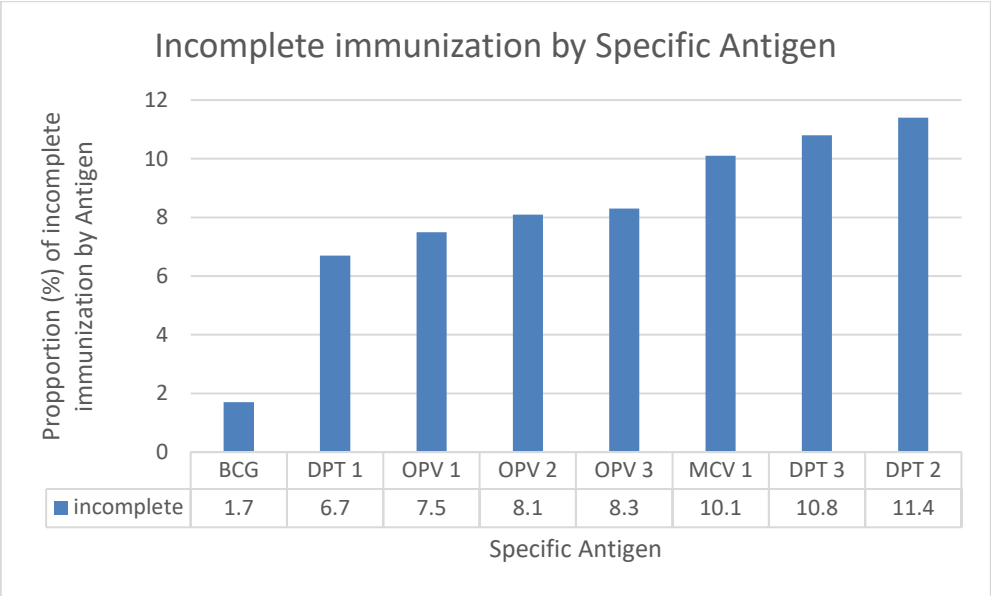


Figure 3.2: Graph Showing Incomplete Immunization by Specific Antigen for Children aged 11- 23 Months

3.3.2 Immunization status by maternal socio-demographic characteristics

Table 3.5 gives the immunization status of children by maternal characteristics and results presented in weighted percentages.

Mothers' age

Women aged between 35 and 49 years had the highest proprotion of children who were not fully immunized (27.2%).

Region

The proportion of children who were incompletely immunized was very similar in the four regions.

Area of residence had no influence on child immunization, those living in the rural area have 22.9% of children who were incompletely immunized and 23.0% were incompletely immunized among the children residing in the urban area.

Marital status

These results indicated that marital status had an influence on the immunization status of children. Single and widowed, divorced, separated mothers had similar proportions of incomplete immunization (20.7% vs 19.8%). Married mothers on the other hand had a slightly higher percentage of incomplete immunization 27.0%.

Education level

The results in table 3.5 shows that children whose mothers had no education had a high proportion of incomplete immunization, 33.6% compared to mothers with secondary education having the lowest percentage of incompletely immunized children, 20.5%.

Parity

Parity was found to be associated with incomplete immunization. Children of mothers with five or more children had the highest percentage of incomplete immunization (29.8%), while children of mothers having two children had the lowest percentage of incomplete immunization (19.5%).

Religion

Those mothers who were traditionalist or other had a high proportion of incomplete immunization status (85.8%) compared to mothers who were Christians (22.4%). Mothers in the traditionalist or other were very few compared to Christian mothers.

Exposure to media

Children of mothers who were not exposed to media had a higher proportion of children who were incompletely immunized (30.6%) compared to children of mothers who were exposed to media (21.3%).

Wealth index

The richer the household, the greater the probability that the child was incompletely immunized, with the exception of the second poorest wealth quintile which had the highest proportion with incomplete immunization (28.5%).

