FACTORS RELEVANT FOR THE INTRODUCTION OF RUBELLA VACCINE IN NAMIBIA

Erwin Nakafingo

Namibia

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KIT (ROYAL TROPICAL INSTITUTE)
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

Factors relevant for the introduction of rubella vaccine in Namibia

A thesis submitted in partial fulfilment of the requirement for the degree of Master of Public Health

By

Erwin Nakafingo
Namibia

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List of Abbreviations and Acronyms

CDC	Center for Disease and Control
CRS	Congenital Rubella Syndromes
cYMP	Comprehensive Multi-year Plan
DPT	Diptheria-Pertusis and Tetanus
EPI	Expanded Programme on Immunization
EVM	Effective Vaccine Management
GAVI	Global Alliance for Vaccines and Immunization
GDP	Gross Domestic Product
GGE	General Government Expenditure
GNI	Gross National Income
GRN	Government of the Republic of Namibia
HIS	Health Information Systems
ICC	Inter-Agency Coordinating Committee
IgM	Immunoglobulin
MDG	Millennium Development Goals
MMR	Measles-Mumps and Rubella
MMRV	Measles-Mumps, Rubella and Varicella
MoHSS	Ministry of Health and social Services
MR	Measles and Rubella
NCDs	Non-Communicable Diseases
NDHS	Namibia Demographic Health Survey
NSA	Namibia Statistics Agency
PHC	Primary Health Care
THE	Total Health Expenditure
UNICEF	United Nations Children's Fund
VPDs	Vaccine Preventable Diseases
WHO	World Health Organization

Glossary

Adverse Event Following Immunization (AEFI): Undesirable experiences occurring after immunization that may or may not be related to the vaccine (CDC 2015b).

Attenuated or live vaccine: A vaccine in which lives virus is weakened through chemical or physical processes in order to produce an immune response without causing the severe effects of the disease (CDC 2015b).

Immunization coverage: Proportion of individuals in the target population who are vaccinated (CDC 2015b).

Incidence: The number of new disease cases reported in a population over a certain period of time (CDC 2015b).

Potency: A measure of strength of the vaccine or any medical product (CDC 2015b).

Prevalence: The number of disease cases (new and existing) within a population over a given time period (CDC 2015b).

Vaccine Effectiveness: The probability that a vaccine, when used in the field under routine vaccination circumstances, confers immunity in a population. It is expressed as a percentage (CDC 2015b).

Vaccine Efficacy: A measure used to describe the capacity of the vaccine to prevent the disease (percentage of cases among the vaccinated group that was prevented by vaccine (CDC 2015b).

Vaccine: A product that produces immunity therefore protecting the body from the disease (CDC 2015b)

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Abstract

Background: Vaccination against rubella is not publicly available in Namibia. The country has recently considered introducing rubella vaccine within its national immunization programme. In spite of past experience in introducing new vaccines, no in-depth study has been conducted to analyze pre-existing conditions and implications related the introduction of rubella vaccine.

Objectives: This study describes and critically analyses factors relevant for the introduction of rubella vaccine in Namibia, in order to make recommendations to the government and stakeholders on the decision making and implementation processes for the introduction of rubella vaccine.

Methods: The study is based on literature review and rubella case-based surveillance data for 2009-2014 was analysed. An analytical framework adopted from the WHO which identifies both policy and programmatic factors affecting decisions for the introduction of new vaccines was used.

Results: The Namibian EPI enjoys high political support. Rubella infection is endemic and transmission is countrywide. Of the confirmed rubella cases (n=582), 45% were among children below 15 years old. Women of reproductive age accounted for 16.6 %. Safe, effective and highly efficacious rubella vaccine is available. The performance of EPI in Namibia is relatively sufficient. However, poor performance was noted in vaccine management.

Conclusions and Recommendations: The country's decision to introduce the rubella vaccine is a step in the right direction. Namibia seems to be meeting some conditions for the introduction of rubella vaccine. However, there is need to improve vaccine management. The country should conduct epidemiological studies to establish the burden of CRS.

Key words:

Rubella, Vaccine, Namibia, Introduction, Immunization,

Word count: 11, 743

Introduction

Namibia is committed to strengthening its infectious disease programmes in order to improve its population's health status. In doing this, the country has taken up several child survival strategies so as to contribute to the improvement of progress towards the attainment of Millennium Development Goals (MDGs). Among the adopted strategies includes the enhancement of immunization programme by introducing new vaccines. However, some infectious disease such as rubella have not been recognised/identified as a priority diseases and as a result, nothing significant has been done to control the widely circulating rubella virus in Namibia.

Given the country's consideration in 2014 to introduce rubella vaccine, the need to explore areas for consideration to introduce a new vaccine became apparent. This thesis attempts to identify key factors that need to be considered while deciding to introduce the vaccine. My motivation to select this study area arose from my work as a national Health Information Officer in the division, Health Information Systems (HIS) and Disease Surveillance within the Ministry of Health and Social Services (MoHSS) in Namibia. This division is responsible for amongst others, disease surveillance with a main focus on control of infectious diseases and monitoring and evaluation.

Doubling as a member of the national Maternal and Child Health Care Committee, I was able to recognise the gap and value of evidence in decision making process for rubella vaccine introduction in Namibia. Lack of evidence hampers and misguides decisions which may lead to wastage of resources and results in poor health outcomes (WHO 2008). The paper will review and discuss key elements to be taken into account while deciding to introduce the vaccine and make policy recommendations.

CHAPTER 1: BACKGROUND INFORMATION

This introductory chapter presents the country overview in terms of geography, demography, socio-economic status and health sector which includes a brief overview of the immunization programme.

1.1 Country's context

Namibia is one of the vast Sub-Saharan African countries covering a surface area of 824, 000 square Kilometres (NSA, 2011). The Atlantic Ocean laps the western part of the country, while Angola and Zambia borders the northern part. On the east, there is Botswana and Zimbabwe, while South Africa covers the south and some eastern parts of the country **Error! Reference ource not found.**. The country is generally dry with two deserts, the Namib Desert in the west and Kalahari Desert in the east. Namibia has arid and semi-arid to sub-tropical climate with average temperature of 5^0C and 20^0C. The daytime temperature ranges between 9^0C and 30^0C. Rainy season starts from September through to March while winter covers the period between May and August (NSA 2011).

Figure 1: Namibia Map, showing bordering countries

Namibia gained her independence from South Africa on the 21st of March 1990. The country is governed by the rule of law through a democratic system. Namibia has a multi-party system with general elections held after every five years. Administratively, the country is divided into 14 political administrative regions and 107 constituencies (KPMG 2012). Before then, there were 13 regions until 2013 when Kavango region was split into two regions namely, Kavango east and west.

In 2011, the population of Namibia was estimated at 2.1 million (NSA 2011) and projected at 2.2 million in 2015 (NSA 2014). About 51.6% of the population are females. With a median age of 21 years, the country has a relatively young population. It is estimated that close to 40% of the population is under 15 years of age and 14% are children less than 5 years old (NSA 2011). In spite of increased urbanisation at 43%, Namibia

is mainly a rural society with close to two third of the population living in rural area (57%) (NSA 2011). Namibia is sparsely populated with about 2.6 people living per square kilometres (NSA 2011). Khomas region which is home to the capital city is the most densely populated with about 9.3 people living per square kilometres. However, about 20.4 and 22.9 people per square kilometres lives in Ohangwena and Oshana region respectively (NSA 2011).

The country's annual population growth rate was estimated at 1.4% in 2011 which is a decrease from the 2.6% observed in 2001. The total fertility rate was estimated at 3.6 children per woman and is projected to decline to 2.4 births per woman by 2041 (NSA 2014). The life expectancy at birth is estimated at around 53.3 and 60.5 years for males and females respectively. In 2013, infant and under-5 mortality rates were estimated to be around 39 and 54 deaths per 1,000 live births respectively (MoHSS 2014b).

Namibia is classified as an upper-middle income country. In 2013, the Gross Domestic Product (GDP) was estimated at US$ 5,462 per capita (WHO 2014b). According to the Namibian National Accounts of 2013, the Gross National Income (GNI) was recorded at U$ 12.3 billion in 2013 which was an increase from U$ 10.4 billion in 2012 (NSA 2013a). In spite of economic improvements, the country's income distribution is not equitable. The Gini-coefficient of 0.597 places Namibia among the top ten unequal countries in world (Word Bank 2014). According to the United Nation Development Programme (UNDP), Namibia ranks in the 127th, position of the Human Development Index (UNDP 2014).

The country's economy depends largely on agriculture, fishing, tourism and mining and these sectors are the main drivers of the economy and source of employment in Namibia. Findings from the Labour Force Survey of 2013 shows that agriculture and fishery accounted for 31.4% of employment and ranks number one in the formal labour market (NSA 2013b). In 2013, unemployment rate was estimated to be 28.1% (NSA 2011; NSA 2013b). About 28.7% of the population is poor and 15.3% of the population is severely poor (NSA 2012). In 2014, the overall dependency ratio was estimated at 69.9% which means that there are 7 dependant people (<15 years old and >65 years old) for every 10 people in the productive age (15-65 years old) (NSA 2015). Nearly above 90% of the population above 15 years of age is literate. At national level, there is no significant difference in literacy level between males and females (85.4% and 85.1%). However these figures mask literacy variations by regions, urban and rural settings.

Namibia is culturally diverse, with more than ten ethnic groups of various cultural beliefs. Ovambo ethnic group is the largest and makes half of the entire population. Other ethnic groups include Damara-Namas, Kavango, Herero's, Himbas, Basters and Caprivian. The whites of Dutch, French, Portuguese, British origin makes up to 7% of the population (KPMG,

2014). About 90% has Christianity as a denomination. The rest of the population mainly follows indigenous beliefs (KPMG 2012).

1.2 Health sector overview

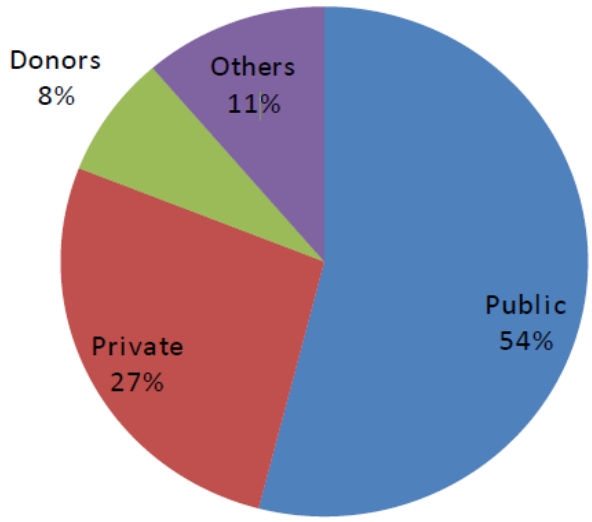
Namibia inherited a fragmented and racially segregated health care delivery system from the apartheid (MoHSS 2014b). It focused largely on curative services and most health facilities were concentrated in urban areas. After independence in 1990, a health reform started to take centre. The Ministry of Health and Social services (MoHSS) adopted the Primary Health Care (PHC) approach with primary focus on disease prevention, health promotion, curative and rehabilitation services (MoHSS 2014b).

The key stakeholders of the country's health system are the government, private sector which includes, Faith-Based Organizations (FBO), donors, Community Based Organizations (CBO), households, traditional healers and development partners (MoHSS 2010b). However, the government remains the main health care service provider (MoHSS 2014b). The country's health system is organised in different structures. At central level, there are eight (8) national directorates that provide overall guidance, policy formulation, planning, monitoring and evaluation, resource mobilization and standard setting (MoHSS 2010b). Fourteen (14) regional directorates oversee health delivery in 35 health districts and are responsible for health services management in the entire region. Each level of health care however, has its own management team though central level handles overall management of the public health sector (MoHSS 2010b).

Namibia has a three-tier health care delivery system (central, regional and district levels) which is run through a devolution type of decentralisation system. The district level provides health services through designated district hospitals, health centres, clinics and outreach services (MoHSS 2010b). The public sector infrastructure has 1 national referral hospital located in the Capital city of Windhoek, 3 intermediate hospitals, 35 district hospitals, 44 health centres, 365 clinics and over 1,000 outreach services countrywide (MoHSS 2011b). Private sector plays an important role in the country's health care system. As at 2009, there were 844 registered private health facilities which included 13 hospitals, 75 clinics, 8 health centres, and 75 pharmaceutical outlets countrywide (MoHSS 2011b). Although the government has recognised the importance of multi-sectoral partnership, collaboration in some areas such as vaccination is weak (MoHSS 2014f).

According to the World Health Organization (WHO) estimates of 2013, Namibia spent 14% of General Government Expenditure (GGE) on health (WHO 2013c) which is slightly below Abuja declaration target of 15%. In contrast, findings from the National Health Accounts for 2012/13 fiscal year however, show a slight decline from 14.7% in 2008/09 to 13% in 2012/13 (MoHSS 2015c). Of note is that there is no National Health Insurance in Namibia. Only 15% of the population has insurance covered. Above 80% of the population is not insured and depends largely on public health sector for health services (Gustafsson-Wright et al. 2009). During the fiscal year 2012/13 the Out Of Pocket expenditure was estimated at 11%(MoHSS 2015c). The main sources of health care financing in Namibia consist of government, privates, households and donor agencies as shown in Figure 2: Total Health Expenditure by source of funding in Namibia, 2012/13 (MoHSS 2015c).

Figure 2: Total Health Expenditure by source of funding in Namibia, 2012/13



Source: (MoHSS 2015c)

Further, the health system faces challenges ranging from shortage of staff, fragmented health information and surveillance systems, emerging and re-emerging infectious diseases as well as the epidemiological transition to non-communicable diseases (MoHSS 2010b). HIV/AIDS and Tuberculosis (TB) remain the major public health problems in Namibia. According to the sentinel surveillance of 2014, HIV prevalence rate was estimated at 16.6% (MoHSS 2014a). TB incidence rate was estimated at about 700 cases per 100,000 population in 2013 (WHO 2014a). In addition, the country has high maternal mortality with recent estimates at 385 deaths per 100,000 live births (MoHSS 2014b).

1.3 Expanded Programme on Immunization (EPI) overview

The national EPI in Namibia was introduced in 1990, 16 years after the WHO established the EPI in 1974 (MoHSS 2014b). The programme has grown into one of the successful Primary Health Care Directorate (PHC) programmes since its establishment. The main goal is to ensure that all high risk groups are vaccinated with vaccines that are effective and safe and consequently contribute to the reduction of infant and child mortality as well as disability due to Vaccine Preventable Diseases (VPDs) in Namibia.

The programme began with priority diseases: Bacillus Calmette-Guerin (BCG), Measles, Diphtheria, Pertussis & Tetanus (DTP) and Oral Polio Vaccine (OPV) for children less than one year and tetanus toxoid (TT) vaccination for pregnant women. Hepatitis B and *Haemophilus Influenza* type b (Hib) were introduced in 2009 as a combination commonly known as pentavalent vaccine. By April 2015, Rotavirus, Pneumococcus and a birth dose of Hepatitis B vaccines had been introduced (MoHSS 2015a). The national policy for EPI calls for all children below one year old to be vaccinated according to the schedule as indicated in Table 1.

Table 1: EPI schedule: MoHSS, Namibia as at April 2015

Age	Vaccine
New born	Polio (OPV) BCG, Hepatitis B **(At birth and up to 24 hours)**
6 weeks	Pentavalent (Penta),Rotavirus(RV1), Pneumococcus (PCV1)
10 weeks	Pentavalent (Penta),Rotavirus(RV2) Pneumococcus (PCV2)
14 weeks **9 months** **5 years**	Pentavalent (Penta), Pneumococcus (PCV3) Measles and Vitamin A Polio (OPV), Diphtheria and Tetanus (DT)
10 years	Polio (OPV), Diphtheria and Tetanus (DT)

Source: EPI, MoHSS, Namibia

1.4 Disease surveillance

Namibia has a functioning disease surveillance system. Over the past years the country was able to detect a number of epidemics such as for malaria, measles, rubella, meningitis and cholera (MoHSS,2011c). The country has adapted Integrated Disease Surveillance and Response technical guidelines and from the generic tools developed by the WHO. By 2010, the MoHSS had about 17 priority diseases and conditions suggested for IDSR of which rubella is not part. See annex 1 for a detailed list of priority diseases and conditions under IDSR in Namibia.

Case-based surveillance system for measles was established in 1998 (MoHSS 2011c). The clinical presentations of measles and rubella are similar. Therefore, surveillance for both diseases is done in a combined fashion. Suspected cases are identified using the case definition for measles definition which is defined as follow;

- **A Suspected case**: Any person with fever and maculopapular (non-vesicular) generalized rash and cough, coryza or conjunctivitis (red eyes) or any person in whom a clinician suspects measles.
- **A Confirmed case**: A suspected case with laboratory confirmation (positive Immuno-globulin (IgM) antibodies) or epidemiological link to confirmed cases in an outbreak.

Blood samples are collected from all suspected measles cases and sent to the laboratory for testing. Ideally all health facilities are required to collect blood samples. In the event that they cannot, a suspected case can be referred to the district hospital at which blood sample will be collected.

The primary purpose of testing is to exclude measles infection. However, all samples that test negative for measles IgM Antibodies are subjected to Rubella IgM Antibodies testing. That is done to ascertain the cause of febrile rash manifestations in those cases. Currently, there is no surveillance system for Congenital Rubella Syndrome (CRS) in Namibia. Ideally, case based surveillance forms are filled at all health facilities and sent to the central surveillance unit through respective districts for data entry into the electronic database. However, these forms are commonly incomplete. See annex 2 for a case based surveillance form for measles and rubella currently used to collect data at health facility level.

2 CHAPTER 2: PROBLEM STATEMENT, JUSTIFICATION, OBJECTIVES, METHODOLOGY AND LIMITATIONS

This chapter presents the statement of the problem, study objectives as well as the methods used in the study. Justification and study limitations will also be described.

2.1 Problem statement

Rubella is an acute viral infection caused by rubella virus of *Togavirus* and *Rubivirus* family (Duszak 2009). Clinically it is a mild disease characterised by fever and generalised maculopapular rash (McIntyre et al. 2000). The virus is transmitted when infected airborne droplets released through coughing or sneezing get in contact with mucous membranes (Plotkin 2006).

Although rubella infection is mild and mainly occurs during childhood, infection during pregnancy is of major public health importance due to the serious complications it can cause to the unborn baby (Bouthry et al. 2014). These complications may lead to Congenital Rubella Syndrome (CRS) which can cause among others eye abnormalities (25%), deafness abortion (60%), low birth weight (23%), liver disorders (19%) and cardiac defects (45%) (Nazme et al. 2015), (Dewan & Gupta 2012). Babies may also develop growth retardation, liver problems and low birth weight (Chimhuya et al. 2015,WHO 2011).

Rubella infection is currently among the leading causes of preventable congenital birth defects globally (WHO 2012). In 2008, it was estimated that about 110,000 babies from developing countries are born with CRS annually (Reef et al. 2011). In 2012, about 94,030 rubella infection cases were reported from all member states of which 89.2% were reported from developing countries (WHO 2014e). During the same period, 11.5% rubella infection cases came from the African region (Martínez-quintana et al. 2015) (WHO 2014e). All 72 CRS cases reported in 2012 were from high income countries. This could be due to lack of surveillance systems for CRS in developing countries (WHO 2014e).

The exact burden of rubella and CRS in Sub-Saharan Africa remains unknown. This is due to the lack of priority, capacity and poor performance of the national surveillance systems (Plotkin 2006), (Goodson et al. 2011, Mitiku et al. 2011). Using measles surveillance as a backbone to detect rubella infection, about 357 laboratory confirmed rubella infection cases were reported from Namibia in 2014 (MoHSS, 2014). Although the exact number of CRS cases in Namibia is unknown, findings from a sero-prevalence study for measles and rubella of 2010 shows that, 15% of pregnant women in Namibia are not immune against

rubella (Cristina Cardemil , Goodson 2010). This means that a significant portion of pregnant women who are exposed are at risk of becoming infected with rubella and therefore ending up with a child with CRS. Lambert et al (2015) emphasized that the risk of CRS can be high in countries with high susceptibility to rubella on women of childbearing age.

Due to its mild clinical presentation there is no treatment for rubella infection. On the other hand, the physical malformations related to CRS are untreatable and therefore lifelong. As a result, the cost of providing care to children born with CRS is high (Babigumira et al. 2013). Babigumira et al (2013), found that in developing countries, the cost per CRS case is estimated to be around U$ 4,200 and U$ 57,000 annually.

Although there is no treatment for CRS, rubella infection during pregnancy is preventable with vaccination. Therefore, the occurrence of CRS can be reduced and eliminated through vaccination (Hamborsky J, Kroger A 2015) (Goodson et al. 2011). Safe, effective, and cost-effective rubella vaccine is available (WHO 2011). Through vaccination, rubella has been already eliminated in some western hemisphere (Goodson et al. 2011), (Castillo-Solórzano et al. 2003), (WHO 2011), (Hamborsky J, Kroger A 2015).

Although the number of countries using rubella vaccine seems to have increased over the years, many countries especially in Africa have not yet introduced the vaccine within their routine immunization programmes (Goodson et al. 2011). As at 2013, Rwanda was the only and first Sub-Saharan African country to introduce rubella vaccine nationwide (GAVI 2013). However, Rwanda has not yet reported any outcomes since the introduction of the vaccine. As for Namibia, rubella vaccination is not part of national routine immunization schedule (Ogbuanu et al. 2014). However, some private facilities provide rubella vaccination at a cost for the end user. Immunization activities performed by the private providers are not supervised or monitored by the national health authority (MoHSS 2010a).

Namibia is one of the countries in the elimination phase for rubella and CRS and is equally committed to contribute to the well-being of its population by reducing the burden of vaccine preventable diseases including rubella and CRS. Without rubella vaccination, the disease will continue to pose health threats to unborn babies, add a burden to their families and to the health system.

2.2 Justification

To In light of moving towards universal vaccine coverage, Namibia has considered to introduce rubella vaccine within her national immunization programme. While the country's decision is commendable and timely, it is equally in line with WHO recommendation which calls for countries to use opportunities presented by measles programmes to introduce the under-utilized vaccines such as rubella (WHO 2011).

Given the complexity of the new vaccine adoption process and limited resources, it is important to ensure that evidence around relevant policy decision areas is sought locally, within the region and internationally to support decision making (Blume & Tump 2010), (Ngcobo & Cameron 2012), (Schoub et al. 2012). Jauregui et al, (2015), highlights that, lack of evidence hampers programme outcomes and may lead to inefficient use of resources.

In spite of the government's past experience in introducing new vaccines, no in-depth study has been conducted in Namibia to analyze the pre-existing conditions and implications related to the introduction of rubella contained vaccine into the national immunization scheme. A study by de Oliveira et al (2013) found that the adoption of new vaccines in some Latin American countries was not preceded by systematic analysis of the situation. This in some cases led to poor decisions (de Oliveira et al. 2013). In the absence of country based information however, the use of experiences from somewhere else was critical in facilitating the decision making process (de Oliveira et al. 2013). In the event that Namibia fails to use a systematic approach while analyzing the key factors relevant to the introduction of a new vaccine, chances of misguided decision are high.

This study will try to address this knowledge gap by systematically describing and analysing essential elements to be considered before introducing a new vaccine. These elements are related to the burden of the disease targeted, the readiness of the immunization programme and the health system to adopt an additional vaccine and the suitability of the vaccine to the context of Namibia. In addition, this study will contribute to enlarge the body of knowledge around the introduction of rubella vaccine and aims to be used as a reference tool by other countries within the region and globally.

2.3 Objectives

2.3.1 General objective

To describe and critically analyse factors relevant for the introduction of rubella vaccine in Namibia, in order to make recommendations to the government and stakeholders on the decision making and implementation processes.

2.3.2 Specific objectives

1. To describe and analyse the political priorities, the burden of the disease, the status of other prevention and control measures of rubella in Namibia
2. To describe the characteristics of rubella vaccine and analyse its suitability to the Namibian context.
3. To describe and analyse the characteristics of the Namibian EPI in relation to its capacity to adopt rubella vaccine.
4. To make recommendations to the government and key stakeholders in relation to the decision making process for the introduction of the vaccine in Namibia.

2.4 Methodology

This is a descriptive study based on literature review complemented with the analysis of secondary data.

2.4.1 Literature review

2.4.2 Search strategy

Published peer review literatures: Published articles, journals reports, books and online publications were accessed through Google Scholar, PubMed and Medline. The Library Catalogue of the Vrije Universiteit Amsterdam was also used to access published literatures. Google Scholar alert was set up to access the latest publications on rubella and new vaccines introduction. In addition, the reference list of identified literatures was used to access related articles.

Grey literatures: Institutional websites such as the WHO, MoHSS CDC, UNICEF, and GAVI were used to access reports, guidelines, policies and strategies on rubella prevention and control.

Key search words: Rubella in combination with vaccine introduction, epidemiology, outbreak, Congenital Rubella Syndrome, CRS, Namibia, Sub-Saharan New vaccines introduction, Africa, vaccine safety, vaccine efficacy, vaccine effectiveness, vaccine supply, vaccine cost, financing, control measures and vaccination strategies.

2.4.3 Secondary data analysis

Rubella case-based data for 2002-2015 collected through the Measles case-based surveillance system was further analysed. The dataset was obtained from the epidemiology division of the MoHSS in Namibia. Rubella infection cases included in the dataset were described by person, place and time.

Where relevant, measures of location and dispersion (frequencies, means, median and standard deviations) were used to present the data. Epi-info 7 and Micro-Soft excel 2010 were used for data analysis. Although the dataset contained information about cases reported between 2002 and 2015, the secondary analysis is limited to the period between 2009 and 2014. This decision was made because the data for that period was found to be more reliable and complete than the data collected prior to 2009.

Data cleaning and analysis: The original data set received was not complete. As part of the data cleaning phase, variables with missing values were identified. For example, 12.4% of rubella confirmed cases had age information missing. The variables with missing values included among others age, sex, year of onset, and region of residence. In spite of this limitation, the author was able to reconstruct most of the missing data using information from other variables in the dataset.

2.4.4 Inclusion and Exclusion criteria

Only published literatures in English and with a full text version available were reviewed. There were no limitations for year of publications. Given the limitations to find literature about rubella in Namibia, evidences from similar countries were used whenever possible.

2.4.5 Study limitations

Due to time limitations, primary data collection was not considered in this study. Therefore, interviews with key informants such as the EPI programme officers, Inter Agency-Country Committee (ICC) members, United Nation Children's Fund (UNICEF), the WHO country office support staff and policy makers in Namibia who could have provided more insight on key factors influencing the adoption of rubella vaccine were not done.

Case-based surveillance data on rubella infection had missing values in some variables. Although most of the missing values were reconstructed, using existing information from other variables in the dataset, a certain number of registers (2%) had to be dropped out of the analysis. In addition, reporting biases that could be encountered in any surveillance system, might limit accurate estimation of cases. Also, there is no surveillance system collecting and reporting the number of cases of CRS in the country, which made it difficult to estimate the burden of CRS in the country. Another limitation observed was that, the analytical

framework used in this study focuses strongly on the supply side and a little on the demand side of the factors related to the introductions of new vaccines.

2.4.6 Conceptual Framework overview

Evidence has shown that the adoption of new vaccine can be a complex process (Gordon et al. 2012), (Strebel et al. 2011), (Clemens & Jodar 2005). There are many factors that affect decisions to introduce new vaccines into the national immunization programmes (Kochhar et al. 2013). Several studies have attempted to explore factors influencing the introduction of a new vaccine in many countries, most of which were looking at establishing evidence of the disease, policy support, cost and the vaccine characteristics (de Oliveira et al. 2013). Although different frameworks were used, findings from a study by Gonzalez-Lorenzo et al (2015) which analysed a number of frameworks used to explore these factors, shows that the burden of a disease, vaccine characteristics, cost, resource use, decision making, equity and feasibility were the most common reported in all frameworks reviewed.

The recently updated conceptual framework by De Roeck & Wang 2014 on behalf of the WHO was found appropriate for the study (

Figure 3: Conceptual Framework). The strength of this framework lies around the fact that its development was informed by recent research findings as well as experiences from various countries that have introduced new vaccines within their routine immunization programmes (De Roeck & Wang 2014). The framework is not vaccine specific. Hence, it can be used for any vaccine of interest. The resource document where this framework was obtained, became the latest guiding tool that the WHO has developed to assist countries in decision making and planning for new vaccines introduction.