Table 3.5: Immunization Status by Maternal Characteristics (N=520)

characteristics		Incomplete	Complete	Total
	Level	N (Weighted %)	N (Weighted %)	
Mothers' Age	15-24	44 (23.9)	154 (76.1)	198 (100)
	25- 34	44 (20.0)	167 (80.0)	211 (100)
	35-49	35 (27.2)	76 (72.8)	111 (100)
Region	Hhohho	36 (25.3)	100 (74.7)	136 (100)
	Lubombo	23 (20.6)	92 (79.4)	115 (100)
	Manzini	32 (22.3)	105 (77.8)	137(100)
	Shiselweni	32 (24.2)	100 (75.8)	132 (100)
Area	Rural	99 (22.9)	328 (77.1)	427 (100)
	Urban	24 (23.0)	69 (77.0)	93 (100)
Marital status	Single	63 (20.7)	222 (79.3)	285 (100)
	Married/cohab	48 (27.0)	141 (73.0)	189 (100)
	Widowed/di/se	12 (19.8)	34 (80.2)	46 (100)
Education level	No educ	12 (33.6)	20 (66.4)	32 (100)
	Primary	38 (25.9)	109 (74.2)	147 (100)
	Secondary	36 (20.5)	139 (79.4)	175 (100)
	Higher +	9 (23.0)	24 (77.0)	33 (100)
Parity	1	32 (23.4)	116 (76.6)	148 (100)
	2	26 (19.5)	103 (80.5)	129 (100)
	3-4	32 (21.3)	116 (78.7)	148 (100)
	5+	33 (29.8)	62 (70.2)	95 (100)
Religion	Christianity	120 (22.4)	396 (77.6)	516 (100)
	Traditional/Other	3 (85.8)	1 (14.2)	4 (100)

Table 3.5 (*cont.*)

Characteristics	Level	Incomplete N (Weighted %)	Complete N (Weighted %)	Total
Exposure to Media	Yes	92 (21.2)	326 (78.8)	473 (100)
	No	31 (30.6)	71 (69.4)	102 (100)
Wealth index	Poorest	27 (18.6)	111 (81.4)	138 (100)
	Second	34 (28.5)	91 (71.5)	125 (100)
	Middle	25 (20.4)	89 (79.6)	114 (100)
	Fourth	17 (22.6)	55 (77.4)	72 (100)
	Richest	20 (24.3)	51 (75.7)	71 (100)

3.4 Immunization status by health facility utilization

Utilization of health facility had an influence on the immunization of children. It can be seen from Table 3.6 that children of women who did not utilize the health facility during pregnancy and during delivery and who did not receive postnatal care their children had a higher proportion of incomplete immunization.

Table 3.6: Immunization status by utilization of health facility

Characteristics	Levels	Incomplete N (Weighted %)	Complete N (Weighted %)	Total
Received ANC	Yes	104 (21.5)	369 (78.5)	473 (100)
	No	19 (40.2)	28 (59.8)	47 (100)
Received PNC	Yes	77 (19.7)	300 (80.3)	377 (100)
	No	46 (32.5)	97 (67.5)	143 (100)
Place of Delivery	Home/elsewhere	34 (33.5)	69 (66.5)	103 (100)
	Health facility	89 (20.6)	328 (79.5)	417 (100)

3.5 Immunization status by child factors

Immunization status by sex of child

Figure 3.3 shows that incomplete immunization status of the males is slightly higher 25.1% compared to that of females 22.2%.

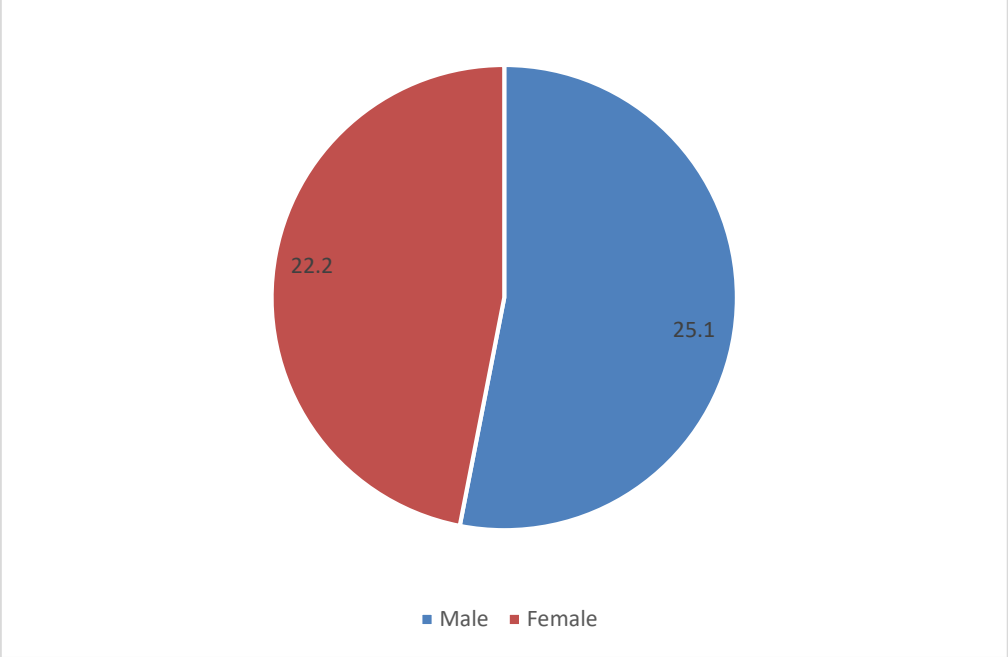


Figure 3.3: Incomplete Immunization by Sex of Child

Vaccination card

The results in table 3.7 show that availability of the immunization card had an influence on the immunization of children. Those who were seen to be in possession of an immunization card had a low proportion of children with incomplete immunization (18.5%) compared to children who reported to have immunization cards and were not seen (62.8%). A high proportion of children who were incompletely immunized was observed among children who did not have immunization cards (79.9%).

Birth weight

Table 3.7 shows that children with low birth weight were less likely to be incompletely immunized (3.8%) compared to children with normal birth weight (23.9%). However it is worth noting that there were 28 children with low birth weight and only 7 without immunization cards.

Table 3.7: Immunization status by child factors

characteristics	Level	Incomplete N (Weighted %)	Complete N (Weighted %)	Total
Sex	Female	66 (22.0)	194 (78.1)	259 (100)
	Male	58 (23.9)	203 (76.1)	261 (100)
Vaccination card	Yes, seen	91 (18.5)	377 (81.5)	468 (100)
	Yes, not seen	27 (62.8)	18 (37.2)	45 (100)
	No	5 (79.9)	2 (20.1)	7 (100)
Birth weight	Normal weight	85 (23.94)	317 (79.3)	402 (100)
	Low birth weight	6 (3.8)	22 (96.3)	28 (100)
	Missing	32 (37.9)	58 (62.1)	90 (100)

3.6 Factors associated with incomplete immunization

Table 3.8 presents results obtained after fitting robust (svy) univariable logistic regression models to investigate the associations between maternal and child characteristics and incomplete immunization among children aged 11 - 23 months. The maternal and child characteristics that were found to be associated with incomplete immunization in the univariable analysis are place

of delivery, postnatal care, antenatal care, religion, birth weight and vaccination card. Exposure to media was marginally significant in this robust univariable analysis.

The odds of incomplete immunization were higher for mothers who did not attend antenatal care, the children were 2.4 times (Odds Ratio [OR] = 2.45; 95% CI = 1.29 – 4.68) more likely to be incompletely immunized compared to mothers who received antenatal care.

The odds of incomplete immunization were high for mothers with traditionalist or other religion, the children were 21 times (OR= 21.02; 95% CI= 2.10-210.69) more likely to be incompletely immunized compared to mothers from the Christian religion. The odds of incomplete immunization were high for children who were delivered at home (OR= 1.94; 95% CI= 1.18-3.20) compared to children who were born in health facilities. Children of mothers who did not receive postnatal care are more likely to be incompletely immunized (OR=1.78; 95% CI = 0.81 - 3.89) compared to children of mothers who received postnatal care.