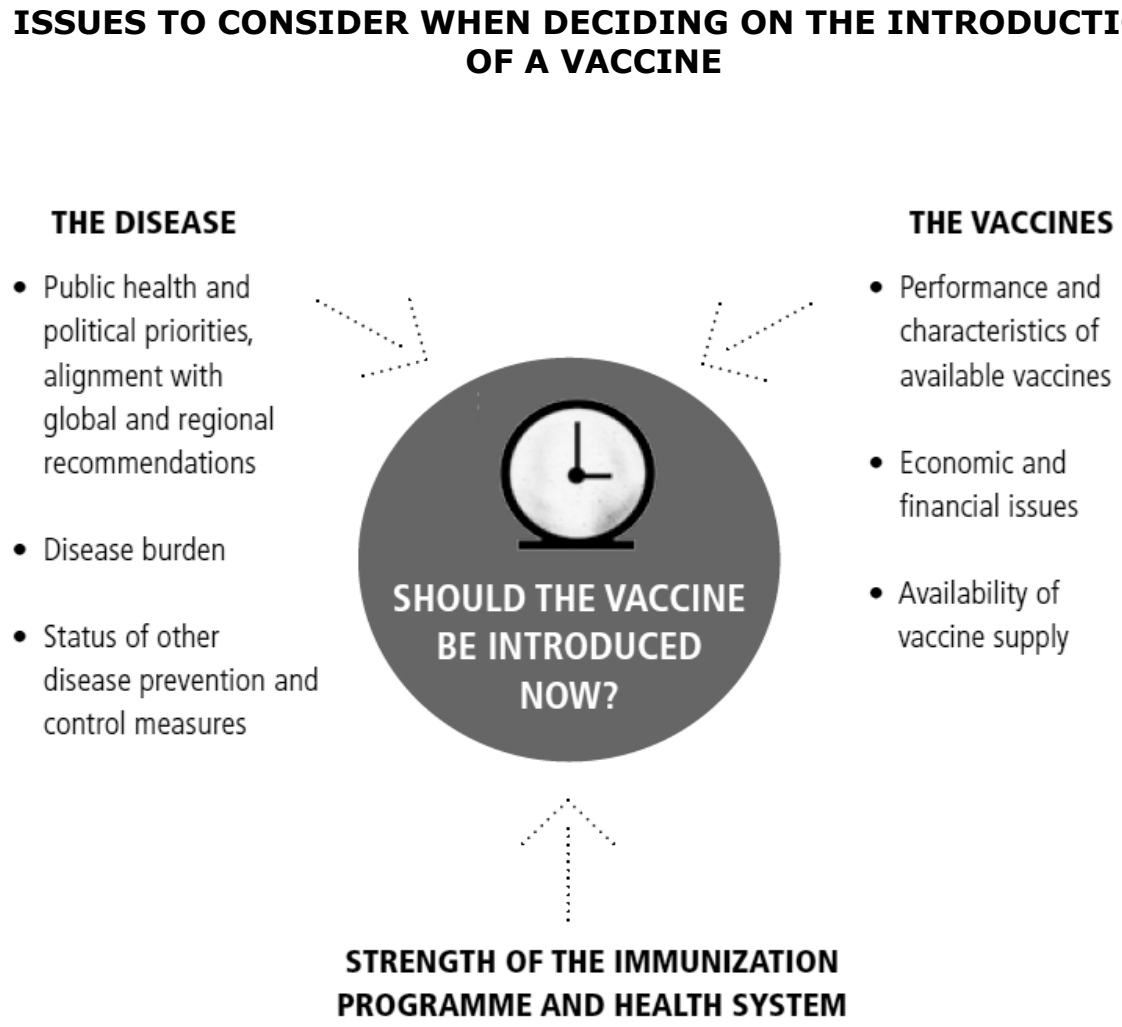
In addition, the framework identifies both policy issues and programmatic factors that influence the adoption of a new vaccine in three thematic areas, namely the burden of the disease that the envisioned vaccine targets to control, the vaccine's characteristics and its performance (safety, efficacy, effectiveness), financial implications and the supply of the vaccine as well as the strength of the immunization programme and health system (De Roeck & Wang 2014). Of note is that, the model identifies factors with primary focus more on the provider/supplier than on the beneficiary or user of service. A brief description of each elements of the model is given below.

Disease: This dimension identifies the political involvement within the overall disease control initiatives. It also establishes the country's alignment with global and regional disease control recommendations. Further, it provides opportunities to understand the magnitude and distribution of the disease of interest (in this case rubella) affecting the population targeted for vaccination. In addition, this dimension seeks to understand and explores the availability of other disease prevention and control measures.

Vaccines: This dimension describes and analyses the vaccine's performance and characteristics to establish the suitability of the vaccine to the given context. The components of this dimension also describe economic and financial implications related to the introduction of the new vaccine. It also seeks to understand the status of the vaccine availability and supply within the global market.

The strength of immunization programme and health system: This dimension provides opportunities to explore the performance of immunization programme in the context of health system which can be used as evidence to establish the feasibility and sustainability of the programme to adopt the new vaccine.

Figure 3: Conceptual Framework



Source: (De Roeck & Wang 2014)

3 CHAPTER 3: RESULTS AND FINDINGS

This chapter describes and analyses results of the study following the logic of the conceptual framework.

3.1 The disease

3.1.1 Public Health and political priorities of rubella

The WHO recommends that countries should introduce rubella vaccines into their routine national immunization programmes (WHO 2011). In 2011, countries in the WHO African Region of which Namibia is part adopted the elimination goals for measles and rubella by 2020 (WHO 2012). By 2014, Namibia has developed its strategic plan for rubella and CRS as a statement of intention to contribute to the attainment of elimination goals for rubella and CRS (MoHSS 2015b). This move is also in line with the country's national goals. Namibia has recognised health as the backbone for socio-economic well-being of the population (GRN 2004). Other countries in the region such as Rwanda have already introduced rubella vaccine. Ghana is also in the process to introduce rubella vaccine as part of rubella control measures in line with global initiatives (GhanaWeb 2013).

Through the national development plan, the government stresses the need to ensure that the entire population is protected from preventable infectious diseases and causes of physical ill-health (GRN 2004). Additionally, the national health policy framework suggested the use of evidence based norms and standards as one of the strategies to improve maternal, neonatal and child health in the country (MoHSS 2010b). Evidence based planning by conducting operational research is also prioritised in the Comprehensive Multi-Year Plan (cMYP) of 2011-2015 (MoHSS 2011a). The 2011-2015 cMYP does not include the introduction of rubella vaccine. However, it was suggested that current plan be revised to include rubella contained vaccine introduction (Masresha 2014).

The literature review did not show evidence about the public and medical community perception about rubella and CRS in Namibia. However, according to personal experience, people in Namibia do not normally seek medical attention for minor illnesses. There are also myths that generalised body rashes with no other serious signs is due to weather or food allergy. One study on the willingness to accept MMR vaccination among students showed that those who believed that vaccination is beneficial were willing to participate (Donkers et al. 2015). Donkers et al (2015) also found that acceptance and participation is likely to be high once it is offered for free. In Namibia immunization is voluntary and immunization coverage is relatively high which suggest that acceptability is high.

According to WHO, there is a gap in accessing new and under-utilized vaccines between social classes particularly in developing countries (WHO 2013a). In Namibia, since rubella vaccine is available in private sector, only people with high sufficient economic resources can access the vaccine (MoHSS 2010a). Including rubella vaccine in the national immunization programme should close this inequity gap this inequity gap (WHO 2013a).

3.1.1 The burden of rubella in Namibia

This section presents results from the analysis of case based surveillance data for rubella infection in Namibia for the period between 2009 and 2014. In addition, a brief description of the CRS burden in Namibia based on estimates will be provided here.

3.1.2 Rubella infection in Namibia

Between 2009 and 2014, a total of 4,358 suspected measles cases were screened and tested of which 943 tested positive for measles. Figure 4 below shows that of the 4,228 cases tested, 582(13.8%) were laboratory confirmed positive as rubella and 3239 (83.7%) tested negative for rubella IgM antibodies, while 107 (2.5%) had intermediate results. Figure 5 indicates that an increased number of rubella confirmed cases was reported in 2011 and 2014. Generally the illustration shows a wide gap between negative and confirmed (positive) cases, which seems to raise questions; for instance regarding sensitivity of the test.

Figure 4: Percentage of specimen tested for Rubella IgM Antibodies and results in Namibia, 2009-2014 (n=4228)

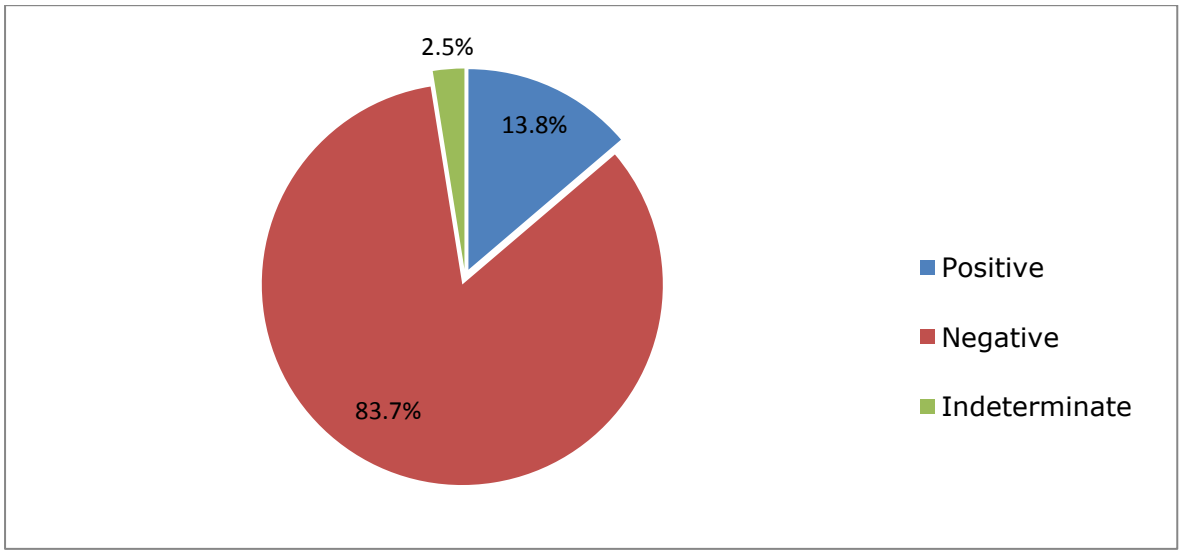
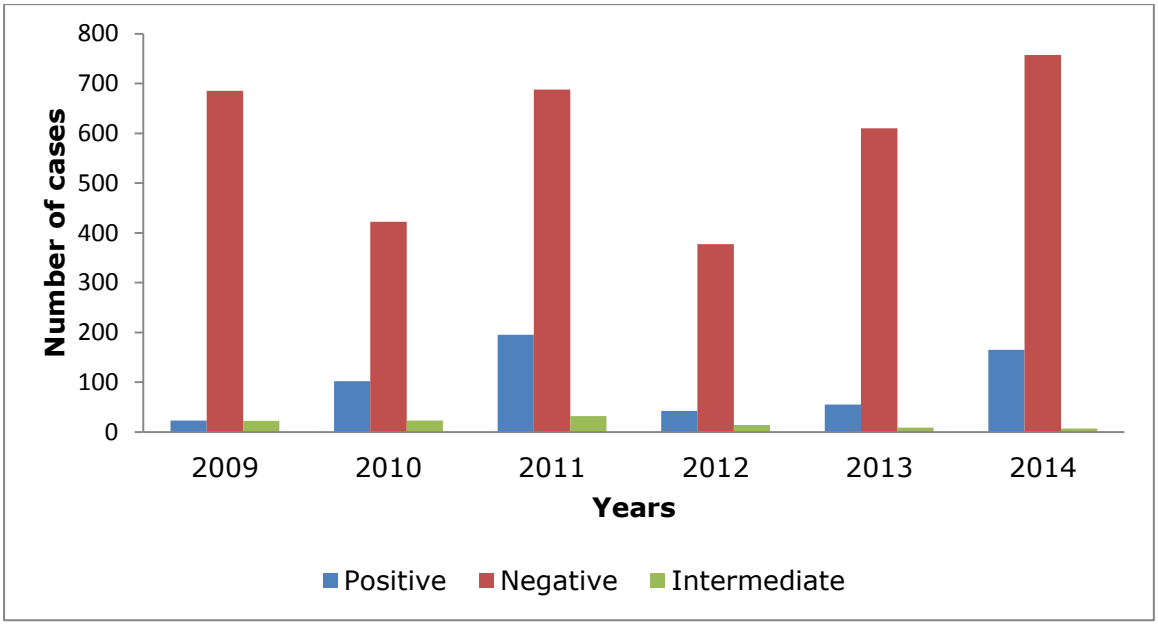


Figure 5: Number of specimen tested for Rubella IgM Antibodies and results by years in Namibia, 2009-2014 (n=4228)



Age and Sex Distribution

Table 2 below shows that among the rubella confirmed cases with information about sex (n=580), 50.2% were females. This means that there is no difference in sex distribution of the reported rubella confirmed cases. Results on sex distribution are similar to the observed sex distribution in Kenya (Females =54%) (Njeru et al. 2015) and Ethiopia (Females=54%) (Mitiku et al. 2011). Although Zimbabwe had marginally more males (n=51%) than females, the distribution is even. (Chimhuya et al. 2015)