The odds of incomplete immunization were associated with the status of the immunization card. Both children for whom the immunization card was not seen (OR=7.43; 95% CI = 3.30-16.7) and those who did not have immunization cards (OR=17.4; 95% CI= 1.98-153) were more likely to be incompletely immunized than children who had immunization cards. The odds of incomplete immunization were high for children who had missing birth weight (OR= 2.42; 95% CI= 1.24 -4.11) compared to children with a recorded birth weight or that was recalled by the mother. The odds of children with low birth weight for incomplete immunization (OR=1.04; 95% CI 0.34 - 3.18) are similar to the odds for children with normal birth weight. Children of

mothers who did not have access to media were more likely to be incompletely immunized (OR = 1.64; 95% CI= 0.95 - 2.82) compared to children of mothers who did have access to media.

3.7 Predictors of Incomplete Immunization

Robust multivariable logistic regression models were fitted to determine the predictors of incomplete immunization among children aged 11- 23 months old. Table 3.8 presents the results of the analysis. The table shows that vaccination card status was a significant predictor of incomplete immunization among children aged 11-23 months in Swaziland, while place of delivery and religion were marginally significant.

The results shows that after adjusting for other variables, children whose mothers reported having a card, but for whom the card was not seen were 7.1 times (Adjusted Odds Ratio [AOR] = 7.11; 95% CI= 3.19, 15.86) more likely to be incompletely immunized compared to children for whom the immunization cards were available and seen. Children not having an immunization card were 15.3 times (AOR = 15.32; 95% CI= 1.89,124.17) more likely not to be immunized compared to children with available and seen immunization cards.

There was some evidence of an association between place of delivery and incomplete immunization; children who were delivered at home were marginally significantly more likely to be incompletely immunized (AOR=3.46; 95% CI 0.92y, 12.92; P=0.065), Similarly children of mothers who followed a religion other than Christianity were marginally significantly more likely to be incompletely immunized (AOR=14.09; 95% CI 0.76, 260.96; P=0.076).

In conclusion, from this multivariable logistic regression analysis, the mother's age, exposure to media, postnatal care, antenatal care and birth weight were found not to be predictors of incomplete immunization among children aged 11- 23 months in Swaziland in 2014.

Table 3.8: Predictors of incomplete immunization

Factor	Level	Unadjusted odds ratio (95% CI)	P-value	Adjusted odds ratio (95% CI)	P-value
Mothers age		1.02 (0.99, 1.05)	0.221	0.10 (0.96, 1.03)	0.768
Religion	Christianity	1.00 (base)		1.00 (base)	
	Traditionalist/other	21.02 (2.10, 210.69)	0.010	14.09(0.76,260.96)	0.076
Place of delivery	Health facility	1.00 (base)		1.00 (base)	
	Home/elsewhere	1.95 (1.18, 3.20)	**0.009**	3.46 (0.92, 12.92)	0.065
Exposure to med	Yes	1.00 (base)		1.00 (base)	
	No	1.64 (0.95, 2.82)	0.078	1.35 (0.75, 2.41)	0.313
Antenatal care	Yes	1.00 (base)		1.00 (base)	
	No	2.45 (1.29, 4.68)	**0.007**	1.44 (0.52, 3.98)	0.485
Postnatal care	Yes	1.00 (base)	**0.003**	1.00 (base)	
	No	1.96 (1.26, 3.05)		1.80 (0.81, 3.99)	0.146
Vaccination	Yes, seen	1.00 (base)		1.00 (base)	
card	Yes, not seen	7.43 (3.30, 16.73)	**<0.001**	7.11 (3.19, 15.86)	
	No	17.43 (1.98, 153.66)		15.32 (1.89,124.17)	**<0.001**
Birth weight	Normal	1.00 (base)		1.00 (base)	
	Low birthweight	1.04 (0.34, 3.18)	**0.005**	1.25 (0.34, 4.59)	0.131
	Missing	2.42 (1.42, 4.11)		2.96 (0.61, 14.38)	

The final model above was checked for goodness of fit using Hosmer and Lemeshow test, p value 0.88 showing that there was no evidence of lack of fit of the model. Also, a test for multicollinearity was carried out and the mean variance Inflation factor (VIF) was 2.56 less than 10 indicating that there was no multicollinearity.

CHAPTER 4: DISCUSSION

4.1 Introduction

This study was conducted to determine the maternal and child factors associated with incomplete immunization among children aged 11- 23 months in Swaziland in 2014. We found that the prevalence of incomplete immunization was 24%. Considering antigen specific immunizations, DPT and measles had the highest prevalence of incompletely immunized children. The study assessed a number of maternal and child factors that might contribute to incomplete immunization. From the analysis the factor that was found to be associated with incomplete immunization was the status of the immunization card (children of mothers who either did not have an immunization card or who had not brought the card with them being more likely to have incomplete immunization), while place of delivery and religion were marginally significant. According to WHO a child has to complete immunization before the first birthday: a child who is fully immunized must be vaccinated with one dose of BCG, three doses of DPT and OPV and one dose of MCV1 (4).

4.2 Discussion

The percentage of full immunization coverage remains far below the EPI program's objectives described in their five-year comprehensive Multi Year Plan (cMYP) of 2016- 2020. The objective was to increase and sustain routine immunization coverage from 75% in 2010 to 95% in 2016 (72). The EPI conducts programme reviews every five years that are found to be important in the effective implementations and strengthening of national programs. From the review conducted in 2011, they reported that in 2010 full immunization coverage was 75% (72).

The study has observed that full immunization coverage in 2014 was 76% (23), which is an increase of only one percent from the 2010 coverage. In the African continent, our immunization coverage is comparable to a coverage that was recorded in Kenya (76.6%) (73) , but not for children in Nigeria who have a higher coverage (84.9%) (74). WHO sets immunization targets of 90% at national level for all member state countries, the country is still falling short.

There were variations in the coverage for the different antigens. The coverage for BCG, which is administered at birth, was very high at 98.3%. These results are similar to those from a study that was conducted in Cameroon (64). DPT3 recording a coverage of 91.7%, OPV3 89.2% and MCV1 89.6%. Though DPT3 and OPV3 are routinely administered at the same time at fourteen weeks, DPT coverage is slightly higher by 2%, OPV and DPT vaccines are often routinely administered at the same time. These results were puzzling, nevertheless, there may be different interpretations to this anomaly and the obvious interpretation is that it could be due to poor documentation on children's cards and another possibility could be vaccine stock outs. WHO has targeted 90% for DPT3, OPV3 and MCV1 coverage at national level (21), in 2014 the country managed to achieve the set target of these antigens. However, the country has its own target of achieving 95% immunization coverage (72). These estimates of specific vaccine coverage are used in the monitoring of vaccination services to guide disease eradication and elimination programmes and as indicators for health system performance (42).

We found a high dropout rate between BCG (98.3%) vaccination and MCV1 (89.6%), a dropout of almost 10%. In 2010, measles coverage was 77% and in 2015 coverage was 81.5%, indicating poor compliance for vaccines that are administered later in infancy. The reason for the high rate

of incomplete immunization might be the long period between the first dose of BCG at birth and the measles immunization at 9 months. One study conducted in Malaysia also indicated similar trend in measles coverage (75).

The MCV1 coverage rates are far below the targets for a country that is in the elimination phase of measles. The target that was set by the African Region for measles elimination by 2020 is 95% measles coverage at national and regional level. With the resurgence of measles in some parts of the world this is alarming because some were close to achieving elimination and some had achieved it, the WHO Strategic Advisory Group of Experts (SAGE) have concluded that elimination of measles is under threat. Reported cases of measles in 2017 rose by 31%, leading to about 110,000 deaths worldwide (76). There is a need to strengthen routine immunization coverage to eliminate measles. Measles is one of the world's most infectious diseases and one of the leading causes of death in children (77). Apart from measles, the coverage of individual antigens was high and was highest for BCG (98.3%).

In order to achieve the objectives of the programme of increasing routine immunization coverage, it is important to identify the factors associated with incomplete immunization in the country, a wide range of social and demographic factors which were potential explanatory variables were identified from the MICS5 dataset. The potential explanatory variables were also selected based on findings in the reviewed literature.