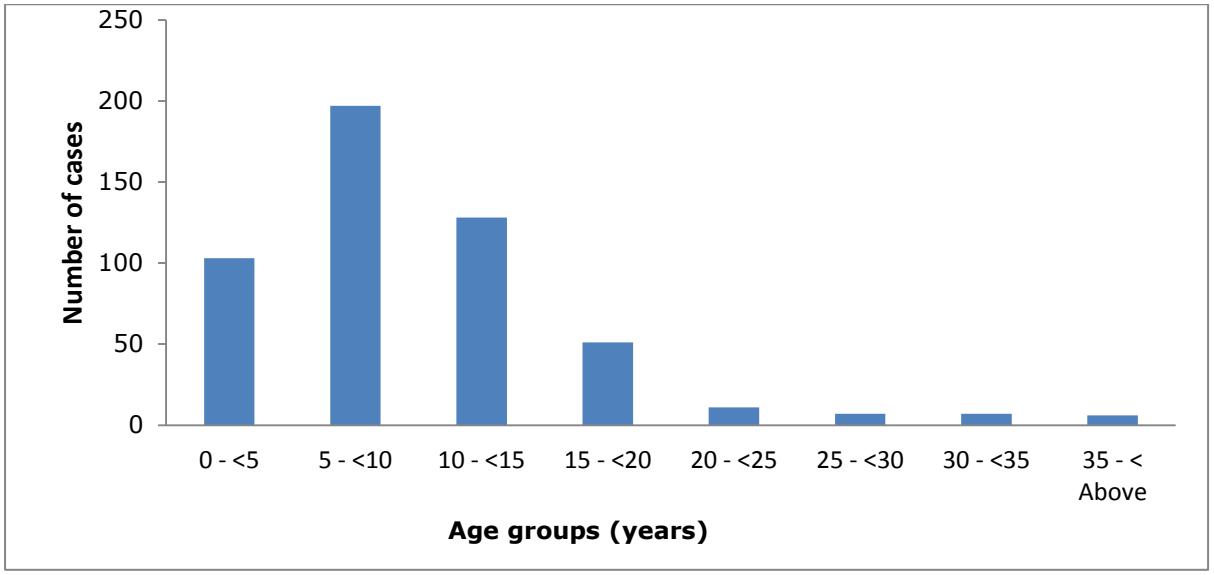
Table 2: Sex distribution of laboratory confirmed rubella cases in Namibia, 2009-2014, (n=580*)

Sex	Frequency (%)
Male	289 (49.8%)
Female	291 (50.2%)
Total	**580 (100%)**

n* = cases with sex information recorded. Two of the confirmed cases had no sex information recorded hence (n=510)

Figure 6 below indicates that among the rubella confirmed cases with information about age (n=510), 39% were in the age group 5-<10 years followed by 10-<15 (25%) and 0-<5 (20%) groups. Cases reported among the older age groups remained relatively low. The mean age for the rubella infection cases was 9.6 years old with interquartile ranges between 5 and 12 years and the mode of 7 years. The observed mean age of rubella infection is consistent with findings by Lambert et al (2015) indicating the range to be around 5 to 9 years where there is no vaccination. Women of reproductive age (15-49) accounted for 16.6% (n=43) of rubella confirmed cases reported during this period.

Figure 6: Age distribution of lab confirmed rubella cases in Namibia, 2009-2014 (n=510)*



*** n= total cases with age information recorded**

Geographical Distribution

Table 3 below shows the distribution of laboratory confirmed rubella cases by regions. Between 2009 and 2014, Hardap region had the most cases reported (n=114) followed by Kavango (n=92) and Ohangwena (n=88). The number of positives rubella cases reported from the rest of the regions ranges between 19 and 43 respectively.

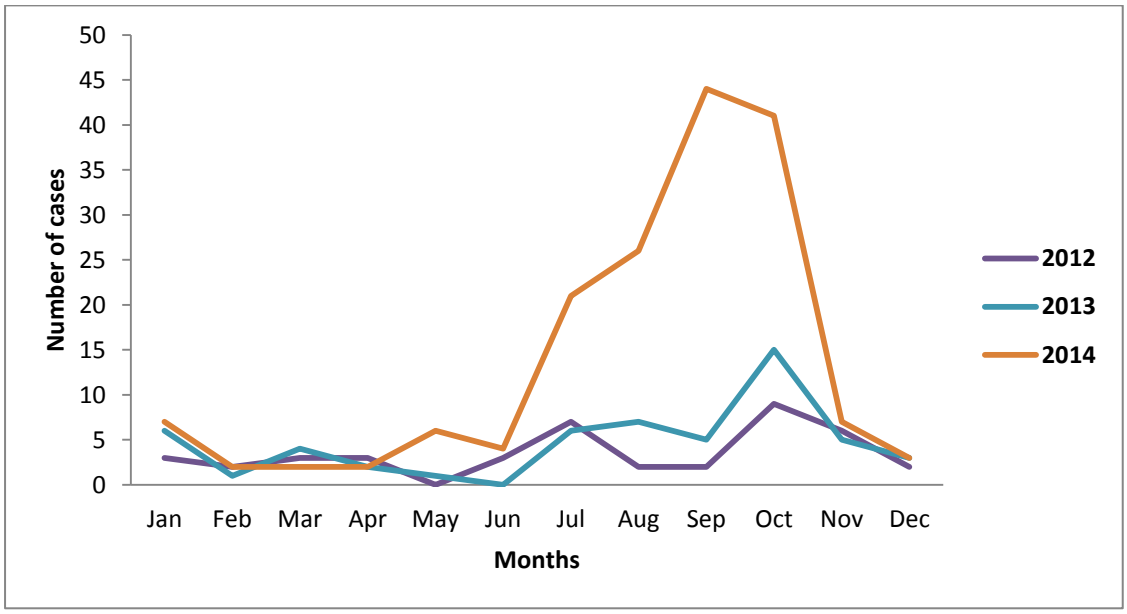
Table 3: Distribution of Laboratory confirmed rubella cases by regions in Namibia, 2009-2014

Region	Total Specimen tested for Rubella	Rubella IgM positive	Positivity Rate (%)
Erongo	345	43	12.5
Hardap	396	114	28.8
Karas	161	21	13.0
Kavango	544	92	16.9
Khomas	339	23	6.8
Kunene	490	59	12.0
Ohangwena	845	88	10.4
Omaheke	111	30	27.0
Omusati	242	19	7.9
Oshana	220	29	13.2
Oshikoto	162	23	14.2
Otjozondjupa	212	20	9.4
Zambezi	161	21	13.0
TOTAL	**4228**	**582**	13.8

Seasonal Distribution

The increase in cases was observed around June and peaked in October and November each year (Figure 8). The increase in cases can be due to more gathering and population movements during festive season. The same pattern in seasonal variation is similar to that observed on rubella trends in Zimbabwe (Chimhuya et al. 2015) and agrees with temporal patterns of the rubella infection as indicated by (Hamborsky J & Kroger A 2015). Lambert et al (2015) shows that an increase pattern of rubella infections is usually observed in spring. Overall, the majority of cases were due to increased pattern reported cases in 2014.

Figure 7: Distribution of lab confirmed rubella infection cases by months in Namibia, 2012-2014



3.1.1.1 CRS burden in Namibia

In the absence of data on CRS, the number of CRS in Namibia was estimated by using incidence rates from other countries. Data from the WHO shows that before the introduction of rubella vaccine in developing, countries, the estimated incidence of CRS in babies varied between 0.1-0.2 babies per 1,000 live births per year (WHO 2011). This number could increase to 0.8-4 babies per 1,000 live births following an increased pattern of rubella infection (WHO 2011).

Using the total number of live births in Namibia for 2013 (n=58,589), the estimated incidence of CRS in Namibia was calculated. In a stable situation, around 6 to 12 babies per year would be born with CRS while during an increased pattern of rubella infection, this number could go up to 46 to 234 babies per year.

3.1.2 Status other disease prevention and control strategies

Vaccination is an effective prevention and control measure for rubella and CRS in history (Plotkin 2001). Since its licensure in 1969, cases of rubella and CRS cases were reported globally to have dropped significantly (Banatvala & Brown 2004). However, vaccination is not the only control measure for rubella (WHO 2011).

The WHO, recommends other control measures particularly during an outbreak of rubella (WHO 2013b). These measures include among others surveillance, isolation of infected cases, contact management, community mobilization and public awareness. The use of these measures can contribute to the interruption of rubella infection transmission. Identifying pregnant women who might have been exposed to rubella infection and follow them up is critical for CRS surveillance. According to CDC, all women of childbearing age can be vaccinated including health workers who are attending them (CDC 2001).

Currently, Namibia does not have specific control measures for rubella in place and public awareness on the disease is poor. As mentioned earlier, rubella suspected cases are detected through the existing measles surveillance system. Cases are investigated and followed up to identify contacts and primarily to rule-out potential measles outbreaks. The measles case management and control measures which include isolation and case management are applied though primarily to interrupt measles infection. When an outbreak for rubella is confirmed, communities are sensitised and health education is given. Although isolation is encouraged, this may not be helpful given the fact that rubella is infectious even before an infected person start showing symptoms. Nearly 50% of rubella infected cases may not show clinical signs (Mitiku et al. 2011).

3.2 The vaccines

This section presents findings on rubella vaccine characteristics and describes its performance in relation to its safety, efficacy and effectiveness. In addition, economic and financial implication related to rubella vaccine as well as the status of its availability will be described

3.2.1 Performance and Characteristics

3.2.1.1 Characteristics of the vaccine

Different types of rubella vaccines strains are available. Other rubella vaccines strains that were licensed in 1969 were discontinued following the licensure of the RA 27/23 strain in 1979. The RA 27/23 strain is still widely used (Hamborsky J & Kroger A, 2015). Other rubella vaccine strains also available includes the BRD-II strain commonly used in China,

Takashashi, Mattsuura and TO-336 strains which are used in Japan (WHO 2011).

Rubella vaccine is a live attenuated virus based on the RA 27/3 strain (WHO 2011). The vaccine presents as a lyophilised powder with solvent solution for reconstitution. It is subcutaneous or intramuscular injection (Taneja & Sharma 2012) and can be administered as a combination with measles, mumps and /or varicella (MR, MMR or MMRV) (Hamborsky J, & Kroger A ,2015), (WHO 2011). It is usually supplied as a vial containing 10 single doses.

Rubella vaccine is light and heat sensitive as compared to other vaccines. (See figure 8). It is better preserved under temperatures +2 ^{0}C to + 8 ^{0}C of which shelf life can extend up to 36 months if stored at +4 ^{0}C temperature (WHO 2011).The vaccine's dilutes are not temperature sensitive and as such it can be stored at a cooler or room temperatures (WHO 2011). Once diluted, the vaccine can be used for up 8 hours (MERCK & CO. 2014). This suggest the need to ensure that the country's climatic conditions and cold chain are taken into account when deciding to introduce the vaccine (Kochhar et al. 2013).

Figure 8: Temperature sensitivity of selected vaccines

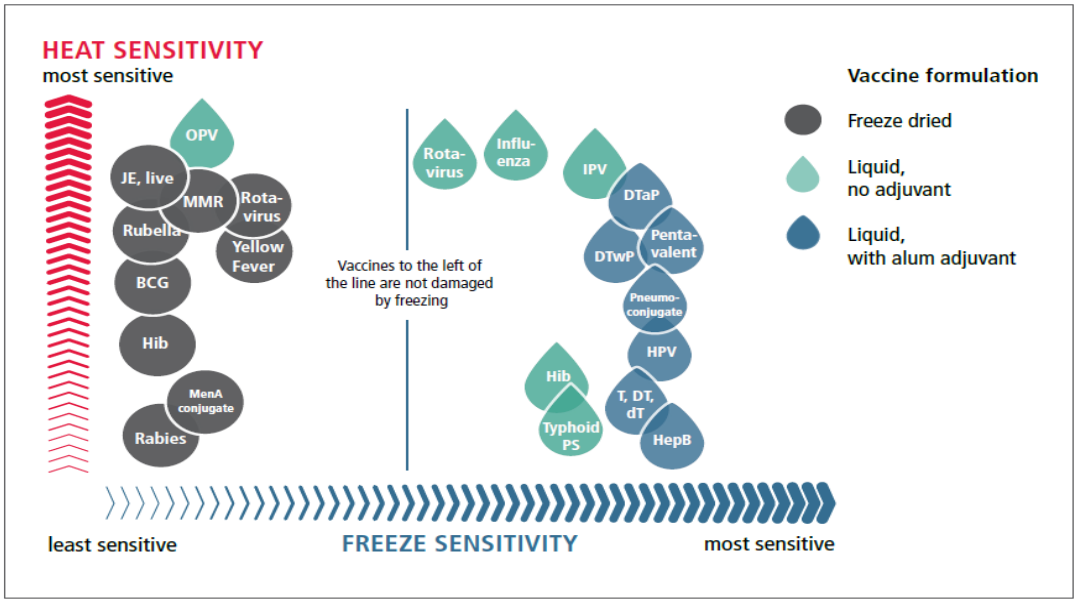


Figure 8 above illustrates relative sensitivity across antigens, as the same type of vaccine from different manufacturers may have different vaccine vial monitors (VVMs).

Source: (De Roeck & Wang 2014)

3.2.1.2 Vaccines performance

Vaccine safety

Evidence across all forms of rubella vaccines indicates that the vaccine is generally safe (He et al. 2014), (Naim 2015). However, like any other medical product, rubella vaccine is associated with some potential side effects (CDC 2013b). These side effects include redness at injection site, fever and pain which occurs mainly among children (WHO 2014c).These side effects are similar to the ones observed for measlses vaccine in Namibia (Tjiveze K 2012).

Above 70% of joints pains were reported in adolescents females and adults (CDC 2001) (Hamborsky J & Kroger A 2015)(WHO 2014c). Severe adverse effects such as seizures, allergic reactions (1 per 1000,000 doses), difficulty in breathing and low platelet levels (1 per 30,000 doses) are rarely reported (Naim 2015). Between 2003 and 2013, fever (19%), pain (13%), rash (17%) and arthralgia (13%) were the most common side effects associated with MMR reported to the Adverse Event Reporting System (Sukumaran et al. 2015). A recent study by Pasternak et al. (2015) shows that about 3 to 16 febrile seizures cases reported in 10,000 children were due to Measles-Mumps and Rubella (MMR) vaccine (Pasternak et al. 2015). One Cochrane study found that rubella vaccine with varicella component commonly known as MMRV increase the risk of febrile seizures (Demicheli et al. 2013).

The side effects caused by a single and combined forms of rubella vaccines are similar (WHO 2014c). Rubella vaccine is contraindicated in people who are HIV positive and severely immuno-compromised or with severe allergic reactions (CDC 2015a). In contrast, some guidelines suggest that rubella vaccines can be administered in situations where the vaccine causes more good than harm (Demicheli et al. 2013) (Banatvala & Brown 2004). Though there is no evidence of increased risk to the unborn baby, vaccination in pregnancy is contraindicated (Plotkin 2001). One study on MMR cognitive effect of child development shows no association between the MMR and a child's cognitive development (Mrozek-Budzyn et al. 2013).

Namibia does not have a fully functional national surveillance system for Adverse Effect Following Immunization (AEFI) in place (MoHSS 2010a). However, AEFI is monitored during immunization campaigns (MoHSS 2010a). According to the EPI review of 2010, no major events were reported since establishment of EPI programme. In addition, the country has in place a policy on injection safety which promotes safe injection practices (MoHSS 2010a). To ensure safe injection, injectable vaccines are normally administered by trained health workers (MoHSS 2014c). In addition, all vaccines in Namibia are regulated through existing medicine regulatory body and professional health council (MoHSS 2014c).

Efficacy

Vaccine efficacy is defined as "...a measure used to describe the capacity of the vaccine to prevent the disease and it is expressed as percentage of cases among the vaccinated group that was prevented by vaccine..."(CDC 2015b). Vaccine efficacy can influence the decision to use it in any setting and conditions where it is developed and controlled dictate its performance. Results from clinical trials shows that above 95% of susceptible persons developed rubella antibodies after a receiving a single dose of a live attenuated rubella vaccine of RA 27/3 strain (WHO 2011). A single dose of rubella vaccine can induce lifelong protection against rubella infection (Taneja & Sharma 2012). Taneja & Sharma (2012) highlights however re-infection do occur but in very rare events. According to CDC, rubella antibodies could still be detected 16 years after the first dose was administered (CDC 2013a).

The WHO suggest that a second dose of rubella vaccine can be administered given the existence of combination platform with other antigens such as mumps and measles (WHO 2011). The first dose of rubella vaccine is given at 12-15 months with the second dose at 4-6 years of age (WHO 2011). Above 90% of children aged 12 months develop rubella antibodies with the first dose. Efficacy of rubella vaccine in children below one year is not well established (WHO 2011). According to the WHO, about 5% of susceptible persons may not develop antibodies following vaccination.

Effectiveness

The vaccine effectiveness entails how vaccines can effectively prevent the disease in real life conditions. Vaccine effectiveness increases public trust in the entire immunization programme (Pillsbury, Alexis 2015).

The use of rubella vaccine resulted in elimination of rubella infection and CRS in the Americas and western hemisphere countries (Taneja & Sharma 2012). During outbreaks, a significant number of rubella cases decreased after vaccination (Gallegos et al. 2011). According to CDC and the WHO, the effectiveness of rubella vaccine of RA 27/3 strain is over 95%. Other rubella vaccines strains that especially the commonly used BRD II strain was found to be above 90% effective which is comparable to the widely used rubella vaccine strain - RA 27/3 (Chang et al. 2015). However, rubella outbreaks among populations that are vaccinated using this strain occurs albeit rare (CDC 2013a).

No experience exists about the effectiveness of rubella vaccine in Namibia. However, limitations of the EPI programme might suggest that effectiveness in the country is low. Refer to figure 10 which illustrates the mean score per vaccine management criteria as observed in the recent

vaccine management assessment conducted in Namibia in 2014. Details will be provided in the section on immunization programme performance.

Studies have shown that the main goal of rubella vaccination is to prevent CRS (Poethko-Müller & Mankertz 2012; WHO 2011; Reef et al. 2011). In Africa, one case of rubella infects up to 5.2 persons which is also known as a reproductive number (R_0) while in Namibia it is estimated to be around 5.0 (Lessler & Metcalf 2013). The same study estimated the R_0 in Namibia in 2011. The effectiveness of rubella vaccine depends on high vaccination coverage (above 80%) (WHO 2011). However, the impact of rubella vaccination varies depending on the type of vaccination strategy employed. Current evidence shows that rubella will continue to circulate and the age of susceptibles increases when rubella vaccination is low. As a result, women of childbearing age will have an increased risk of getting infected with rubella and their babies will consequently develop CRS (WHO 2011). The use of combined vaccination strategies with extended target age groups in other countries, have demonstrated positive results (WHO 2011). However, the time required to see epidemiological impact varies with these strategies (WHO 2011). See annex 3 for detailed vaccination strategies and their time cohorts.

In her strategic plan for rubella and CRS, Namibia has considered to target children from 9 months -14 years old with MR vaccine. However, this will be preceded by a countrywide vaccination campaign with the target group of 9 month-39 years.

3.2.2 Economic and financial issues

New vaccines may be expensive (Wolfson et al. 2008). Hence cost influences the uptake of new vaccines (Kochhar et al. 2013). However, available rubella vaccines are affordable and cost effective (WHO 2012). De Roeck & Wang (2014) indicated that new vaccines recomended for introduction into the EPI will increase the cost of vaccination package from U$ 1.35 to more than U$ 30 per child.

However, rubella vaccine is affordable (Reef et al. 2011). The average unit price for a combined Measles- Rubella (MR) vaccine and single – antigen vaccine on UNICEF prices is estimated to be around $0.52 and $0.24 respectively (Lambert et al. 2015). Lambert et al. (2015) further indicated that, a 10 vial for MMR costs about U$ 1.07 per dose which is slightly higher than the cost for MR formulation.

A study by Portnoy et al (2015) found that, for non GAVI eligble countries, the cost of MMR is estimated to range between 1.56-2,36 U$ while MR ranges between 0.63-1.08 U$ (Portnoy et al. 2015). These findings on the cost of rubella vaccine are consistent with estimates by Reef et al (2011).

In South Africa, a 10 dose vial of measles vaccine is $0.30 per vial while the private sector spent close to $14.00 per MMR vaccine vial (Cameron 2012). Another study on economic analysis of measles and rubella vaccination shows that in South Africa, vaccination is more cost effective than responding to an outbreak (Thompson & Odahowski 2014). This is in agreement with findings by confirmed by Thompson & Odahowski (2015) that the cost to manage rubella infection and CRS cases exceeded the cost of the vaccines (Thompson & Odahowski 2015). Further Castillo-Solórzano et al. (2003) estimated the average cost effectiveness per CRS prevented to be around U$ 2, 900 for mass vaccinations (Castillo-Solórzano et al. 2003).

Cost analysis for EPI in Namibia is not available. The government is fully funding the immunization services. However, the country doesn't have a specific budget line item for immunization included in the Ministry of Health annual budget or in the Medium Term Expenditure Framework (MoHSS 2011a). Vaccines and other immunization commodities are paid from general expenses budget.

Experiences from Chile and Zimbabwe, indicates that vaccines that are introduced in combination forms resulted in reduced cost (Hyde et al. 2012). In Rwanda, the cost of 2013 MR catch up was estimated at 3,279,392 U$ of which 80% was covered by GAVI while the government covered the rest (GAVI 2013). The cost of the catch-up campaign planned for 2015 is estimated at 5,1567,58.00 US$ (MoHSS 2014e). This allows vaccinating 1.801,766 people between the ages of 9 months to 39 years. Table 3, provides the budget analysis of the planned MR campaign.

Table 4: Budget summary for MR Supplementary Immunization Activities in Namibia, 2015

	BUDGET ANALYSIS	USD $	$Namibian
A	Cost of Operations at National level	779,430	9,197,270
B	Operation Cost at Region and District levels	2,107,340	24,866,710
C	Total Cost for operations (A+B)	2,886,770	34,063,980
D	Total cost for Logistics (Include bundled MR Vaccine)	2,269,988	26,785,850
E	**Total Budget for (C+D)**	5,1567,58	60,849,830
F	Cost per person – total cost (operations +logistics +vaccines)	2.86	34
G	Cost per person for operations	1.5	17.7

Source: Plan for an integrated measles/rubella vaccination campaign in Namibia, MoHSS, 2014 (MoHSS 2014e)

3.2.3 Availability of vaccine supply

Studies found that developing countries experiences logistic and supply challenges to get new vaccines (Zaffran et al. 2013). Many developing countries do not manufacture their own vaccines (Leach-kemon et al. 2014). As a result, they rely heavily on international market for their vaccines supply. A study by Muzumdar & Cline (2009) found that the number of suppliers for new vaccines can be limited (Muzumdar & Cline 2009). According to UNICEF, rubella vaccine particularly the MMR formulation is widely used (UNICEF 2015). Therefore it is expected to increase proportionally to the number of countries using rubella contained vaccine (UNICEF 2015).

The vaccine forecast by UNICEF suggest that current supply of rubella vaccine is sufficient to meet the increasing demand of the vaccine worldwide (UNICEF 2015). In contrary, Kochhar et al (2013) argued that uncertainty associated with the demand for under-utilized vaccines from the suppliers led to the delayed introduction of these vaccines in developing countries (Kochhar et al. 2013). Namibia procures her vaccines from the private sectors through a government tendering system (MoHSS 2014c). Vaccines are stored at central medical stores from which are then supplied to the regions, districts and health facilities countrywide (Kojak 2013) (MoHSS 2014c).

3.3 Status of immunization programme

3.3.1 Leadership and Governance

Governing authorities have the responsibility to ensure that populations are protected from infectious diseases (Obioha & Matobo 2015). The Namibian government through the MoHSS provides overall leadership and governance of the national EPI programme (MoHSS 2010a). The EPI policy, cYMP and strategic plan of for EPI are in place (MOHSS 2012).

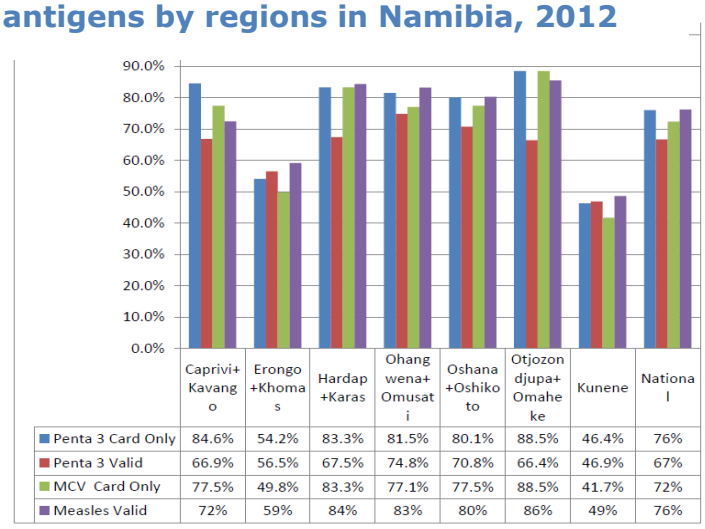
Available evidence shows that performance of immunization programmes requires coordination and partnerships between various sectors (Obioha & Matobo 2015). Namibia has in place a functional Inter-Agency Coordination Committee (ICC) as the lead organization responsible for oversight and management of immunization services in the country. The committee is comprised of key stakeholders and relevant experts from various departments and institutions. Although the ICC's primary focus was on coordination of Polio Eradication activities, it was later expanded to include all other immunization activities (MoHSS 2010a). The committee is chaired by the Hon. Deputy Minister of Health and the EPI programme unit within the MoHSS serves as the secretariats (MoHSS 2010a).

Coordinating committees in other countries was also found to be chaired by individual with authority (Grundy 2010). Grundy find that such coordinating committees such creates good platform for information sharing which can facilitate decision making. As at 2014, Namibia did not still have a National Advisory Technical Group (NTAG) in place (WHO/UNICEF 2014). Furthermore, it was found that the EPI supervision processes at lower level is relatively weak (MoHSS 2010a). That continued to hamper programme performance at those levels.

3.3.2 Service delivery

The government policy on EPI calls all government owned facilities to provide immunization on routine basis (MoHSS 2014d). Namibia provides routine immunization services through all public health facilities country wide (MoHSS 2010b). In 2010, About 80% of the public health facilities were providing immunization services on routine basis (MoHSS 2010a). As earlier mentioned, immunization services are also available through private sectors. In private sector, rubella vaccine in form of MMR is administered (MoHSS 2010a). This means that the immunization schedule in private sector is different from that of the public as it includes vaccines that are not yet publicly available in the country. In addition to the routine immunization services, other strategies such as nationwide campaigns and outreach are used to reach out to communities that may have difficulties to access health facilities. The country conducts Supplementary Immunization Activities twice a year to boost the coverage. See figure for SIA coverage (MoHSS 2010a). Findings from EPI coverage survey of 2012 shows that outreach services accounted for nearly 50% of vaccine administered (MoHSS 2012). Evidence from other countries shows that, new service delivery strategies were devised and in some instances existing strategies were adjusted to accommodate new vaccines (Hyde et al. 2012).

Figure 9: EPI coverage for various antigens by regions in Namibia, 2012



	Caprivi+ Kavango	Erongo +Khomas	Hardap +Karas	Ohangwena+ Omusati	Oshana +Oshikoto	Otjozondjupa+ Omaheke	Kunene	National
Penta 3 Card Only	84.6%	54.2%	83.3%	81.5%	80.1%	88.5%	46.4%	76%
Penta 3 Valid	66.9%	56.5%	67.5%	74.8%	70.8%	66.4%	46.9%	67%
MCV Card Only	77.5%	49.8%	83.3%	77.1%	77.5%	88.5%	41.7%	72%
Measles Valid	72%	59%	84%	83%	80%	86%	49%	76%

Source: EPI coverage Survey (MoHSS, 2012)

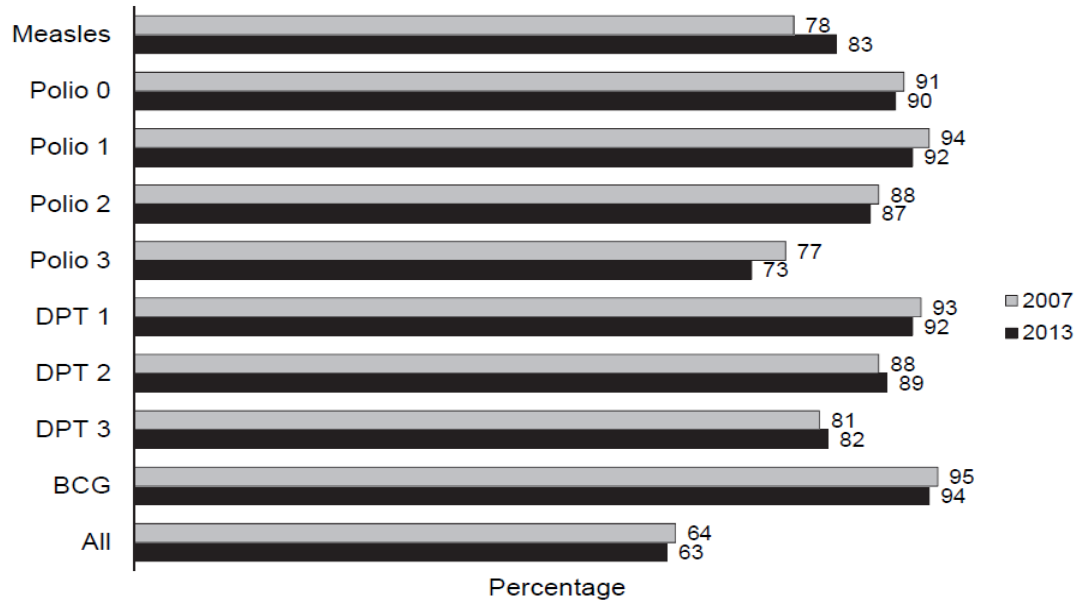
Immunization coverage is a key indicator to measure the EPI performance (Ngcobo & Cameron 2012). The national immunization programme in Namibia has shown major improvements in its coverages over the past years. Figure 10 and 11 and Table 5 provides coverage figures on routine immunization in Namibia by source of data. According to the NDHS of

2013, the coverage for DPT3 was 82.4%, and for MCV 1 was 82.9% (MoHSS 2014b). This is the first time that the countries exceeded the 80% vaccination coverage mark since the introduction of the EPI. Namibia also conduct vaccination campaign for measles every second year with coverage above 80% (MoHSS 2014b).

The WHO recommend countries that have not yet included immunization against rubella in their routine EPI schedule to consider adding the vaccine once they are able to achieve and maintain measles vaccination coverage of 80% or greater through routine and/or regular campaign (Lessler & Metcalf 2013) (WHO 2011). Estimates which compared the birth rates and vaccination coverages indicates that, CRS cases are likely to increase in countries with vaccination below 50% and high birth rates (Lessler & Metcalf 2013).

However, current immunization performances at different levels of service delivery suggest that the country may not sustain this coverage levels in the long run. See figure 11 on coverage variation by regions in Namibia. According to the EPI review, the drop-out rate between DPT1 (penta) and Measles Contained Vaccine (MCV1) in most part of the country is above 10%. Routine immunization data coverage data are comparable to EPI coverage, household survey findings and WHO/UNICEF joint reports.

Figure 10: Trends in vaccination coverage during the first year of life among children aged 12-23months, Namibia, 2007-2013



Source: Namibia Demographic Health Survey (NDHS), 2013

Table 5: EPI coverage in Namibia, 2009-2014

	OPV1 %	OPV3 %	DPT1 %	DPT3 %	MCV1 %	WHO/UNICEF Estimates of MCV1 (%)	Admin DTP1 to MCV1 Dropout rate (%)
2001	58	64	58	63	80	58	-38
2002	86	78	86	78	78	68	9
2003	87	83	87	83	72	70	17
2004	88	81	88	81	75	70	15
2005	85	69	70	69	71	73	-1
2006	86	73	86	73	73	63	15
2007	88	69	74	69	72	69	3
2008	88	83	88	83	73	73	17
2009	86	83	87	83	76	76	13
2010	85	83	87	83	74	75	15
2011	91	85	88	82	75	74	15
2012	90	84	89	84	76	76	15
2013	94	89	94	89	82	82	13
2014*	93	88	93	88	82	83	11

Source; (MoHSS 2015b)

Table 6: Household survey coverage estimates for EPI in Namibia, 2000-2013

	BCG	OPV0	OPV1	OPV2	OPV3	DPT 1	DPT 2	DPT 3	MCV1	FIC
2000 (DHS by 12 months)	90.0	86.9	93.0	87.5	76.1	91.4	87.0	78.4	72.2	58.7
2006 (DHS by 12 months)	94.7	90.6	94.1	85.4	76.5	93.4	88.2	81.0	78.0	63.8
2013 (DHS by 12 months)	94.2	89.9	92.2	87.4	73.2	92.3	88.8	82.4	82.9	62.6
2012 EPI Coverage survey (Crude)	95.8				93.0	96.0		94.0	89.0	66.0

Source: (MoHSS 2015b)

3.3.3 Health workforce

Namibia has 3 health workers per 1000 population which is above the WHO requirement of 2.3 health workers per 1,000 needed to provide 80% coverage of immunization (MoHSS 2010b). However, a study by McQuide et al (2013) shows that although the country has relatively adequate number of nurses, they are not evently distributed (McQuide et al. 2013). The national EPI has a critical shortage of staff, both at national and sub-national levels. At national level, the programme is managed by one technical program officer (MoHSS 2010a). Current structure of the national EPI does not include positions for a cold chain manager, logistician, data manager, surveillance officer and social mobilization officer have (MoHSS 2010a). Although the need for extra staff was suggested, following the EPI review in 2010, implementation in that regard is yet to take effect (MoHSS 2010a). This could be due to lack of right skill mix in the country (MoHSS 2014f). The Ministry is currently in the process of restructuration.

Experiences from other countries indicates that health workforce is not expanded to accommodate for the introduction of new vaccines (Wang et al. 2013). Vaccines that are introduced within existing immunization routine schedules have minor impact on staff workload (Hyde et al. 2012). Wang et al went further to highlight that extra staff may be required during mass vaccination campaigns.

Findings from EVM assessment conducted in 2014 identified that the majority of the nurses in Namibia are lacking knowledge on vaccine management. This was demonstrated by a significant number of who could not for instance interpret the vaccine vial monitors. Staff training on new vaccines that are introduced in combination with existing vaccines was found to be easy (Wang et al. 2013). Findings from EPI review of 2010 shows that curriculum for training health workers at local training institutions does not include EPI and more than 50% of the teaching staff are not trained in EPI (MoHSS 2010a).

3.3.4 Medical Products (Supply chain and logistics)

Namibia has an objective included in the cYMP of 2011-2015 which calls for efficient and functional vaccines logistic with adequate storage equipment in all districts by the end of 2015 (MoHSS 2011a). There was no major vaccine stock out of existing antigen in the past year (MoHSS, 2014). The country's vaccine management system was assessed in 2014 and significant areas of improvement(MoHSS 2014c). The country scored only 22% and 44% on vaccine management and storage temperatures respectively. Above 77.8% of the indicators at national level, were below the Effective Vaccine Management (EVM) initiative target of 80% and this

was the same for the district and health facility level while the regional level had 66.7%. See figure13.

Other findings included, lack of vaccine wastage monitoring systems and vaccine forecasting at lower levels which led to overstocking or vice-versa in various facilities. Additionally, findings from the cold chain assessment conducted in 2013 shows that about 64% of cold chain equipment were in use for more than 10 years and needed to be replaced (Kojak 2013). See figure 14. These findings led to the development of a costed improvement plan of which is yet to be fully implemented. These challenges are consistent with observations and experiences from many African countries (Machingaidze et al. 2013).

Namibia does not use WHO/UNICEF structures to order and receive her vaccines. Instead the country uses the tendering system directly from private sectors. The vaccines are received like all other medical products by the MoHSS through Central Medical Stores (CMS) after which are supplied at sub-national level. Vaccine Arrival Report (VAR) is not completed upon receipt of vaccines and as per UNICEF VAR guidelines (MoHSS 2014c). The country does not have electronic stock management system in place especially at district levels. Shortage of cold-storage space was experienced when pentavalent vaccine was introduced 2009.

Namibia does not have a strong National Regulatory Authority. As a result, vaccines that are received are not tested for biological credibility before they are used in the country. Additionally, the national EPI programme does not have in place the vaccine potency monitoring system (MoHSS 2014c) However, the country imports all her vaccines of which are WHO pre-qualified (MoHSS 2014c).

Figure 11: Effective vaccine management mean criteria scores, Namibia, 2014

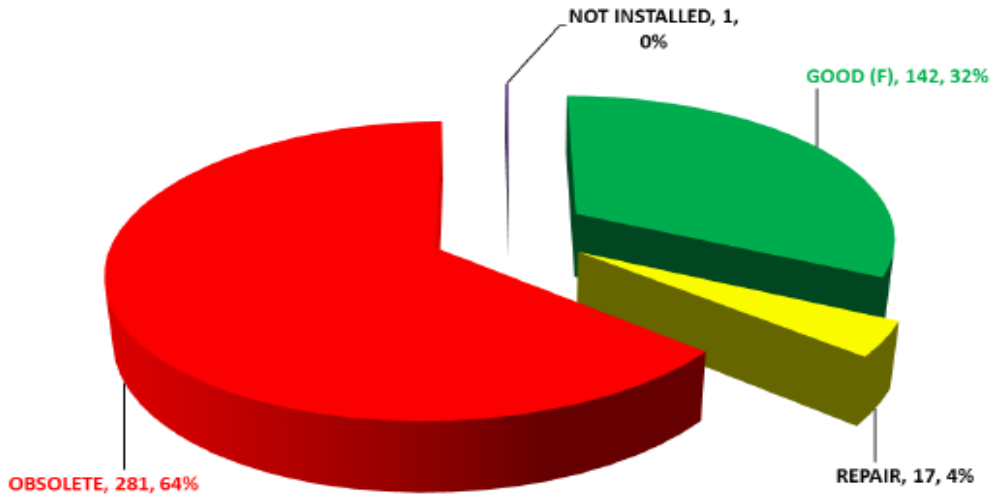
#	Criteria	Levels			
		National	Regional	District Hospitals	Health Centers/Clinics
1	Pre–shipment and arrival procedures	12%	Not applicable	Not applicable	Not applicable
2	Storage temperature	44%	31%	51%	59%
3	Capacity - vaccine and supplies	58%	78%	69%	59%
4	Building, equipment and transport	83%	70%	78%	70%
5	Maintenance	91%	66%	41%	42%
6	Stock management	32%	50%	41%	24%
7	Distribution	11%	51%	41%	69%
8	Vaccine Management	22%	42%	55%	69%
9	MIS and supportive functions	40%	30%	16%	16%

Legend:
- **80% and above:** EVM Expectation, keep it up
- **61% to 79%:** Intervention with time
- 60% and less: Quicker interventions needed

Result precision:
- All level : 80%
- Confidence level and Precision: ±15%

Source: (MoHSS 2014c)

Figure 12: Analysis of cold chain equipment in Namibia, 2013



Source: (Kojak 2013)

3.3.5 Information

According to Article 5, 6 and 7 of the International Health Regulation (2005), member states are obliged to assess, notify and report health conditions and events that constitute public health threats (WHO 2005). A well-functioning system for VPD assist decision makers and managers to manage vaccines stock more efficiently (Hyde et al. 2013) (Zaffran et al. 2013). As mentioned earlier, Namibia does not have surveillance system for CRS. Surveillance system for CRS serves as one of the requirement for the introduction of rubella vaccine.

Current Health Information Systems (HIS) in Namibia is characterised by fragmentation and parallel information systems (MoHSS 2006). Data collection, analysis and utilization of surveillance data at all levels is inadequate (MoHSS 2010a). This is further compounded by lack of skilled surveillance and HIS officers in the ministry. Data collection tools are not updated to include indicators for previous added antigens such as pentavalent since their introduction in 2009 (MoHSS 2010a). As mentioned earlier, reporting of immunization data from private sector to the MoHSS is not happening (MoHSS 2010a).

Although EPI surveillance is integrated into the ISDR and HIS, different reporting formats are used to report coverage data to the HIS and EPI units. This led to the variations in immunization coverages (MoHSS 2015b). The AEFI monitoring system is not fully functional although there is evidence that it is included in the vaccination campaigns (MoHSS 2010a). However, AEFI is monitored during immunization campaigns

(MoHSS 2010a). Further, the country doesn't have in place standardised reporting and recording formats for stock management (MoHSS 2014c). The country conducts periodic EPI coverage survey, EPI review and EVM assessment among others. However, post evaluation of recently introduced vaccines is not done.

3.3.6 Financing and Sustainability

Wang et al (2013) highlights that many countries rely on donors for the introduction of new vaccines and this may risk financial sustainability in the long run. Account for all cost related to EPI was found to be key for financial sustainability (Le Gargasson et al. 2015). As the number of GAVI eligible countries are graduating, countries are increasingly encouraged to find innovative ways to increase their own funding for their immunization programme (Saxenian et al. 2014).

Review of financial sources for immunization services indicates that Namibia is financial independent (MoHSS 2010a). The country is not GAVI eligible and as such it funds its own vaccines for both routine and SIAs (MoHSS 2010a). Other partners and donors are however encouraged to contribute by covering technical support related activities (MoHSS 2012).

However, according to the EPI review of 2010, there was no specific budget line for immunization included in the Ministry's annual budget, hence making it difficult to identify specific cost for EPI. One study found that the inclusion of a specific line item for immunization increases the availability of financial resources for the programme (Lydon et al. 2008). For example, findings from Lesotho shows that about 15% of the total health budget was earmarked for the procurement of vaccines (Obioha & Matobo 2015).

4 CHAPTER 4: DISCUSSION

This chapter discusses and draws conclusions based on the findings from the three main thematic areas of the framework. In addition, recommendations are also presented in this chapter and were largely guided by findings on the best practices from other countries with the same setting

4.1 The disease

The global perception on rubella has changed over the years. It is known that lack of knowledge on the disease burden, lack political commitment and prevailing competing priorities may impede potentials to interrupt the infection and eliminate CRS (Lambert et al. 2015). The adoption of WHO/AFRO targets for 2020 demonstrates the country's political commitment towards the elimination goals for rubella and CRS. Although Namibia did not specifically prioritise rubella prevention over the past years, the country's intentions towards the well-being of its people are well articulated in the national developmental documents. Therefore current commitment of the government towards vaccine preventable diseases creates opportunities to mobilize resources needed to control the rubella infections and eventually eliminate CRS.

Results from analysis of rubella case surveillance data provide good evidence that rubella is circulating countrywide as clearly indicated by ongoing the transmission of rubella infection year round. Although there is no information on CRS burden, an observed increase pattern of rubella confirmed cases infection along with estimates provided on CRS may further assist decision makers to understand current state of affairs in relation to the magnitude of the problem. Furthermore, the study findings reveal rubella infection seems to occur more in the age group below 15 years of age. Results showed no difference in age distribution of rubella infection which suggests that both females and females are at equal risk of acquiring infection. The number of females is slightly higher than males. This could also be due to the fact women tending to seek health services more than man of which could result in more screening for women.

Although the number of cases appears to be relatively low among the older age groups, woman of reproductive age may be at high risk of infection as indicated by 16.6% of confirmed rubella cases among women of reproductive and about 15% of pregnant women who were found to lack immunity against rubella. Since the cases were detected passively and that adults are unlikely to seek for medical care of a mild infection,

the burden of rubella infection among the adults may be under-estimated (Njeru et al. 2015). The distribution of rubella infection cases in Namibia is however comparable with the distribution of rubella infection observed in other countries that do not vaccinate like Ethiopia, (Mitiku et al. 2011) Kenya (Njeru et al. 2015) and Zimbabwe (Chimhuya et al. 2015).

Information about the availability of other disease prevention and control measures is equally very important for the decision makers. Decision makers are usually compelled to justify policy options taking into account the cost-effectiveness of interventions available. In the face of increasing patterns of rubella infection there are no other control measures in place in Namibia to interrupt the rooming circulation of rubella infection. In situations where there is no vaccination, then one would prefer that rubella infection to occurs as early as possible in life so that the population particularly women develop immunity by the time they reach childbearing age. This would prevent them acquiring rubella virus during pregnancy.

4.2 The vaccine

Vaccines that are safe, affordable, of good quality and high efficacy, are critical for effective immunization programmes and remain important attributes for health system strengthening (WHO 2007). These attributes, together with perceived danger of the diseases, influence the acceptance and use of the vaccine by the public (Nabel 2013)(Lambert et al. 2015). This information becomes critical for decision makers when deciding to add an extra vaccine to the immunization programme. Given the existing vaccines coverage levels, it is safe to suggest that acceptance of vaccines in Namibia is high and this may benefit the uptake any additional vaccine to be introduced.

The available rubella vaccine is safe and it high efficacious and real world effectiveness was demonstrated in other countries that have eliminated rubella and CRS through its use. Rubella vaccine effective to control and eliminate CRS is determined by high vaccination coverage which once not maintained above 80%, the cases of CRS will increase. However the vaccine's sensitivity to heat is also concerning. This means that the suitability of rubella vaccine in Namibia will largely depend on the performance of local conditions and overall vaccine management processes in the country.

Namibia is generally a hot country and poor performance of the vaccine management in terms of cold chain management, storage, transportation and administration may affect the vaccine's potency, efficacy and effectiveness (Kochhar et al. 2013). This is not only applicable to the rubella vaccine but to all other vaccines existing within the national immunization programme. A well-functioning EPI programme ensures that vaccines are available and sufficient for the targeted population.

According to WHO, success of the programme largely depends on a robust vaccine supply chain system (WHO 2014d). Although historically, countries have experienced technical difficulties in ensuring sustainable supply of vaccines (Andrus et al. 2007), the international market and supply for rubella vaccine is favourable and future supply of the vaccine is positive (UNICEF 2015). It is therefore likely that the supply of rubella vaccines is not much of a concern for now.

4.3 Status of immunization programme

The strength of the immunization programme influences the decisions to introduce any new vaccine (Ngcobo & Cameron 2012). According to WHO, it is important for decision makers to know that the immunization programme has capacity in different health systems areas to absorb a new vaccine (De Roeck & Wang 2014). The immunization programme in Namibia seems to be receiving sufficient support through established coordinating committees such as ICC and developed cYMP, policies and strategic plans. However, critical shortage of key positions for EPI will continue to affect programme management. During the introduction of rubella vaccine, the EPI programme will be overwhelmed by a lot of activities all to be coordinated by one technical staff currently at central level. The absence of a logistician will not enable the EPI to ensure that enough vaccines are procured and delivered to all levels in time. It is also important to communicate to the general public about the introduction of the new vaccine which once not done appropriately may affect acceptability and consequently lead to poor vaccination coverage in the long run. A well performing EPI programme would require evidence based decision for ongoing planning and programme. The programme will surely benefit from another staff that is responsible for monitoring and evaluation by analysing routine immunization data. Although investing enough resources for EPI programme is commendable, better results will not be possible without good management.

In spite of various challenges faced with the immunization programme in Namibia, the trend of immunization coverage of existing antigens is encouraging. Although the monitoring and evaluation system is poorly performing, the author is confident that current estimation of coverage levels from triangulation of surveys and routine data presents reality. On the other hand, it is not only important to know how adequate the coverage is but most importantly to also ensure that vaccines administered are of good quality. Observed gaps on supply and cold chain management are of serious concern.

In addition to the procurement of rubella vaccine, EPI programme in terms of capacity enhancement for storage, vaccine management and information systems may be required and this will come at added cost as well. Introducing a vaccine that is light and heat sensitive under conditions characterised by poor vaccine management practices will compromise the efficacy and effectiveness of the vaccine. Although the health system is adequately funded to provide basic health services, lack of specific funds ear-marked for EPI creates concerns over efficiency and financial sustainability of the EPI in the country. Furthermore, the current state of affairs in terms of financing the immunization programme without a specified budget may at times lead to the shift of resources from other equally important health interventions to EPI related activities thereby creating opportunity costs.

5 CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The decision to introduce rubella vaccine countrywide is a step in a right direction. However, it is important that evidence is used to inform decisions for the introduction of the vaccine. Information about the suitability and feasibility of the vaccine in the context of Namibia is central to the selection of implementation strategies of rubella vaccine. The elimination targets for rubella and CRS by 2020 are clearly off target and unrealistic given the maximum time needed to eliminate CRS which is up to 30 years depending on the vaccination strategies employed. See annex 2. The study explored factors that are relevant for the introduction of rubella vaccine in Namibia.

Although the exact burden of rubella infection and CRS in Namibia may be underestimated, current evidence is relatively enough to spark deliberation and inform pre-liminary planning activities towards the introduction of rubella vaccine. Notably, Namibia seems to be within favourable range to introduce rubella vaccine. However, having achieved MCV1 coverage above 80% mark for the first time may not confidently suggest a sustainable coverage in the years to come. Equally, the current state around cold chain and vaccine management is worrisome as it currently indicates that there seems to be little attention paid to the vaccine management arena. Without serious investment to improve the situation, the vaccine potency, efficacy and effectiveness will be affected and this is not only affect rubella vaccine but all other vaccine. As discussed earlier, the introduction rubella vaccine has two scenarios; one of which requires herd immunity by sustaining high vaccination coverage. The option is to do "nothing" and allow people to acquire immunity through early infection. However, this may not be ethically advisable as the country has a responsibility to ensure that people are protected from preventable illnesses. In addition, availability of rubella vaccine which is only accessible in the private sector will continue to fuel prevailing inequity in accessing essential vaccines and hinders realization of attaining universal health coverage goals.

Having highlighted the above scenarios, it is critical for the policy and decision makers to know that inappropriate and misguided decisions for the introduction of rubella vaccine in the country will lead to the increase the burden of CRS in the population. Situations which will in the long run cost the country a lot of resources to rehabilitate cases of CRS. This means investing money in an intervention that does more harm than good is commendable. Should there be doubts about the success, then is

healthier to invest resources into other health priorities until the conditions are adequate and favourable for the introduction.

5.2 Recommendations

To the author's knowledge, this is the first study in Namibia to document factors that affect decisions for the introduction of rubella vaccine. Although, the study had some limitations, it is suggested that its findings be considered during decision making processes for rubella vaccine implementation strategies. The epidemiological impact of rubella and CRS requires long term commitment of prevention and control strategies. Therefore, the choice of effective strategy and its implementation depends on the knowledge base of the factors analysed. The following recommendations are suggested

The Government/Policy makers

1. The government may need continue its commitment by advocating for more resources needed to implement strategic initiatives as outlined in the rubella and CRS strategic plan.

2. The government should consider fast tracking the recruitment of extra staff as identified by recent EPI reviews to support the current under-staffed EPI programme.

3. Government should engage private sectors through puplic-private partnerships mechanisms to ensure that immunization activities and are monitored by the central government.

The MoHSS/EPI programme

4. The country through the MoHSS should establish sentinel surveillance for CRS and conduct epidemiological studies in order to fully understand the burden of rubella and CRS in the country.

5. Enhance cold chain and logistics as well as the vaccine management practices at all levels of immunization service delivery points.

6. Conduct studies to determine the perception and acceptability of the new vaccines among different population groups and health workers

7. Improve immunization information systems by integrating sub-existing information systems and through capacity building on data collection, analysis and use of information.

8. The country should introduce rubella vaccination for adolescent's females and all women of childbearing age while preparing to introduce the vaccine country wide.

To stakeholders/supporting partners (WHO/ UNICEF)

9. Continue supporting the EPI programme by providing technical support and capacity building for programme staff and health workers particularly on good vaccine management practices.

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APPENDICES:

ANNEX 1: Priority diseases, conditions and events for Integrated Disease Surveillance and Response, 2010

<table>
<tr><th colspan="3">Priority diseases, conditions and events for
Integrated Disease Surveillance and Response, 2010</th></tr>
<tr><th>Epidemic prone diseases</th><th>Diseases targeted for eradication or elimination</th><th>Other major diseases, events or conditions of public health importance</th></tr>
<tr><td rowspan="3">Acute haemorrhagic fever syndrome*
Anthrax
Cholera
Diarrhoea with blood (Shigella)
Measles
Meningococcal meningitis
Plague
SARI**
Typhoid fever
Yellow fever

*Ebola, Marburg, Rift Valley, Lassa, Crimean Congo, West Nile Fever</td><td>Leprosy
Neonatal tetanus
Poliomyelitis[1]
Malaria
[1]Disease specified by IHR (2005) for immediate notification</td><td>Acute viral hepatitis
Adverse events following immunization (AEFI)
Diabetes mellitus
Diarrhoea with dehydration in children under 5 years of age
HIV/AIDS (new cases)
Hypertension
Injuries (Road traffic Accidents)
Malnutrition in children under 5 years of age
Maternal deaths
Mental health (Epilepsy)
Noma
Rabies
Schistosomiasis
Severe pneumonia in children under 5 years of age
STIs
Tuberculosis
Obesity</td></tr>
<tr><td colspan="2">Diseases or events of international concern</td></tr>
<tr><td colspan="2">Human influenza due to a new subtype[1]
SARS[1]
Smallpox[1]
Any public health event of international or national concern (infectious, zoonotic, food borne, chemical, radio nuclear, or due to unknown condition).
[1]Disease specified by IHR (2005) for immediate notification</td></tr>
</table>

ANNEX 2: Measles - case investigation form

Ministry of Health and Social Services
CASE INVESTIGATION FORM – MEASLES
Compulsory notification. Please complete all information in full.

Official use only: EPID NUMBER: _____/_____/_____/_____/_____
Country Region District Year-onset Case number
Date Form Received at National Surveillance Office/Laboratory: _____/_____/_____

IDENTIFICATION

Name(s) of Patient: _____ Father/Mother: _____
Date of birth: ____/____/____ Age: Years _____ months _____ Sex: Male/Female_____
(if DOB unknown)

District: _____ Region: _____

Nearest Health Facility to village: _____ _____Village: _____

Town/City: _____ Urban/Rural

Physical Address: _____Tel (if any):_____

HISTORY

Date rash & fever onset: ____/____/____ Dead: Yes/No/Unknown
Number of valid measles doses: ____ or unvaccinated (0)/unknown (99)
Date last measles vaccination: ____/____/____ Measles doses during NID's? Y/N/DK

BLOOD SPECIMEN

Date specimen collection: ____/____/____
Date specimen sent from the Clinic/Health Centre/Hospital to the District Laboratory: ____/____/____
Date sent to National Laboratory:_____/_____/_____

NOTIFICATION/INVESTIGATION Notified by: _____
Date District notified: ____/____/____ Date Case Investigated: ____/____/____
Investigated by:_____
Source of infection identified?: Yes/No Community investigation done?: Yes/No
Comment:
_____
_____
_____

INVESTIGATOR (Person completing the form)

Name: _____ Title: _____ Unit: _____ Signature:_____Address _____Tel: _____ Fax: _____
_____
__

Please send a copy of this completed form immediately to the National Surveillance Officer, Disease Control Division, Epidemiology Division and the National Lab, MoHSS, Private Bag 13198, Windhoek, Tel.: (061) 203 2756/7/9, Fax: (061) 309745

ANNEX 3: Rubella vaccination and elimination strategies

Table 1 **Vaccination strategies to reduce the incidence of congenital rubella syndrome (CRS) or eliminate rubella and CRS, by cohorts vaccinated and time needed to achieve elimination**

Tableau 1 **Stratégies de vaccination visant à réduire l'incidence du syndrome de rubéole congénitale (SRC) ou à éliminer la rubéole et le SRC, par cohortes vaccinées et durée nécessaire pour obtenir l'élimination**

Cohorts to be vaccinated – Cohortes à vacciner	Goal – Objectif			
	Reduce CRS – Réduire le nombre de cas de SRC	Eliminate rubella and CRS – Éliminer la rubéole et le SRC		
		Strategies to achieve elimination within 20–30 years – Stratégies pour obtenir l'élimination en 20 à 30 ans	Strategies to achieve elimination within 10–20 years – Stratégies pour obtenir l'élimination en 10 à 20 ans	Strategies to achieve elimination within 10 years – Stratégies pour obtenir l'élimination en 10 ans
Women of childbearing age – Femmes en âge de procréer	Routine immunization or SIAs – Vaccination systématique ou activité de vaccination supplémentaire	Routine immunization or SIAs – Vaccination systématique ou activités de vaccination supplémentaire	Routine immunization or SIAs for females not targeted by previous campaigns – Vaccination systématique ou activités de vaccination supplémentaire pour les femmes non ciblées par les campagnes précédentes	Speed-up campaign[c] – Campagne accélérée[c]
Children 9 months–4 years – Enfants de 9 mois à 4 ans		1 dose routine immunization and regular follow-up campaigns[a] or 2 doses given through routine immunization – 1 dose (vaccination systématique) et campagnes régulières de suivi[a] ou 2 doses administrées dans le cadre de la vaccination systématique	1 dose routine immunization and regular follow-up campaigns[a] or 2 doses given through routine immunization after catch-up campaign[c] – 1 dose (vaccination systématique) et campagnes régulières de suivi[a] ou 2 doses administrées dans le cadre de la vaccination systématique après une campagne de rattrapage[c]	1 dose routine immunization and regular follow-up campaigns[a] or 2 doses given through routine immunization after speed-up campaign[a] – 1 dose (vaccination systématique) et campagnes régulières de suivi[a] ou 2 doses administrées dans le cadre de la vaccination systématique après une campagne accélérée[a]
Children 5–14 years – Enfants de 5 à 14 ans			Catch-up campaign[b] – Campagne de rattrapage[b]	Speed-up campaign[c] – Campagne accélérée[c]
Adolescents and adults aged 15–39 years – Adolescents et adultes âgés de 15 à 39 ans				Speed-up campaign[c] – Campagne accélérée[c]

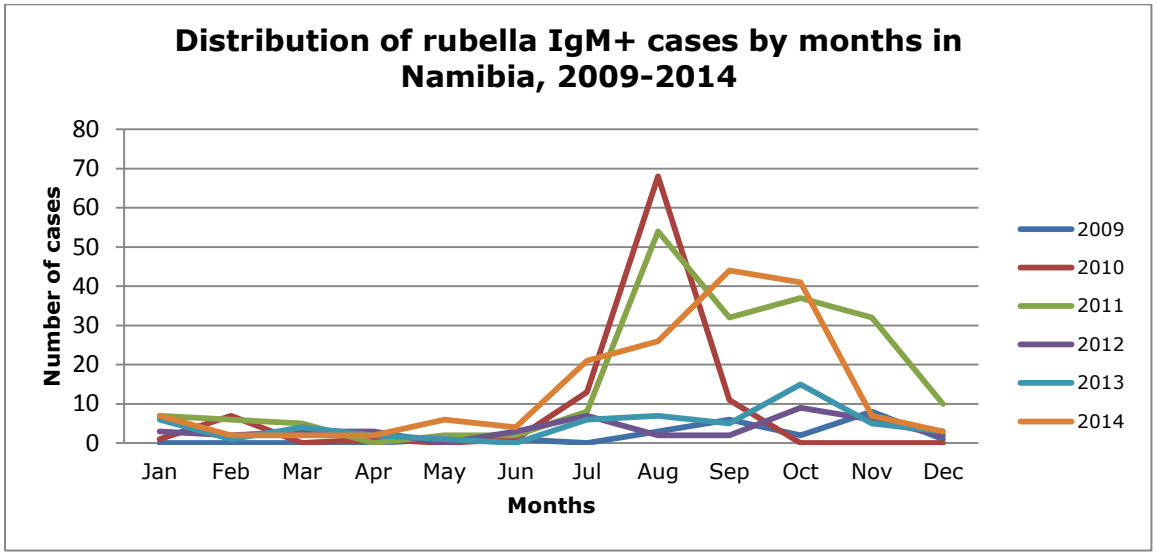
SIAs, supplementary immunization activities.

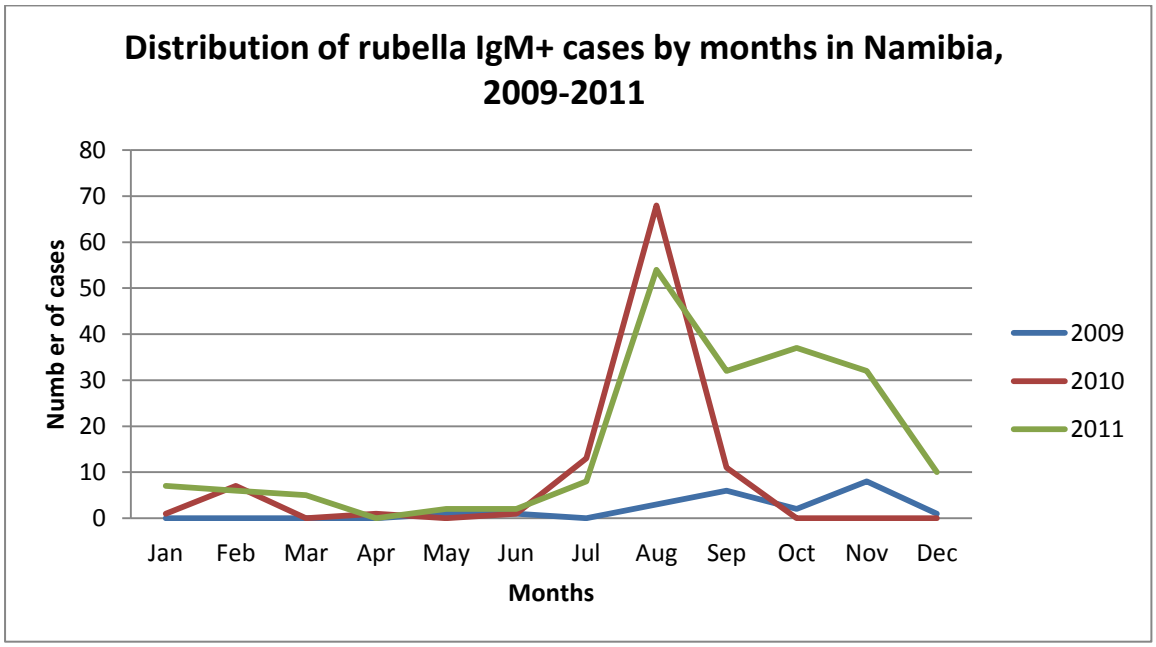
[a] Follow-up campaigns are periodic campaigns that usually target all children born since the previous campaign. These campaigns are usually conducted nationwide every 2–4 years and target children aged 9–59 months. – Les campagnes de suivi sont des campagnes périodiques qui ciblent en général tous les enfants nés depuis la dernière campagne. Ces campagnes sont habituellement menées à l'échelle nationale tous les 2 à 4 ans et ciblent les enfants âgés de 9 à 59 mois.

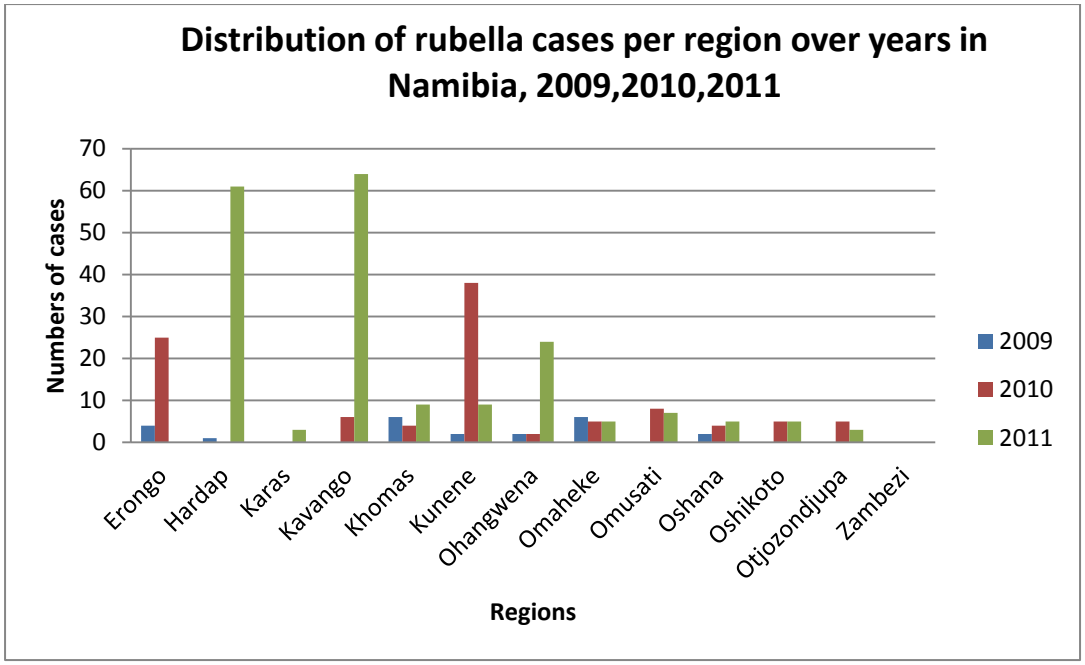
[b] A catch-up campaign is a 1-time campaign that targets all children aged 9 months to 14 years. – Une campagne de rattrapage est une campagne unique qui vise tous les enfants âgés de 9 mois à 14 ans.

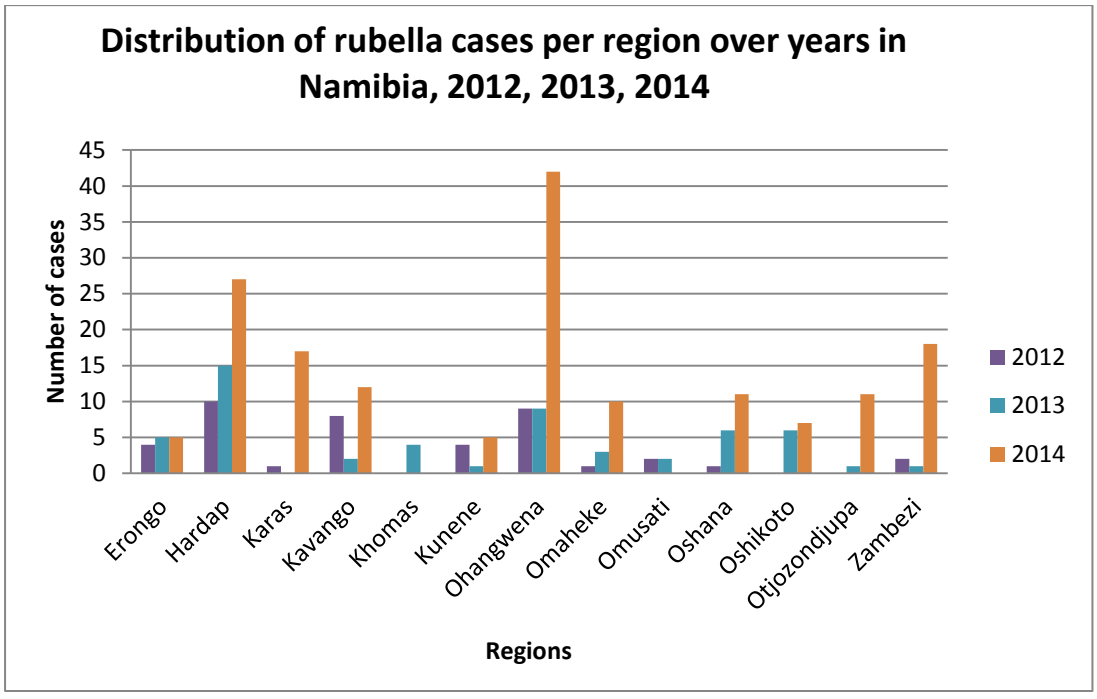
[c] A speed-up campaign is a 1-time campaign that targets older children, adolescents and adults (the age group of males and females to be vaccinated depends on which year the vaccine is introduced, the coverage of follow-up campaigns, epidemiology, and fertility rates in the country). – Une campagne accélérée est une campagne unique qui cible les enfants les plus âgés, les adolescents et les adultes (la classe d'âge des hommes et femmes à vacciner dépend de l'année au cours de laquelle le vaccin est introduit, de la couverture des campagnes de suivi, de l'épidémiologie et des taux de fécondité dans le pays).

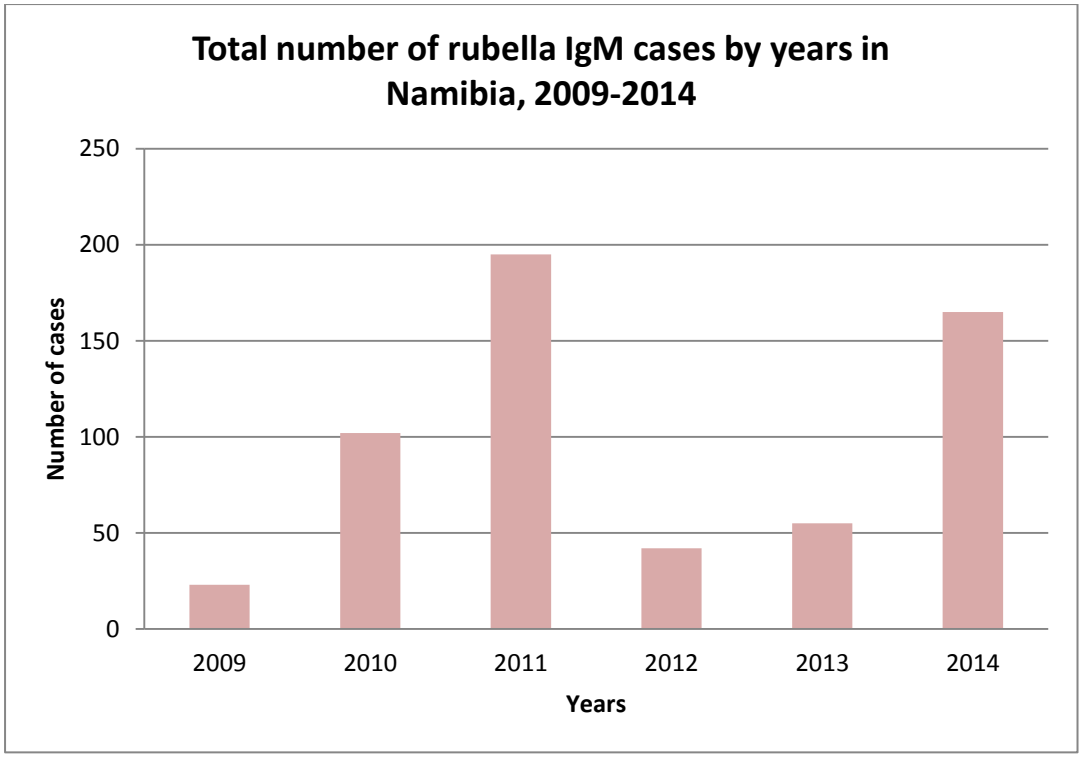
ANNEX 4: Various analysis of rubella IgM + (confirmed cases) in Namibia, 2009-2014






Distribution of rubella cases per region over years in Namibia, 2009,2010,2011
Numbers of cases
70
60
50
40
30
20
10
0
Erongo
Hardap
Karas
Kavango
Khomas
Kunene
Ohangwena
Omaheke
Omusati
Oshana
Oshikoto
Otjozondjupa
Zambezi
Regions
2009
2010
2011


Distribution of rubella cases per region over years in Namibia, 2012, 2013, 2014
Number of cases
45
40
35
30
25
20
15
10
5
0
Erongo
Hardap
Karas
Kavango
Khomas
Kunene
Ohangwena
Omaheke
Omusati
Oshana
Oshikoto
Otjozondjupa
Zambezi
Regions
2012
2013
2014


Total number of rubella IgM cases by years in Namibia, 2009-2014
250
200
150
100
50
0
Number of cases
2009
2010
2011
2012
2013
2014
Years