The immunization cards which are obtained from health facilities are used to capture immunizations given to a child and to track immunization coverage. Not having an immunization card was significantly associated with incomplete immunization among children

aged between 11- 23 months. In this study 90% of the children had immunization cards that were seen. A number of studies from different countries made similar findings: a study conducted in Senegal found that children without immunization cards were more likely to be incompletely immunized compared to children with immunization cards (78). A study conducted in Ghana found that children without immunization cards were 50 times more likely to be unvaccinated compared to children with cards (79). Another study that was conducted in Togo also found that children without immunization cards were at a higher risk of incomplete immunization (80). This result could be because when the mothers lose the card, they fail to take their children to the clinic for vaccinations, which in addition makes it difficult to go back to the health facility to ask for a new card.

Absence of an immunization card has been proven to have a great impact on immunization coverage indicating a need to set up interventions to be put in place to provide an easy way of retrieving child immunization information. Some authors have suggested a web based tracking system or mobile phone to monitor the immunization coverage and to reduce the risk of losing the immunization (78) even though it has its own challenges. Currently the country has started the Client Management Information System (CMIS) where children are registered into the database when child comes to the clinic for the first time for postnatal care. With the use of this system, there is hope that it will be easier to trace and retrieve clinic information in any facility around the country, but this approach has not been evaluated since it was started in 2016.

Not attending antenatal care was marginally significant indicating that there is some evidence of an association with incomplete immunization. This association was found by different authors

from different countries. Several studies have found that the use of health service by pregnant women, during delivery and after giving birth contributes to the improvement of child immunization. Children delivered at home are more likely to be unimmunized compared to children born in a health facility. These findings were cited in a number of studies that were conducted earlier in different countries (81) (57) (82). The reason could be that mothers who delivered in health facilities are taught about the importance of vaccinations, the child gets the vaccination (BCG) and they are given the next appointment for the first dose of DPT at six weeks. Attending postnatal care also plays a vital role in the immunization of children. Children of mothers not attending postnatal care after delivery subjects the child to non- vaccination. This variable was significant in the univariable analysis but not significant in the multivariable analysis. Moreover, it has been found from previous studies that children of mothers who do not attend postnatal care are more likely to be incompletely immunized (83) (56). Children of mothers who did not attend antenatal care during pregnancy have been found in a number of studies to have a higher risk of being incompletely immunized compared to children of mothers who attended antenatal care (56) (84) (85). Health facility utilization affords women the opportunity to obtain information on the importance of routine immunization as well as allowing her to get appointment dates for immunizing their children and hence achieving complete immunization.

We found religion to be marginally significant which is an indication that there is an association with incomplete immunization. Similar results were also found in some studies conducted earlier in different countries. The authors found a positive association of incomplete immunization and religion (53) (86). The reason could be that some religions forbid the use of

health services no matter how sick people may feel, and that their beliefs alone will heal them. Religion is a complex matter whereby, it is not easy to change a person's beliefs, however, it is still important to educate everybody on the importance of childhood immunization.

The characteristics of the child also play a role in immunization. From this study, there was no evidence that gender of the infant had any impact on the uptake of immunization. This finding is similar to a study conducted in Mozambique (82). In some societies around the world there is cultural discrimination against the girl child, the male child is given greater preference and has greater chances of being immunized (59). In our study birth weight was not significant. This result is inconsistent with a study that was conducted in Brazil (58) and one conducted in Nigeria (55) where they discovered that low birth weight babies were likely to be incompletely vaccinated. Low birthweight babies were found to be incompletely immunized by these authors because they are presented for immunization late as their mothers and the health system (87) consider them fragile. These contradictory results may be due to variations in study populations and study setting.

Education of the woman has been found by several authors to have a profound effect on the mother’s health seeking behaviour. It is believed that as the woman’s level of education increases the lesser the probability of her child not to be immunized. Children of women with secondary and higher levels of education have a lower likelihood of not being immunized compared to women with no education or primary education. Such results have been reported by several authors (64) (88) (89) (90). Education level was not significant for this analysis, which could be due to variations in study population and study design.

Children of mothers who are less than the age of 24 years are more likely to be incompletely immunized compared to women who are older (>25 years). This has been found in some studies conducted in different countries (4) (91). This implies that the probability of immunizing a child increases with increasing age of the mother. This may be attributed to the experience that old mothers have in raising children and the knowledge they have acquired as they raise and interact with other women which young mothers are still to acquire. For this study, age of the woman was not statistically significant.

4.3 Strengths of the study

The study is population based and it covered all the four regions in the country. This, therefore, allows the results of this study to be generalizable to the studied population and to be comparable to other countries in sub- Saharan Africa with similar settings.

4.4 Limitations of the study

The findings from this study depend on the quality of the MICS5 data, as it a secondary data analysis. Furthermore, the study design is cross- sectional, so the study cannot establish causal relationships between immunization status and any of the independent variables of interest. Some of the data was self- reported especially for the children without immunization cards, mothers were asked whether the child got the vaccine if yes, they were asked on the number of doses the child received. Mothers might report that the child received immunizations which he/she did not actually receive, so this would more likely lead to underestimation of incomplete immunization. Social desirability bias is also likely to occur, whereby mothers will be answering

question on what is socially desired. Due to these biases, misclassification is likely to happen and the prevalence of incomplete immunization is likely to be under-estimated.

Analysis of secondary data restricts us to analysing variables that were collected for the primary study for example for this analysis occupation status was not collected, thus it was not included in the analysis yet some other researchers in previous studies reported it as a predictor of incomplete immunization. Other variables that were found by other authors to be associated with incomplete immunization were: distance to health facility (42), knowledge, attitudes and perceptions (83) (44) of the woman regarding immunization. The study could not look into factors that are likely to be related to the health care system and those related to the health care provider e.g. provision of vaccinations only during mid-week and looking into the attitudes of health workers.

4.5 Conclusion

Increasing immunization coverage remains a national public health goal in low and middle-income countries. The results from this study indicated that immunization coverage in Swaziland has been stagnant for more than three years. Approximately, a quarter of children between 11- 23 months were incompletely immunized in Swaziland in 2014. Despite all the efforts by the EPI programme to increase the routine immunization coverage, coverage still fell short of the 90% targeted by WHO/UNICEF and the EPI programme. This study provided evidence for further efforts to improve immunization coverage by identifying some (but not all), of the factors contributing to the low coverage in the country.

From the results obtained from this study it was discovered that not having an immunization card was significantly associated with incomplete immunization among children aged 11- 23

months. This calls for the EPI programme to engage in vigorous sensitization and health education activities on the importance of immunization cards through the use of different media platforms to ensure a wider coverage of the population. Delivering in a health facility has been proven by a number of studies that it improves immunization. In this analysis place of delivery was only marginally significant, but the findings tend to support those of other findings. Educating mothers on the importance and benefits of immunization should be an ongoing process from the time the mother comes for antenatal care up until postnatal care.

To intensify vaccination coverage, it is crucial to take into consideration the factors identified from this study because they will guide the vaccination program and improve vaccination coverage in the country.

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APPENDICES

Appendix 1: Approval of Title by University of Witwatersrand, Faculty of Health Sciences

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

30 April 2019
Person No: 819185
TAA

Mrs LB Skonela
P O BOX 8785
Mbabane
Swaziland
H100
Swaziland

Dear Mrs Lindiwe Skonela

Master of Science in Epidemiology: Change of title of research

I am pleased to inform you that the following change in the title of your Research Report for the degree of **Master of Science in Epidemiology** has been approved:

From:	**Factors associated with incomplete immunization among children aged 12-23 months in Swaziland, 2014 - 2015**
To:	**Factors associated with incomplete immunization among children aged 12-23 months in Swaziland in 2014**

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 2: Ethics Clearance Certificate from the University of Witwatersrand Human Research Ethics Committee (Medical)

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Ms L Skonela

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M190219

NAME: (Principal Investigator)	Ms L Skonela
DEPARTMENT:	School of Public Health Division of Epidemiology and Biostatistics Medical School University
PROJECT TITLE:	Factors associated with incomplete immunization among children aged 12-23 months in Swaziland in 2014
DATE CONSIDERED:	22/02/2019
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Professor J Levin
APPROVED BY:	Dr CB Penny, Chairperson: HREC (Medical)
DATE OF APPROVAL:	20/03/2019

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 on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date of the meeting when the study was initially reviewed. In this case, the study was initially reviewed in **February** and will therefore reports and re-certification will be due early in the month of **February** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES