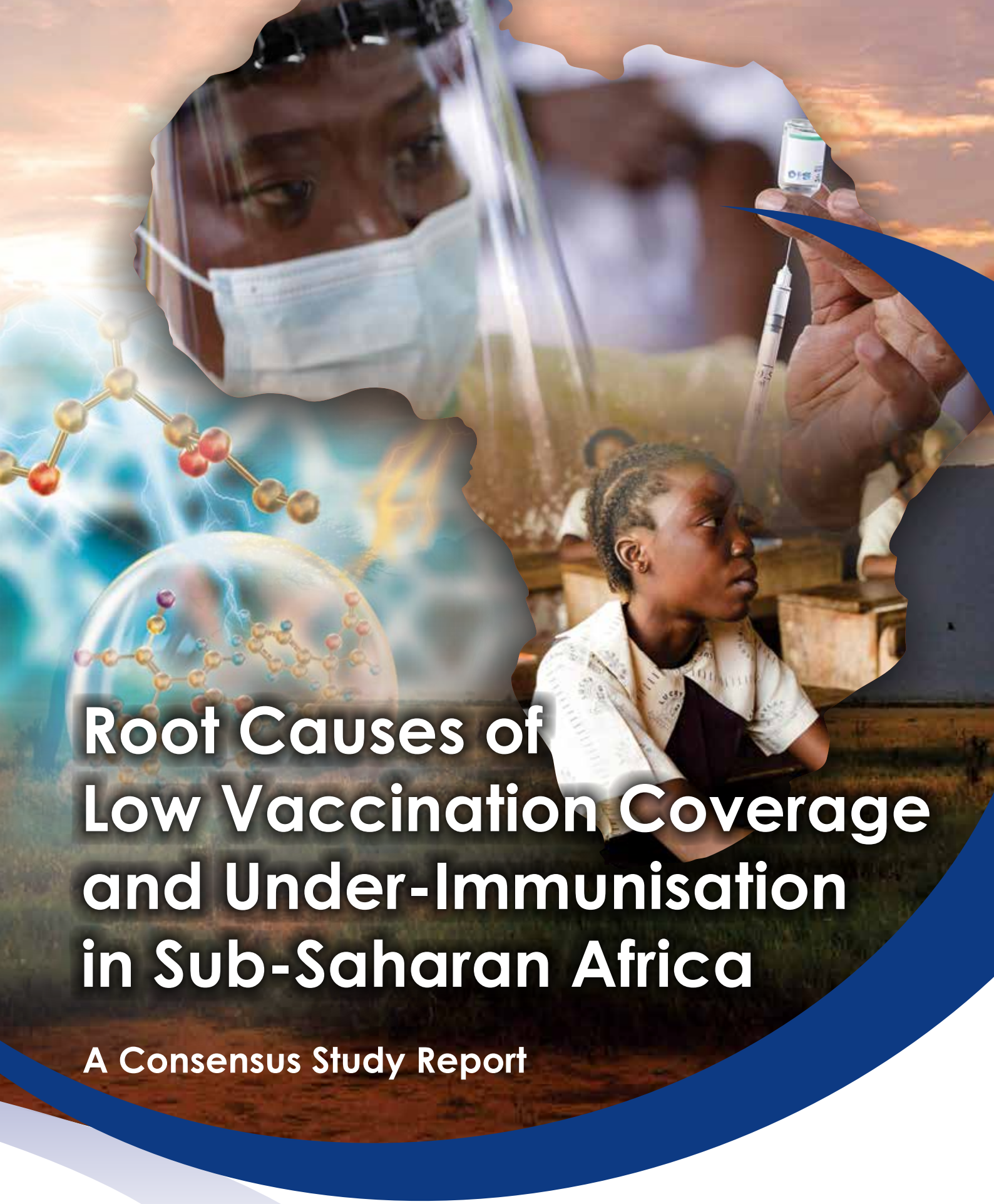

Root Causes of Low Vaccination Coverage and Under-Immunisation in Sub-Saharan Africa

A Consensus Study Report

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Sciences for Prosperity.
Uganda National Academy of Sciences

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PO Box 72135, Lynnwood Ridge, Pretoria, South Africa, 0040
Tel: +27 12 349 6600 • Fax: +27 86 576 9520
E-mail: admin@assaf.org.za

The Academy of Science of South Africa (ASSAf) was inaugurated in May 1996. It was formed in response to the need for an Academy of Science consonant with the dawn of democracy in South Africa: activist in its mission of using science and scholarship for the benefit of society, with a mandate encompassing all scholarly disciplines that use an open-minded and evidence-based approach to build knowledge. ASSAf thus adopted in its name the term 'science' in the singular as reflecting a common way of enquiring rather than an aggregation of different disciplines. Its members are elected on the basis of a combination of two principal criteria, academic excellence and significant contributions to society.

The Parliament of South Africa passed the Academy of Science of South Africa Act (No 67 of 2001), which came into force on 15 May 2002. This made ASSAf the only academy of science in South Africa officially recognised by government and representing the country in the international community of science academies and elsewhere.

About the Academy of Science of South Africa (ASSAf)

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Uganda National Academy of Sciences

About the Uganda National Academy of Sciences (UNAS)

Founded in October 2000, the Uganda National Academy of Sciences (UNAS) is both an honorific and service-oriented science academy. Its members are distinguished professionals from across the sciences, arts, and humanities. Through its membership and broad network, UNAS strives to improve the livelihoods, welfare, and prosperity of the people of Uganda through the development and enhanced application of integrated knowledge in the sciences, arts, and humanities. With its signature convening and consensus activities, UNAS provides an unparalleled service to society when it responds to present and impending contentious issues with a direct impact on society. UNAS' values are (1) scientific rigour, (2) inclusivity, (3) virtue, (4) responsiveness, (5) objectivity, and (6) collaborative learning.

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ADI	Addis Declaration on Immunisation
ASSAf	Academy of Science of South Africa
BCG	Bacillus Calmette–Guérin vaccine
AU	African Union
CAR	Central African Republic
CDP	Consensus Development Panel
CSOs	Civil Society Organisations
CTC	Controlled Temperature Chain
DHS	Demographic and Health Surveys
DTP1	Diphtheria-Tetanus-Pertussis dose 1
DTP2	Diphtheria-Tetanus-Pertussis dose 2
DTP3	Diphtheria-Tetanus-Pertussis dose 3
DSI	Department of Science and Innovation
DRC	Democratic Republic of the Congo
DoH	Department of Health
EPI	Expanded Programme on Immunisation
EVM	Effective Vaccine Management
FSP	Financial Sustainability Plan
Gavi	Gavi, the Vaccine Alliance
GBD	Global Burden of Disease, Injuries, and Risk Factors Study
GNI	Gross National Income
GVAP	Global Vaccine Action Plan
GPEI	Global Polio Eradication Initiative
HBR	Home-Based Record
HICs	High-income Countries
HIS	Health Information Systems
HMIS	Health Management Information Systems
iSC	immunisation Supply Chains
JRF	WHO/UNICEF Joint Report Form
LICs	Low Income Countries
LMICs	Lower-Middle-Income Countries
LISA	Local Indicator of Spatial Association
MCV1	Measles-Containing Vaccine first dose
MCV2	Measles-Containing Vaccine second dose
mHealth	Mobile Health

MOV	Missed Opportunities for Vaccination
NITAG	National Immunisation Technical Advisory Group
NGO	Non-Government Organisation
PAHO	Pan American Health Organisation
RITAG	Regional Immunisation Technical Advisory Group
R4D	Results for Development Institute
RSPI	WHO Regional Strategic Plan for Immunisation
SAGE	WHO Strategic Advisory Group of Experts on Immunisation
SAMRC	South African Medical Research Council
SIVAC	Supporting Independent Immunisation and Vaccine Advisory Committee
SDGs	Sustainable Development Goals
SDI	Socio-Demographic Index
SCM	Supply Chain Management
SES	Socio-Economic Status
SMS	Short Message Service
SoT	Statement of Task
SSA	Sub-Saharan Africa
UNAS	Uganda National Academy of Sciences
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
UNESCO	United Nations Educational Scientific and Cultural Organisation
VPDs	Vaccine-Preventable Diseases
VII	UNICEF Vaccine Independence Initiative
WHO	World Health Organisation
WHO AFR	WHO Africa Region

KEY DEFINITIONS

Academy of Science(s): Academy of Science(s) refers to an assembly of intellectuals or fellowship of scientists dedicated to the advancement of scientific knowledge within their societies and on a global scale. A common feature of all the world's science academies is to seek nationwide economic and social advancements through wise applications of science and technology (Network of African Science Academies, 2010).

Immunisation: The process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease (WHO, 2019)

Vaccination coverage: The proportion of a targeted population immunised with the recommended schedule of vaccines (WHO, 2019).

Missed opportunities for vaccinations: Refers to any contact with health services by an individual who is eligible for vaccination (e.g.: unvaccinated or partially vaccinated and free of contra-indications to vaccination), which *does not result in the individual receiving* one or more of the vaccine doses for which he or she is eligible (WHO, 2019).

Under-immunisation: Refers to a state of sub-optimal protection against vaccine-preventable diseases (O'Donnell, et al., 2017). Sub-optimal levels of immunity result from not receiving all of the vaccinations scheduled for the specific age at which vaccination coverage is being measured. At the population level, under-immunisation results from sub-optimal vaccination coverage, i.e.: vaccination coverage that is below the herd immunity threshold for any particular vaccine-preventable disease (VPD) (O'Donnell, et al., 2017).

Under-vaccinated children: An under-vaccinated child is any child missing one or more of the full series of recommended vaccinations (WHO, 2009)

Unvaccinated children: An unvaccinated child is defined as any child missing the recommended series of vaccinations. Diphtheria-pertussis-tetanus dose 3 vaccination coverage rates are used as a proxy of completion (WHO, 2009)

Vaccine hesitancy: A delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context specific varying across time, place, and vaccines. Vaccine hesitancy is influenced by factors such as complacency, convenience, and confidence (WHO SAGE Working Group, 2014).

ACKNOWLEDGEMENTS

The Academy of Science of South Africa (ASSAf) together with the Uganda National Academy of Sciences (UNAS) led the study. This consensus study report is the result of the collaborative work of a 11-member committee of experts who were approved by councils of both academies. All committee members are hereby acknowledged for their contributions, for volunteering their services and time and for the execution of this report. Both academies are grateful to the committee.

The committee members were Prof Shabir Madhi (co-chair, South Africa), Prof Harriet Mayanja-Kizza (co-chair, Uganda), Dr Juliet Kiguli (Uganda), Dr Annet Kisakye (Uganda), Prof Richard Adebayo Adegbola (Nigeria), Prof Charles Shey Wiysonge (Cameroon and South Africa), Prof Sileshi Lulseged Desta (Ethiopia), Ms Diana Kizza (Uganda), Prof Jeffrey Mphahlele (South Africa), Prof Helen Rees (South Africa), and Dr Helene Mambu Ma-Disu (Democratic Republic of Congo).

Non-committee members who are also experts in the field were solicited to make contributions, including literature, to the study and their contributions are deeply appreciated. Special gratitude is extended to Prof Rosemary Burnett (Sefako Makgatho Health Sciences University, South Africa) for all her contributions and guidance.

The research team members for the study were Dr Janan Dietrich, Ms Tondani Mudau and Mr Graeme Stewart-Wilson. Their contribution is acknowledged. The secretariats from both academies are also acknowledged for their contribution: Mr Christian Acemah, Prof Himla Soodyall, Ms Celia Nalwaadda and Ms Phakamile Mngadi.

The study hosted two regional information gathering symposia in South Africa and in Uganda. We hereby thank all the speakers and the participants for the contributions made to the study.

The report was peer-reviewed by the following distinguished experts: Dr Jean Marie Okwo-Bele (WHO, Switzerland), Prof Fred Were (University of Nairobi, Kenya), Prof Asli Kulane (Karolinska Institute, Sweden), Prof Haroon Saloojee (University of Witwatersrand, South Africa), and Dr Emmanuel Mugisha (PATH, Uganda).

The South African Department of Science and Innovation (DSI) and the South African Medical Research Council (SAMRC) both provided financial support for the study. ASSAf and UNAS express deep gratitude to both entities.

PROBLEM STATEMENT

Despite the global availability of proven efficacious and cost-effective vaccines for the past several decades, vaccine-preventable diseases kill more than half a million children under five years of age every year in Africa – representing approximately 56% of global deaths (WHO, 2017).

Sub–Saharan Africa (SSA) alone accounts for 40% of all global deaths, a phenomenon attributed to lack of access to available lifesaving vaccines (Wiysonge, Uthman, Ndumbe, & Hussey, 2012). WHO estimates that in 2019 the African region accounted for approximately 43% of unimmunised and incomplete immunised infants in the world (i.e.: 8.5 million of the global 19.4 million). Relatedly, the region scores the lowest immunisation coverage, at 76% versus the global coverage of 86% (WHO, 2020a).

This is despite several documented efforts by different stakeholders to improve coverage in the region (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017). Many studies have been conducted on coverage and drivers for and bottlenecks against immunisation in SSA. (Wiysonge, Uthman, Ndumbe, & Hussey, 2012), (Wiysonge, Young, Kredo, McCaul, & Volmik, 2015), (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017), (Madhi & Rees, 2018) (Bangura, et al., 2020), all of which have observed that there is varied performance among the constituent countries, and also within countries over time, denoting some implicitly common underlying correlates threading through areas of higher performance; and the same is seen with the poorer performing areas.

This consensus study therefore seeks to categorise and make explicit these "root causes" and based on documented successes, to make recommendations to address the bottlenecks and harness the opportunities for reaching every child with all the recommended vaccines. The theory of change presentation style used in this report, categorising the root causes under four broad interlinked themes, can provide a common basis to rally like-minded partners around a thematic cause and thus develop multi-component, comprehensive strategies to bring about impactful change. This is in line with the call made by the World Health Organisation Strategic Advisory Group of Experts on Immunisation, which recommended that countries, regions and global immunisation partners commit to a comprehensive review of progress, impact, and implementation of the WHO Global Vaccine Action Plan to inform a post-2020 strategy taking into account lessons learned. This strategy will assist with attaining the relevant United Nations Sustainable Development Goals by 2030.

SUMMARY AND RECOMMENDATIONS

According to WHO, the Africa Region[1] accounted for approximately 43% of unimmunised and incompletely immunised infants in the world (8.5 million of the global 19.4 million). Relatedly, the region had the lowest immunisation coverage, at 76% versus the global coverage of 86% (WHO 2020a).

This is despite several documented efforts to improve coverage in the region (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017). Whilst many academics and international organisations have interrogated the reasons for the region's lower immunisation rates (Wiysonge, Uthman, Ndumbe, & Hussey, 2012), (Wiysonge, Young, Kredo, McCaul, & Volmik, 2015), (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017), (Madhi & Rees, 2018), (Bangura, et al., 2020), this study seeks to review the evidence for the underlying unique characteristics of sub-Saharan Africa (SSA) that are driving this low performance and find interventions that have been shown to work effectively at alleviating them.

In order to undertake this work, ASSAf, together with UNAS, followed a modified consensus study model,[2] that allowed for the study experts to receive input and feedback from stakeholders. An eleven-member committee of trans-disciplinary experts was drawn from six SSA countries representative of the different geographical and relevant expertise categories, and tasked to deliberate on the available scientific evidence (published and grey literature) and through constructive debate and agreement using the evidence reviewed, draw conclusions on the underlying drivers for low coverage and under-immunisation, as well as the proven interventions for improving immunisation coverage in SSA.

Evidence was compiled through a systematic literature search process that included two systematic reviews. In order to make sense of the evidence, the study organised the literature using a problem-based approach. Firstly, it sought to understand the vaccine coverage landscape with regards to the different vaccine characteristics. Three immunisation coverage indicators were used for this: diphtheria-tetanus-pertussis third dose (DTP3) as a proxy for a completely immunised child, measles-containing-vaccine second dose as a proxy for coverage of second year of life vaccines (MCV2), and rotavirus vaccine final dose as a proxy for coverage of newly introduced vaccines. Secondly, the study interrogated the evidence for the root causes of the regions' sub-optimal immunisation coverage by considering demand-side and supply-side causes. In both cases, the study looked for common threads linking the various reasons given for low coverage and examined attributes of countries across the immunisation coverage continuum to identify commonalities that facilitated or hindered coverage improvement. Based on the evidence, the committee made recommendations for priority actions to be undertaken by various immunisation stakeholders in order to reduce the number of un- and under-immunised children and achieve regional immunisation coverage targets.

[1] All Sub-Saharan Africa (SSA) Countries fall within the WHO African region except for Sudan and Somalia
[2] https://www.ncbi.nlm.nih.gov/books/NBK260200/

In reporting the findings and recommendations of the study, a Theory of Change (ToC) approach was used. This summarises the root causes of low coverage and under-immunisation in SSA under four inter-related, topical sub-themes: Knowledge, Trust, Convenience, and one crosscutting theme under-pinning all three, Political Ownership.

The following is a summary of the study findings, conclusions and recommendations:

Despite the global availability of efficacious and cost-effective vaccines, immunisation coverage in SSA is sub-optimal, as shown by the DTP3 regional coverage that has plateaued at 75% for the last five years. An immunisation grant programme by Gavi the Vaccine Alliance, has been pivotal in spurring introduction of new vaccines across the region, as evidenced by the ubiquitous introduction of rotavirus vaccine (37 of 48 countries introduced by 2019). However, uptake for vaccines administered in the second year of life is particularly dismal. Of the 29 countries that had introduced MCV2 by 2019, only three countries (Rwanda, Eritrea and Cape Verde) had achieved 90% coverage (GBD, 2019).

On a positive note, these observations of under-performance are not uniform across the countries in the region, nor across time. Some countries have stood out as having high immunisation coverage and some previously poorly performing countries have made significant improvements in the last ten years. This provides a point for peer examination and learning. Regarding the root causes of low coverage and under-immunisation in SSA and the strategies for addressing them, the following are the study conclusions and recommendations:

Knowledge – deficiencies and inaccuracies

Conclusions

1. Lack of knowledge regarding the benefits of immunisation, and the prevalence of misconceptions about vaccination effects among caregivers and community leaders, is one of the greatest root causes of low coverage and under-immunisation in SSA.
2. This ignorance is commonly found in under-privileged community groups including younger mothers, illiterate and unschooled caregivers, people living in disadvantaged regions within a country, people with no history of contact with health facilities, migrant and refugee communities, among others.
3. Vaccine hesitancy is a growing trend in SSA driven by fears of side effects fueled by ignorance and false information circulated in the media, presenting a serious threat to efforts to increase immunisation coverage in the region. Region-specific studies on interventions against vaccine hesitancy are lacking.
4. Healthcare workers (HCW) are key resources for immunisation service provision as well as providers of accurate immunisation information for care givers and community leaders in their jurisdictions. However, the capacity of HCW to effectively deliver on these mandates is, in many instances, limited by their own knowledge deficiencies regarding vaccines and vaccine effects, immunisation policies, identification of un- and under-immunised children, social mobilisation and counselling skills, and data management. This limitation is attributed to a lack of adequate pre- and in-service training underpinned by limited political investment in this area.
5. Various communication and social mobilisation strategies have been deployed to encourage immunisation uptake in SSA with various degrees of success. However, these efforts are mostly focused around supplemental immunisation campaigns and under-prioritised in resource allocation in routine immunisation budgets. Additionally, impact evaluation research of the different strategies on vaccination uptake is inadequate, with minimal literature coming particularly from the Central African region.

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Recommendations

1. Funders and managers of immunisation programmes should aim to maintain a balance between investment in the essential components of an immunisation system (resources that enable programme readiness) and work force capacity to design and execute implementation strategies. This includes deployment and recurrent training of HCW to fully comprehend vaccines and their effects, the immunisation support practices and policies, and the community needs and desires. This will empower them to tailor appropriate communication and social mobilisation strategies to address knowledge deficiencies and inaccuracies among caregivers and community leaders.
2. Researchers in SSA should address evidence gaps in the areas of impact evaluations of the various communication and social mobilisation techniques employed to address knowledge deficiencies and inaccuracies regarding immunisation. This will provide the evidence base needed by policy and decision-makers to select the most appropriate options for the various settings in the region. Special consideration should be made in Central African countries where evidence gaps are pervasive.

Trust – relationships and allegiances

Conclusions

1. Trust in the overall healthcare system directly impacts on the trust in the immunisation programme in SSA. The conduct of HCW during health seeking visits and community's perceptions of political and socio-economic climates affect individual and community group trust relationships respectively with the healthcare system.
2. Socio-cultural ties and influences, including culture and religion, play a significant role in decisions regarding uptake of vaccinations and are primary causes of hesitancy in SSA.
3. While some measures of success have been demonstrated in the application of various trust building strategies — including training of HCW, use of community change agents, building alliances and partnerships in a contextualised approach, and establishment of National Immunisation Technical Advisory Groups — there is a consistent lack of a systematic evaluation of the impact of these approaches on the uptake of immunisation in SSA.

Recommendations

1. Political and socio-economic leaders should be cognisant in their actions of the sensitivity of the immunisation programme to overall confidence in the healthcare system. Actions that engender trust and confidence in the healthcare systems should be promoted.
2. Researchers should conduct longitudinal studies evaluating the impact of different trust building interventions on the uptake of immunisation in SSA over time, using defined and uniform indicators in order to ease comparability. These would then benefit decision makers to guide policy creation based on sound scientific evidence.

Convenience – access and reliability

Conclusions

1. Physical barriers that create longer travel times from communities to health facilities make it inconvenient for communities to access immunisation services and for health workers to deliver immunisation services to underserved communities. Socio-economic barriers, including heavy workloads and inflexible working environments (particularly for blue collar workers) and lack of family support, make it difficult for caregivers to take time off to access immunisation services. Considering that a majority of workers in SSA are blue

collar and considering the large populations of displaced persons with no family support, there exists a significant challenge to immunisation service provision in the region.

2. Poor service delivery on the part of HCW as poor customer services, long waiting times and inconsistent availability of immunisation services deter immunisation service uptake. Underlying this poor service delivery are systemic challenges such as heavy healthcare workloads due to low health-worker to population ratios, lack of motivation, poor remunerations and resulting high staff turn-over, and limitations within the immunisation supply chain.
3. Strategies deployed aimed at bringing immunisation services closer to communities through establishment of more community-based immunisation posts, conducting outreaches, task shifting, and use of community-based HCW, have shown anecdotal improvements in immunisation coverage.
4. Interventions aimed at improving vaccine security, including re-designs in the immunisation supply chains, use of controlled temperature chains, local manufacturing, and pooled financing and procurement mechanisms, though fairly recent, have been shown to have positive impacts on immunisation coverage based on early implementation stage assessments. However, a lack of comprehensive information on the part of the manufacturing industry has been identified as a challenge to the sustained implementation and scalability of these interventions.

Recommendations

1. District level leadership should own and support the implementation of the WHO/UNICEF designed Reaching Every District/Reaching Every Child (RED/REC) strategy to reach every child with immunisation services implemented at the sub-national level through lobbying for sufficient fund allocation, progress monitoring, and supporting community engagement.
2. National level immunisation sector leadership should ensure that HCW at service delivery points are sufficient (based on task requirements and populations served) and well-motivated. Innovations such as task shifting should be encouraged and supported at district levels through regular training, supervision, and, where feasible, monetary compensation. Additionally, they should prioritise immunisation supply chain (iSC) management through capacity building of iSC experts and their involvement in top management decision making.
3. Regional level leadership, including WHO AFRO and African Union, should encourage national leaders to commit to the long-term vision of local vaccine manufacturing as a means to ensure sustainable vaccine supply for the region by putting in place the foundational structures necessary, including building local expertise, incentives for private sector investment, strengthening in-house research and development, and requisite infrastructure developments.
4. Immunisation development partners and Civil Society Organisations should incentivise and lobby for greater transparency from industry partners in order to support iSC innovations such as controlled temperature chains, and alternative energy sources.
5. Researchers should further study and evaluate impacts of innovations aimed at securing vaccine supply such as pooled procurement and longer-term implementation of immunisation supply chain re-designs on vaccination coverage.

Political ownership – financing, community ownership and an enabling environment

Conclusions

1. The immunisation programme in SSA is still largely dependent on external funding for its operations, putting the programme in a risky and unsustainable position. While there has been an overall positive trend in national governments' commitments to taking greater ownership of immunisation financing, translating this into practice has not been uniformly realised. Of particular concern is financing for newly introduced vaccines that have been observed as the biggest cost driver for incremental immunisation financing needs in the region.
2. Civil Society Organisations (CSOs) are key interlocutors in facilitating ownership at the national level by holding governments accountable to their mandates, and at the community level by fostering participatory inclusion and accountability of sub-national governments and the populace.
3. SSA has been historically vulnerable to disruptive environmental forces such as political and civil unrest, natural disasters, and disease outbreaks resulting in armed conflicts, mass population movements, flooding, droughts, famines, and humanitarian emergencies. These negative environmental events are disruptive to the region's fragile health systems and especially to the highly sensitive immunisation programme, putting the region at a risk of vaccine-preventable disease outbreaks and loss of immunisation gains already made.

Recommendations

1. National governments, being held accountable by regional bodies and national institutions such as the African Union and National Parliaments, should act upon financing commitments made in the Addis Declaration on Immunisation (ADI) to gradually and impactfully increase their budgetary allocations to immunisation and provide the requisite oversight to the transparent and equitable use of funds provided.
2. National and sub-national immunisation programme managers, with the support of CSOs, should provide the enabling financing advocacy and decision support frameworks required by decision-makers. They can do this by developing and making available clear and timely planning, budgeting, and accounting documents; making use of standard tools such as country multi-year plans that outline the country's contextual priorities; as well as demonstrating value for money invested in the immunisation program.
3. National political leaders should be cognisant of the inevitable intertwining of political and health security agendas and should thus ensure peaceful and secure communities through application of democratic principles of governance and equitable share of national resources. This will minimise incidents of conflict, which have significant negative impacts on the immunisation programme. In cases of humanitarian emergencies, lessons learned from the region to ensure continued vaccination of children should be applied.
4. The Africa Centres for Disease Control and Prevention should provide evidence-based technical tools and measures that can be adapted to ensure that the contextual dynamics in individual African countries are taken into account in all disease pandemic mitigation responses in order to minimise adverse effects on healthcare programmes including immunisation.

Overarching conclusions and recommendations

SSA is predominated by countries categorised as low-income, a rapidly growing population with low levels of education, a significant burden of displaced persons, and a weak healthcare system. Still, some recognisable progress has been made thanks to the concerted efforts of immunisation stakeholders ranging from technical staff at all levels of government, researchers, CSOs, and development partners.

Based on the region's demographic challenges, it comes as no surprise that the root causes of low coverage and under-immunisation are summarised under deficiencies in knowledge, shortage of trust, and difficulties in accessing reliable immunisation services. The identified strategies to address these challenges (including increasing access to accurate information, building trust, and removing barriers to accessing reliable immunisation services) centre around national political commitment and ownership of the immunisation programme. Whilst the study identified some significant shortages in empirical research evidence, particularly in the area of effectiveness of strategies deployed to respond to identified root causes for low coverage and under-immunisation in SSA, the lack of such evidence should not be used as a defence for inaction. Where contextualised anecdotal evidence exists, this should continue to inform decision makers as researchers conduct more systematic studies that will inform scaling initiatives.

REPORT OUTLINE

This report is divided into four sections:

1. The **introduction** gives a snapshot of sub-Saharan Africa, describes the rationale of the study, provides the Statement of Task, and outlines the different methodologies and processes used in the study.
2. The **background** describes the immunisation landscape in sub-Saharan Africa, with a specific focus on overall coverage using diphtheria-tetanus-pertussis third dose as a proxy indicator for coverage in the first year of life, second dose of measles-containing vaccine for coverage in the second year of life, and coverage of newly introduced vaccines using rotavirus vaccine as a proxy.
3. The **root causes of low vaccination coverage and under-immunisation in sub-Saharan Africa** outlines evidence of underlying causes of low vaccination coverage and under-immunisation in sub-Saharan Africa categorised under four sub-themes: i) knowledge, ii) trust, iii) convenience, and iv) political ownership. Evidence of interventions that have been implemented and/or proposed in published literature to address the identified root causes are also highlighted. All the evidence reviewed led to summary conclusions and recommendations of the consensus study.
4. The last section highlights **overarching key conclusions and recommendations**.

1. CONCISE DESCRIPTION ON THE STUDY

Based on the high levels of vaccine preventable diseases (VPDs) in children in SSA, the purpose of this consensus study is to:

1. Identify the contextual underlying causes of persistent low vaccination coverage and under-immunisation of children under two years of age in countries within SSA using the expertise that exists within the SSA academies of science as well as other relevant stakeholders.
2. Provide evidence-based recommendations to national and international stakeholders taking into consideration both financial and non-financial factors to address the challenges for the improvement of the overall vaccination strategies in SSA.

For the purposes of this consensus study, three key indicators were used to assess the extent of immunisation practices in SSA countries. The three indicators were:

1. **Diphtheria-tetanus-pertussis third dose (DTP3) coverage** as a WHO/UNICEF indicator for equity of vaccination coverage.
2. **Measles-containing vaccine second dose (MCV2) coverage** as an indicator for vaccination coverage in the second year of life.
3. **Rotavirus vaccine final dose coverage** as a marker of newly introduced vaccines.

1.1 Study objectives

In order to understand the root causes of low vaccination coverage and under-immunisation of children in SSA, ASSAf and UNAS convened a committee of experts. The eleven-member committee of trans-disciplinary experts was drawn from SSA countries (Annex 1).

The study brief to the committee was to:

a) Use published literature and other relevant data sources to assess the trends over the last ten years regarding vaccination coverage in SSA.

b) Analyse and comment on the drivers for change in countries that were formerly poor performers who managed to register improvements in vaccination coverage over the years.

c) Document the gaps and bottlenecks to immunisation in persistently poorly performing countries and to identify the root causes of low vaccination coverage and under-immunisation in those countries.

d) Use an evidence-based approach to provide recommendations for overcoming the root causes of low vaccination coverage and under-immunisation in SSA, with emphasis on priority actions to be undertaken to inform stakeholders with an interest in overcoming these barriers.

1.2 Study methodology

The study proposal (approved by councils of both academies) outlined a combination of methodologies aimed at ensuring that study objectives produced responses that: (i) are evidence-based, (ii) include local experiences and relevance (with examples of innovation), and (iii) make contextualised and implementable recommendations.

The detailed study methodologies included:

1. Closed committee meetings involving deliberations on the study objectives (Statement of Task), review of evidence, multi-disciplinary debates, and development of evidence-informed conclusions and recommendations that address the study objectives.
2. Thematic regional workshops that were open to the public (detailed agendas in Annexes 2 and 3).
3. The involvement of an expert researcher writer who was tasked with spearheading the research and compiling the report as per guidance by the committee.

Table 1 lists the key methodologies and activities that were undertaken to address the study objectives between June 2018 and March 2020. The report is based on these diverse methodologies.

Table 1: Key study methodologies and activities undertaken, June 2018 to March 2020

Activities	Location and duration	Purpose
Closed committee meetings	1. Held in Johannesburg, South Africa on 31 July to 1 August 2018 2. Held in Kampala, Uganda on 1 March 2019 3. Held in Johannesburg, South Africa on 18 to 19 November 2019	Deliberations on all aspects of the study including: • Review of study objectives; stakeholder views and inputs, the evidence; writing of the reports; developing conclusions, recommendations and consensus.
Consultative Regional Symposia	1. Held in Johannesburg, South Africa on 30 to 31 July 2018 (Annex 2) 2. Held in Kampala, Uganda on 27 to 28 February 2019 (Annex 3)	• Mainly as information gathering processes towards the study. • Presentation and sharing of evidence on different aspects of the study.
Research and review of published and grey literature	Done collectively, individually, remotely - including through electronic platforms such as teleconferencing - and physically between June 2018 up to March 2020. All aimed towards addressing the objectives of the study.	
Consultations with experts outside of the committee	Done between June 2018 and March 2020 for the purpose of ensuring the report adequately addressed the study objectives.	
Systematic reviews	Root causes of low vaccination coverage and under-immunisation in SSA	
	Interventions to address the root causes of low vaccination coverage and under-immunisation in SSA	

1.3 Study design

The mixed methods study design used in this study was largely informed by the Consensus Development Panel (CDP) model that brings together experts to produce multi-disciplinary responses to a specific statement of task. Its advantages include an inter-disciplinary composition, accessibility, evidence-based nature and ownership by experts (Waggoner, Carline, & Dunning, 2016).

The CDP model ensures that the language of the study remains easily understandable to a lay audience, and that a broad range of perspectives is included. Furthermore, the model encourages more evidence-based opinions through its reliance on published literature as the grounds for dialogue (Waggoner, Carline, & Dunning, 2016). The drawbacks associated with the CDP model include vocal member domination and the "bandwagon effect", which were mitigated through several face-to-face meetings, and an extensive period of remote contribution where committee members were individually encouraged to review the documents and provide direct online feedback to the secretariat.

The completed draft consensus study report was distributed for peer-review to experts (both from within and outside sub-Saharan Africa) approved by councils of both academies. Peer-reviewers responded to six questions: i) does the report respond sufficiently to the study objectives? ii) does the report remain within the scope of the study objectives? iii) are there any crucial areas of evidence missing in the report? iv) does the report appear balanced and apolitical? v) do the conclusions follow logically from the evidence presented? and, vi) do the recommendations follow logically from the conclusions?

Peer-reviewers' comments were addressed, and consensus was obtained from the committee before final sign off/approval from councils of both academies.

2. SUB-SAHARAN AFRICA IN PERSPECTIVE

2.1 Socio-demographic context

Africa consists of 54 countries with 48 geographically situated within SSA as shown in Figure 1. All SSA countries, except Sudan and Somalia, fall under the World Health Organisation (WHO) Africa Region (AFR) (WHO Africa Region, 2020) (World Bank, 2019a)[3].

Figure 1: Map of Africa highlighting countries in SSA and WHO African Region

Source: Author derived using WHO 2018 and World Bank 2018 Literature

SSA is home to over one billion people, and the population is estimated to grow to over two billion people by 2050 (World Population Prospects, 2017) with Nigeria, Ethiopia and the Democratic Republic of the Congo being the top three most populous countries. SSA is predicted to account for 38% of all births globally by 2025, and is currently the region with the highest number of births, with the trend predicted to persist for the rest of the century

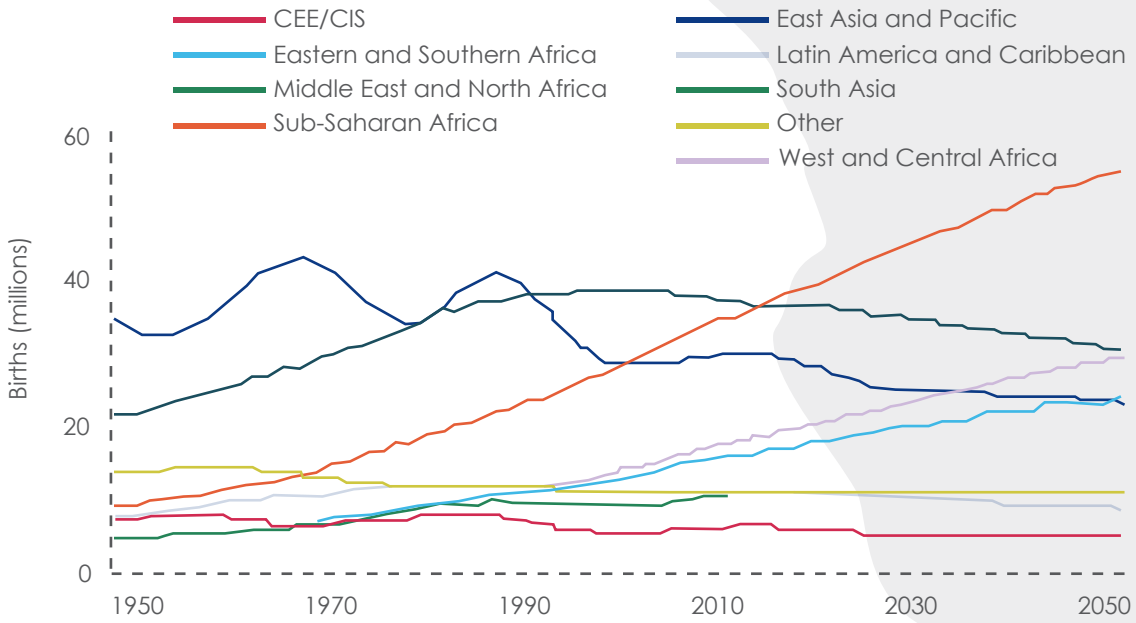
[3] Due to the close similarity of the two regions (Sub-Saharan Africa and WHO Africa), data from both is referred to in this study

(UNICEF, 2019). Nine of the ten countries globally with the highest fertility rates are from SSA. On average, women in these high fertility SSA countries have five or more children over their lifetime (United Nations, 2015a&C) The World Bank statistics show that the overall life expectancy at birth in SSA is 60.88 years (World Bank, 2019b)

SSA has the highest rate of early childbearing (above 178 births per 1,000 girls aged 15 - 19), with the Central African Republic, Niger, Chad, Angola and Mali having the highest adolescent birth rates. For the 2010 – 2015 period, over 45% of women aged 20 – 24 were reported to have given birth for the first time by age 18 (UNICEF, 2019).

SSA is the region with the highest global death rate for children under the age of five, where child mortality is projected to reach 56.6 deaths per 1,000 live births by 2030. By the end of the century the under-five mortality rate is expected to be about five times higher than the lowest regional level observed at present (United Nations, 2019).

Figure 2: Number of births, by UNICEF region, 1950 -2050



Source: UNICEF 2015: Children in Africa, Key statistics on child survival, protection and development. (UNICEF, 2015)

Poverty is prevalent across SSA with 22 of the 48 countries classified as low-income countries (LICs) with a gross national income (GNI) per capita of US$1.025 or less, while 17 are lower-middle income countries (LMICs) with a GNI per capita of US$1.026 to $3.995 thousand, and only nine are classified as upper-middle income countries with a GNI per capita of US$3.996 to $12.375 thousand (World Bank, 2019a).

While approximately 60% of the SSA population lives in rural areas, urbanisation is evolving rapidly and it is estimated that the urban population will be three times larger by 2050 (Simkins, 2019). Much of this urbanisation is unplanned and poorly managed (African Union, 2018). About 70% of workers in SSA are in vulnerable employment against the global average of 46.3% (International Labour Organization, 2018).

Eight of the ten countries globally with the lowest pre-primary net enrolment rates are in SSA, with only 6% of young people in the region in 2015 enrolled at higher education institutions compared to the global average of 26% (UNESCO Institute for Statistics 2019). Across SSA, nine million girls aged six to eleven years will never go to school compared to 6 million boys of the same age (UNESCO Institute for Statistics 2019).

On the global scale, SSA is host to the largest number of persons of concern to the United Nations High Commission for Refugees (UNHCR). By the end of 2017, there were an estimated 24.2 million people of concern in the region, an increase of 4.6 million since 2016. This includes 6.3 million refugees and 14.5 million internally displaced persons (IDPs). In the first half of 2018, the numbers increased, with some 170,000 new refugees and over two million new IDPs - mainly from the Central African Republic, the Democratic Republic of the Congo, Nigeria, Somalia and South Sudan (United Nations High Commissioner for Refugees, 2018).

2.2 Immunisation policy context and outlook

Two scenarios make the timing of this study pertinent: a) the nexus of evaluation timings of global and regional development agenda cycles, and b) the projected future of vaccines and population dynamics in the region.

2.2.1 Immunisation development agenda and timing of cycles

On the global stage, the mid-interval point of the Sustainable Development Goals (SDGs) is approaching (2015 - 2030), which emphasises equity under the "leave no one behind" mandate. SDG 3 is of relevance as it seeks to "ensure healthy lives and promote the wellbeing for all at all ages" and the specific target SDG 3.2 aims to "end preventable deaths of new-borns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births by 2030" (United Nations, 2015b)

A new global immunisation agenda for the next decade, Immunisation Agenda 2030, which aims to ensure that everyone everywhere has access to immunisation, has just been launched. This follows the end of the antecedent Global Vaccine Action Plan (GVAP) 2014 - 2020 and the regional version, the WHO African Regional Strategic Plan for Immunisation (RSPI) (2014 - 2020), whose goal was achieving universal immunisation coverage and reducing mortality and morbidity from VPD within the WHO Africa Region by the end of 2020. Its first strategic objective was "to improve immunisation coverage beyond the current levels with specific targets including DTP vaccine coverage to reach 90% region-wide by the end of 2020 and at least 37 countries to introduce the rotavirus vaccine by 2020" (WHO, 2013b)

Also starting up is a new immunisation funding strategy dubbed "The Gavi 5.0 (2021 - 2025) strategy" which will operate on a principle of giving missed communities first priority, focussing on children missing out on vaccination, including among migrants, displaced persons and other vulnerable populations. In addition, Gavi's new vaccine investment strategy plans to assist countries with prioritising and financing new vaccines in order to reduce their VPD burden (Gavi, 2019).

Regionally, the 10-year interval point for the African Union Agenda 2013 - 2063 is fast approaching, which has a vision of "an integrated, prosperous and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena" and whose top mandate point is "a prosperous Africa based on inclusive growth and sustainable development, healthy and well-nourished citizens" (Commission, A.U, 2015). The target is that "malnutrition, maternal, child and neonatal deaths as at 2013 would be reduced by half by 2023 (Commission, A.U, 2015).

Other policy frameworks of interest to the study are summarised in Table 2.

2.2.2 Outlook for immunisation in Africa

Progress in new vaccine development indicates that there may be more vaccines forthcoming for possible introduction in SSA, in addition to those already planned for introduction. These include vaccines against Group B Streptococcus, HIV, Ebola, malaria, dengue, tuberculosis, RSV, E.coli and shigella (WHO, 2019). The vaccine against COVID-19 is also at hand. With the rapidly growing population, the majority of countries in SSA are in a situation where immunisation programmes must be scaled up, not only to make up for current shortfalls in coverage, but also to prepare for the increasing demand and introduction of new vaccines. The WHO African Regional Immunisation Technical Advisory Group has highlighted a need for the region's stakeholders to develop new innovative immunisation strategies in line with its changing demographics (WHO, 2017).

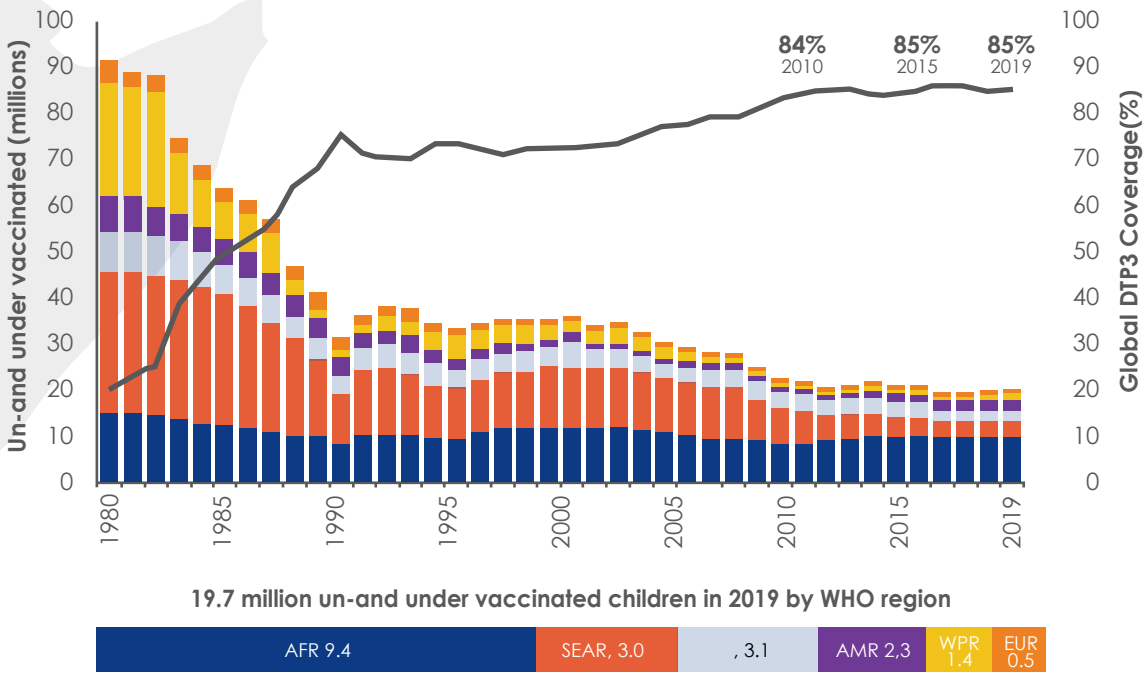
Table 2: Global and regional immunisation agendas and plans

Plan/Strategy/ Commitment	Some relevant targets/objectives
Addis Declaration on Immunisation (ADI) 2017	Keep universal access to immunisation at the forefront of efforts to reduce child mortality. Increase and sustain domestic investments and funding allocations for immunisation. Address the persistent barriers in vaccine and healthcare delivery systems, especially in the poorest, vulnerable and most marginalised communities. Develop a capacitated African research sector to enhance immunisation implementation and uptake. Build broad political will for universal access to life-saving vaccines. Promote and invest in regional capacity for the development and production of vaccines.
Business case for WHO immunisation activities on the African continent 2018 - 2030	Adopt a comprehensive approach of immunisation over the life-course and consider its broader impact on health care. Focus its efforts in supporting countries to build stronger immunisation systems. Adopt a tailored approach to countries, dependent on the maturity of their immunisation system. Reinforce coordination and communication with immunisation stakeholders. Strengthen its accountability framework to better achieve efficiency and transparency. Progressively phase out its technical support to countries as they gain maturity.

2.3 Unvaccinated and under-vaccinated children in SSA

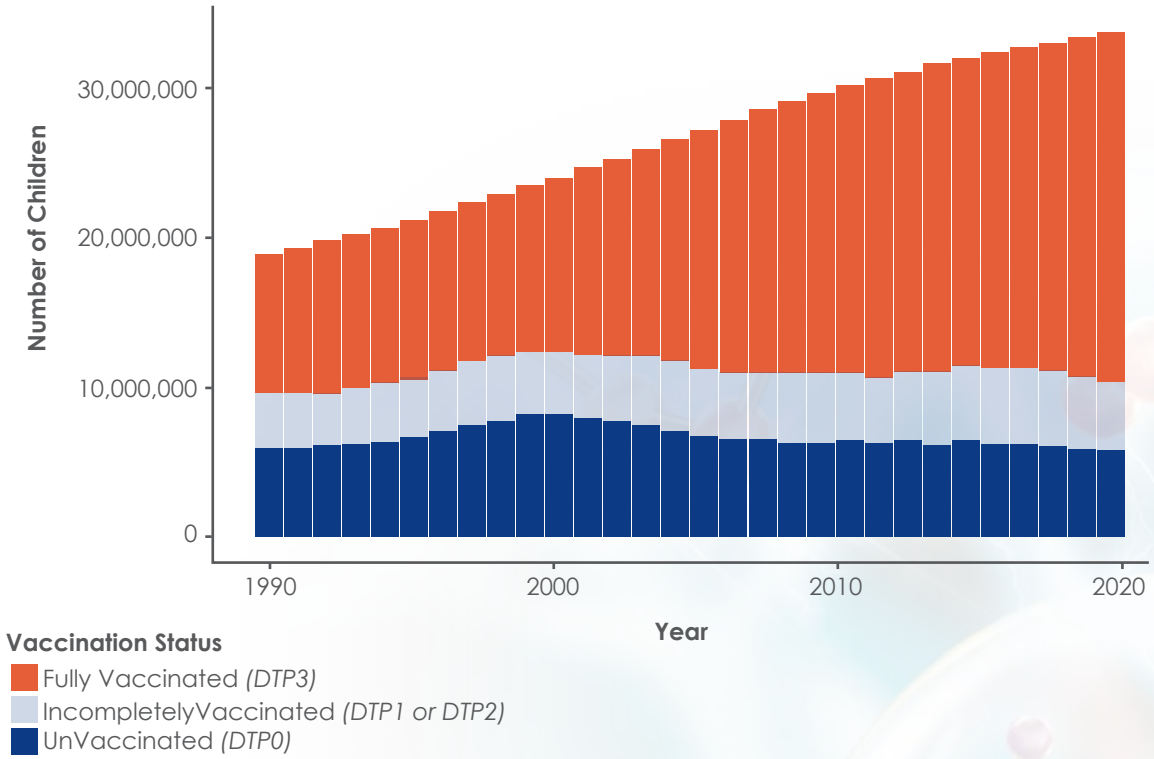
An analysis of global trends for unvaccinated and under-vaccinated infants in terms of absolute numbers has shown a downward trend over the past decade, as the global immunisation coverage increased over time (WHO, 2020) (VanderEnde, 2018). However, there has been overall stagnation for the African Region (Figure 3) which takes the biggest share at nearly 50% of all unimmunised and under-immunised infants for the decade 2010 - 2019. Vaccination uptake and utilisation in SSA faces several challenges, including missed opportunities that warrant special focus (Madhi & Rees, 2018). Closer analysis of the vaccination status of children in SSA shows that while there are overall positive trends in the number of immunised children, there is indeed stagnation in the number of both unimmunised and under-immunised infants over the last decade (Figure 4).

Figure 3: Global trends on DTP3 coverage and number of unvaccinated or under-vaccinated infants by WHO region 2010-2019



Source: WUENIC Analytics 2020 (WHO 2020)

Figure 4: Vaccination status (fully vaccinated, incompletely vaccinated, and unvaccinated) of children in SSA 1990-2019



Source: Global Burden of Disease, Injuries, and Risk Factors Study 2019 (GBD, 2019)

DTP3 coverage at regional, national and sub-national levels

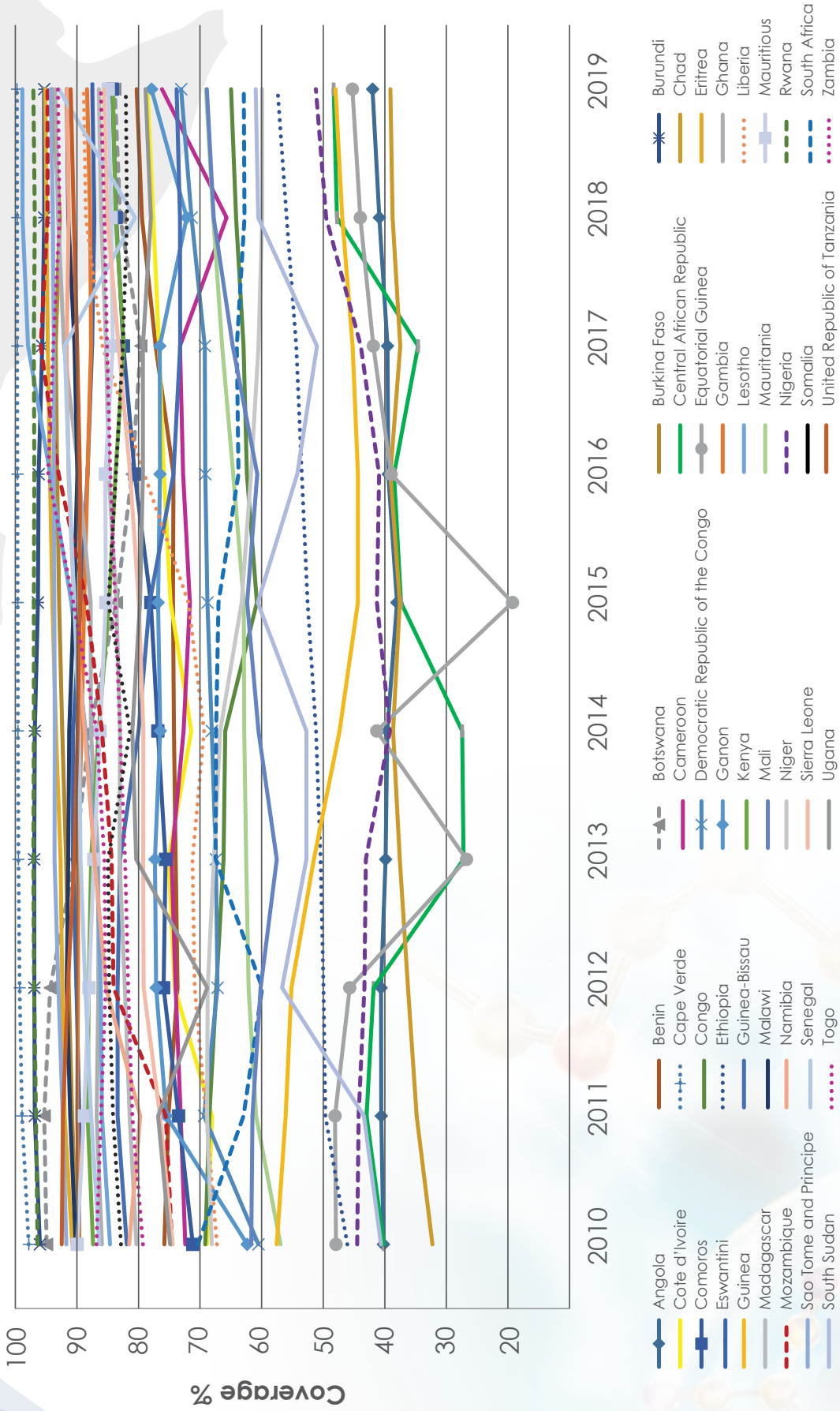
The percentage of children receiving DTP3 is routinely used as an indicator for overall vaccination coverage for children in their first year of life (Burton et al. 2009). The target of the Global Vaccine Action Plan (GVAP) was DTP3 coverage of at least 90% at national level and at least 80% coverage in every district by 2020 (World Health Organization, 2013). The WHO African Region registered a slight increase of DTP3 coverage from 71% in 2015 to 74% in 2019 (WHO, 2020). However, as (Ridpath, et al., 2017) (Metcalf, et al., 2015) point out, the regional coverage score does not give a true picture of the performance of individual countries in SSA, which is highly varied over time (Figure 5).

More detailed studies also highlight the true vaccination coverage disparities that exist even within countries (Ikilezi, et al., 2020), (Utazi, et al., 2019), (Mosser, et al., 2019) and also observed that countries with the largest sub-national relative inequalities in coverage were also among those with the lowest national level coverage, including Nigeria (where 2016 DTP3 coverage for the district level ranged from 7% to 203% of the national average), Chad (20% to 213%), Ethiopia (18% to 172%), and Angola (26% to 160%). However, large relative inequalities at the district level were also noted in some higher-coverage countries, including Kenya (44% to 114% of the national average) and Tanzania (50% to 107%).

In assessing the drivers for change in DTP3 coverage, (Restrepo-Mendez, et al., 2016) found that countries where the national vaccination coverage levels progressively improved over the period 1990 - 2010 (for example in Mozambique and Madagascar), class-based inequality favouring vaccination access for the wealthy decreased over time. For Mozambique in particular, much of the increase seen in the national DTP3 vaccination coverage was linked to increasing coverage in the poorest quintile of the population. (Restrepo-Mendez, et al., 2016), (Bao, et al., 2018) found that the drivers for Rwanda's successful DTP3 vaccination coverage over time were strong, high-level political will; multi-level accountability; effective use of funding; initiatives with development partners; integrated health information; and community-level data collection.

These drivers are replicable in other SSA countries. In terms of the impact of urbanisation, (Restrepo-Mendez, et al., 2016) found that in the 36 SSA countries studied, only seven had mean vaccination coverage rates higher in rural versus urban areas, with this difference being statistically significant only in eSwatini. In Ethiopia, which showed the greatest absolute pro-urban inequality, the mean level of full vaccination coverage in urban areas was 28 percentage points higher than that in rural areas. Côte d'Ivoire, Madagascar, and Nigeria also showed pro-urban differences of at least 20 percentage points. Also, although most countries showed higher levels of full vaccination coverage among boys than girls, such gender-related differences were less than three percentage points in each of the countries and only achieved statistical significance in Mali and Somalia. The Global Polio Eradication Initiative (GPEI) with its substantial partner funding, has also been documented to have had a positive effect on routine vaccination coverage (Van den Ent, et al., 2017)

Figure 5: DTP3 coverage for all SSA countries 2010-2019



Source: Global Burden of Disease, Injuries, and Risk Factors Study 2019 data (GBD, 2019)

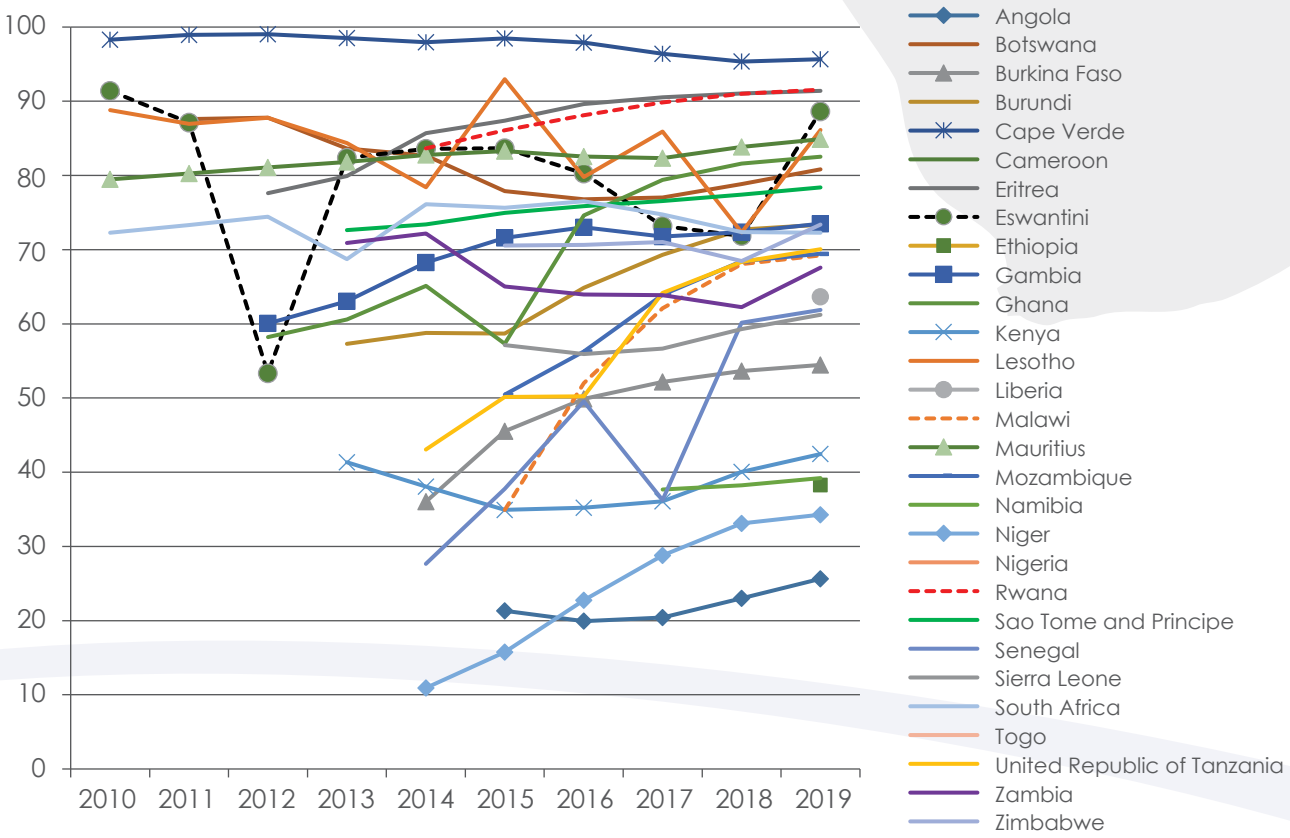
2.4 Second dose of measles containing vaccine (MCV2) coverage

While the WHO issued a recommendation in 2009 for introducing MCV2 in the second year of life, adoption of this recommendation in SSA countries has been limited by the prerequisite of achieving over 80% MCV first dose (MCV1) coverage for three consecutive years (WHO, 2019). In 2016, this pre-condition was lifted following a performance assessment by the WHO Strategic Advisory Group of Experts on Immunisation. Of the 23 countries globally that had not introduced MCV2 and which did not meet the pre-2016 introduction criteria,19 were in SSA (Beillik & Davis, 2017). Of the 29 SSA countries that had introduced MCV2 by 2019, only three countries (Rwanda, Eritrea and Cape Verde) had achieved 90% coverage while the rest had achieved between 50% and 79% coverage (GBD, 2019). Figure 6 shows the 29 SSA countries that had introduced MCV2 by 2019 (Chirwa, Wilkins, & Mercer, 2020).

Gavi's vaccine introduction grant has been a key driver for the introduction of MCV2 in Africa. Of the 26 countries that introduced MCV2 in 2017 in Africa, 18 were Gavi-eligible countries while 8 were self-financing countries (Sambala, Wiyeh, Ngcobo, Machingaidze, & Wiysonge, 2019),. Most SSA countries provide MCV2 between 15 and 18 months of age, however, Mauritius and Seychelles provide MCV2 at school entry and South Africa provides it at 12 months of age (Masresha B. G., et al., 2018).

As with other vaccines, coverage for MCV2 varies widely across SSA countries. MCV2 coverage was a mere 18% in 2015 in the region, growing slightly to 26% in 2018 (WHO, 2019). Country-level analyses showed problems with data recording, possibly resulting in inaccurate reporting from the subnational levels (Masresha B. G., et al., 2018), hence nationally reported figures may be different from actual coverage (Chirwa, Wilkins, & Mercer, 2020).

Figure 6: MCV2 coverage in SSA countries by nationally recommended age 2010 - 2019



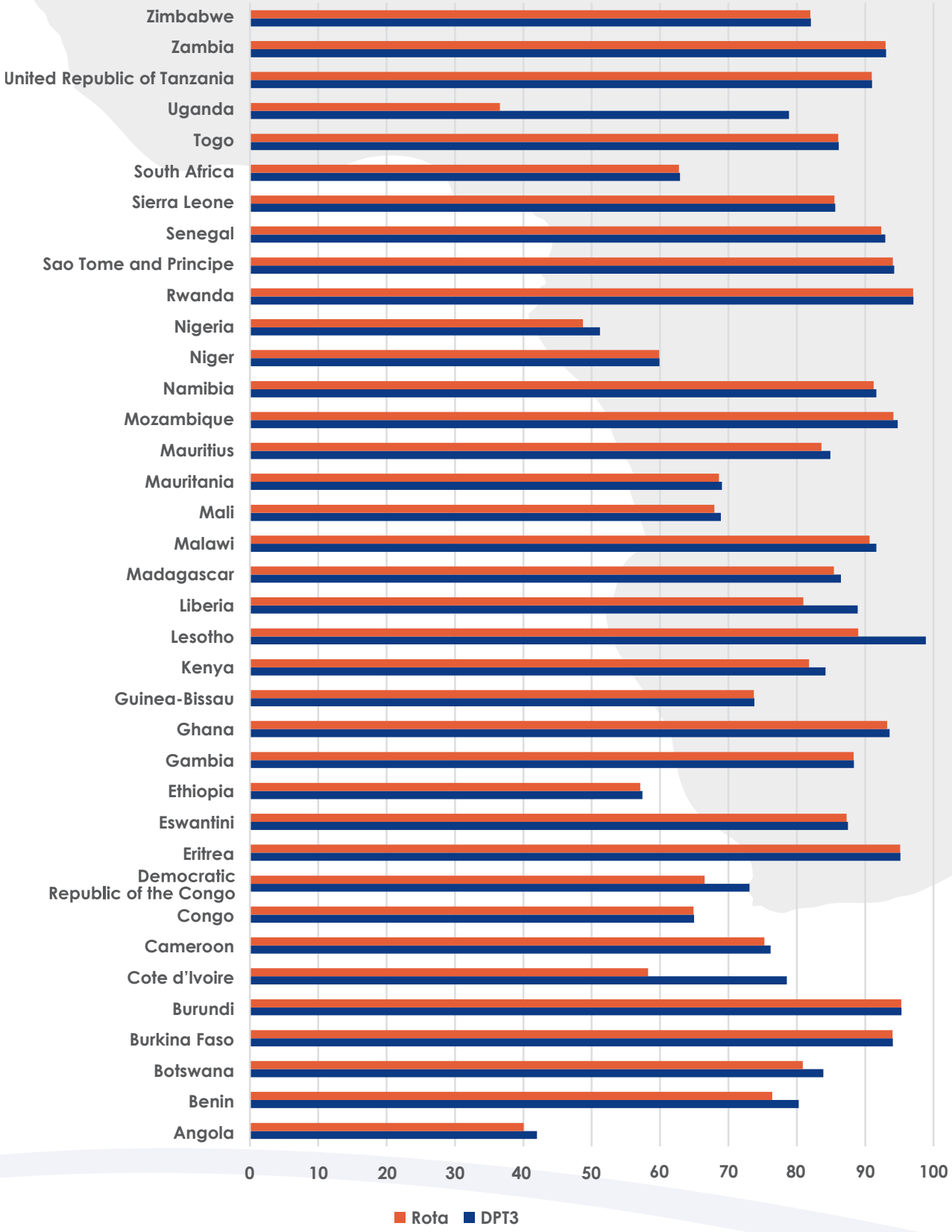
Source: Global Burden of Disease, Injuries, and Risk Factors Study (GBD, 2019).

2.5 Rotavirus vaccination coverage

The highest rates of rotavirus-associated mortality in children younger than five years are in SSA (Tate, Burton, Boschi-Pinto, & Paladin, 2016). Of the five countries that account for more than 50% of all rotavirus deaths globally, three (Nigeria, DRC, and Angola) are in SSA (Steel, et al., 2019). The WHO recommended global introduction of rotavirus vaccination in 2009 (using either Rotarix® or RotaTeq® vaccines), with the first dose to be administered at six weeks of age, along with DTP vaccination for protection prior to natural rotavirus infection (WHO, 2013b). Rotarix® is administered orally in a 2-dose schedule at the time of DTP dose 1 (DTP1) and DTP dose 2 (DTP2) with an interval of at least four weeks between doses. RotaTeq® is administered orally in a 3-dose schedule at the same time as DTP1, DTP2 and DTP3, with an interval of at least four weeks between doses (WHO, 2013b). The only SSA country to introduce the rotavirus vaccine in 2009 was South Africa, a self-financing country. By 2017, 34 countries (28 Gavi-eligible; 6 self-financing) had introduced the vaccine (Sambala, Wiyeh, Ngcobo, Machingaidze, & Wiysonge, 2019), (Platts-Mills & Steele, 2018). Unlike most new vaccine introductions in the past 20 years, the global leaders in introducing rotavirus vaccination have been LICs and LMICs in Africa, with 77% (37 of 48 SSA countries) having introduced or been approved to introduce the vaccine by 2019 (GBD, 2019). In addition, 44% of SSA children live in countries that were approved to introduce the vaccine only in 2019, including Nigeria and the DRC (Abou-Nader, et al., 2018). The need to expand cold chain capacity to accommodate rotavirus vaccines delayed its introduction in some countries, for example Malawi's existing cold chain capacity was only 50% of what was needed for rotavirus vaccine introduction (Madsen, et al., 2014). In response to this challenge, Gavi-eligible countries received support to expand their cold chain capacity. In addition, newer rotavirus vaccines are available in multi-dose vials, reducing their impact on storage capacity (Rota Council, 2019).

In most SSA countries, coverage with the last dose of rotavirus vaccine is comparable to DTP3 coverage (Figure 7) (Rota Council, 2019)

Figure 7: Comparison of DTP3 and rotavirus vaccine series completion for countries that have introduced the rotavirus vaccine in SSA



Source: Global Burden of Disease, Injuries, and Risk Factors Study (GBD 2019)

SSA in Perspective: Section Summary

Compared to other world regions, sub-Saharan Africa (SSA) is home to the highest number of unimmunised and under-immunised infants, has the greatest share of the burden of vaccine-preventable diseases and, consequently, the largest portion of the millions of under-five deaths annually. These statistics are gravely concerning, especially because SSA has the fastest population growth in the world.

Unfortunately, despite the global availability of efficacious and cost-effective vaccines, immunisation coverage in sub-Saharan Africa is sub-optimal, as shown by the DTP3 regional coverage that has plateaued at around 75% for the last five years. Vaccine introduction grants from Gavi, the Vaccine Alliance, have been pivotal in spurring introduction of new vaccines across the region; including the introduction of the rotavirus vaccine, pneumococcal conjugate vaccine, and measles second dose. However, uptake for vaccines administered in the second year of life is particularly dismal.

These observations of under-performance are not uniform across countries in the region, or across time. Some countries have stood out as having high immunisation coverage and some previously poor-performing countries have made significant improvements in the last ten years. This provides a point for peer examination and learning.

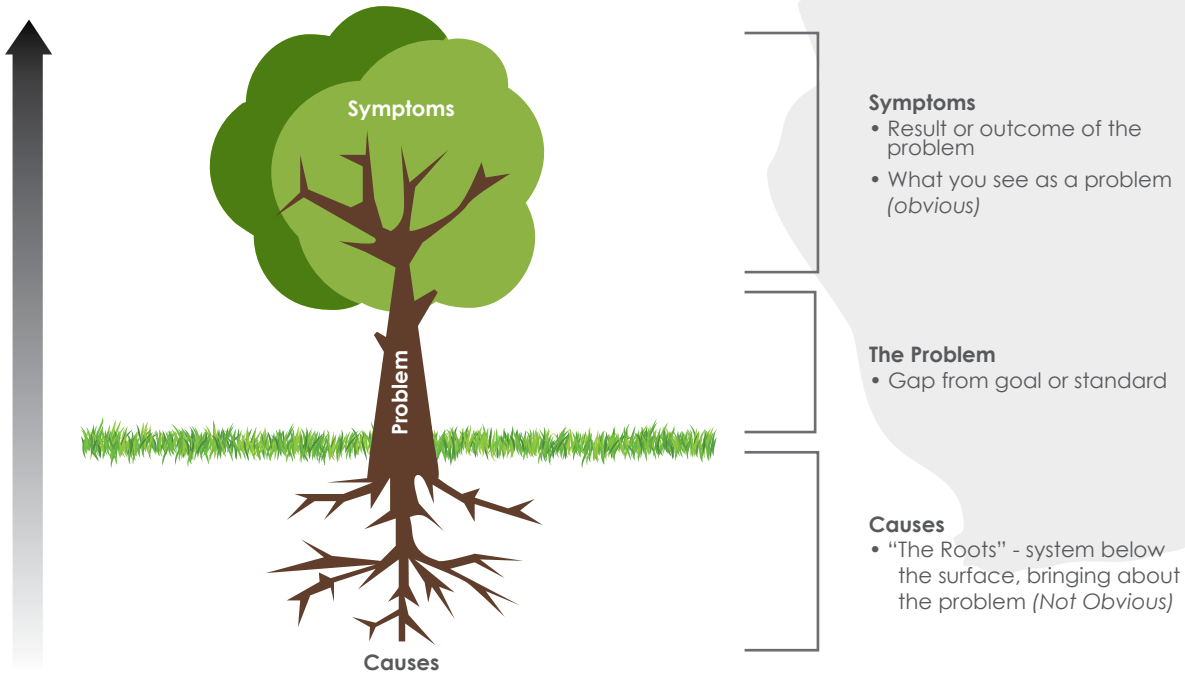
3. ROOT CAUSE OF LOW VACCINATION COVERAGE

3.1 Introduction

3.1.1 Root cause analysis

Generally, root causes are those factors and issues underlying a problem that might not be obvious but can be identified as the cause of a problem, usually through inferential statistical analysis.

Figure 8: Root causes analysis tree illustration.



Source: Adapted from (Operational Excellence Consulting, 2014))

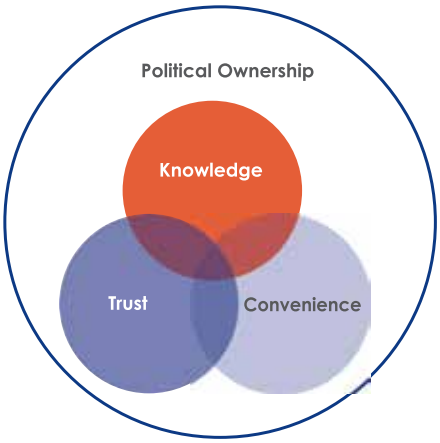
Figure 8 provides a diagrammatic illustration. In the context of this study the problem is low vaccination coverage and under-immunisation in SSA. The problem, when not addressed, leads to symptoms or undesirable health outcomes. In this context, VPDs in children are the outcomes.

3.1.2 Theory of change

One way to address complex societal problems is to use a theory of change (ToC). ToC models use backwards mapping to "begin with the end in mind" and are useful because they force the evaluator to start from large-scale goals and work backwards to interventions that will achieve the goals (Anderson 2004). ToC allows for multiple causal pathways, levels of interventions and feedback loops which better reflect the reality of how complex

interventions achieve their impact. Secondly, the articulation of the evidence base as the rationale for each link (pre-condition) in the causal pathway ensures that each step along the causal pathway is evidence based (De Silva, et al., 2014). This study looks at the root causes of low immunisation coverage and under-immunisation in SSA, studying demand-side and supply-side root causes as well as cross-cutting issues between them. Having reviewed the evidence on interventions to address these root causes, this study came up with a ToC with four overlapping topical sub-themes: Knowledge, Trust, Convenience, and Political Ownership.

Figure 9: Theory of Change for low coverage and under-immunisation in SSA



3.2 Knowledge - deficiencies and inaccuracies

Knowledge deficiencies and inaccuracies among various stakeholders are one of the underlying root causes for low coverage and under-immunisation in SSA.

3.2.1 Demand-side knowledge deficiencies and inaccuracies

On the demand side, a systematic review of the barriers to childhood immunisation in SSA found that parents not being knowledgeable of immunisation was the most frequently and consistently reported barrier to childhood immunisation (Bangura, et al., 2020), (Wiysonge, Uthman, Ndumbe, & Hussey, 2012). (Tefera, Wagner, Mekonen, Carlson, & Boulton, 2018) found that mothers in Ethiopia indicated a variety of reasons for not completing the recommended vaccination schedule for their children, which included attitudes about vaccines or misperceptions about vaccinations, such as fear of side reactions, hearing rumours, or being unaware of the need for vaccination or the need to return to the vaccine clinic to complete the vaccine series. (Braka, et al., 2012) through focus group discussions in Uganda also found that a general lack of information among caretakers about immunisation benefits, immunisation safety concerns, and misconceptions were to blame for not taking children for immunisation. Some community members were reported to refuse immunisation services due to the belief that vaccines were not safe for their children. The knowledge of fathers' also plays a role as overall family decision-makers and in situations where fathers did not understand immunisation, they refused to allow their children to get vaccinated (Ebot, 2014) or refused to facilitate mothers' to access immunisation services for their children (Babirye, et al., 2012).

Some demographic correlates for knowledge deficiencies have been pointed out as predisposing factors to un- and under-immunisation such as poverty, living in certain disadvantaged regions within a country, previous contact with health facility through antenatal care or delivery, refugee status, and mother's education level (Wairiri, et al., 2019), (WHO, 2016). In Togo, children under the care of illiterate mothers were 1.7 times more likely to be poorly vaccinated compared to those with secondary education level

and above while in Nigeria mothers with no education were 31% less likely to have fully vaccinated their children than mothers with secondary or higher education and rural-urban migrants were less likely to be fully immunised compared to the general population (Landoh, et al., 2016), (Antai, 2011), (Awoh & Plugge, 2016).

However, a deeper analysis study in Ethiopia found that the mother's education level had no significant influence on immunisation outcomes, but rather affected health education on the importance of immunisation (Lakew, Bekele, & Biadgilign, 2015), (Atkinson & Cheyne, 1994) also noted that in areas where immunisation is generally accepted, lack of specific knowledge on timing for immunisation may not necessarily affect coverage if health workers provide regular motivation and screening of children brought to health facilities for curative care. For instance, in Zambia only 57% of mothers knew that the poliomyelitis immunisation was needed three times, although the coverage was 90%. Less than half of the women interviewed knew why tetanus toxoid was given, although the coverage was 68%. Maternal age was also found to be a strong predictor of vaccination of a child, with older mothers being more likely to have children who were vaccinated compared with mothers who were aged less than 20 years (Mutua, Kimani-Murage, & Ettarh, 2011).

Parental knowledge on immunisation was found to be highly influenced by their source of information. (Chidiebere, Uchenna, & Kenechi, 2014) and (Wiysonge, Uthman, Ndumbe, & Hussey, 2012) found that care givers referred to misinformation spread in the media on poor efficacy of vaccines and false vaccine attributable side effects as reasons for refusing or delaying having their children vaccinated, a phenomenon termed vaccine hesitancy. Numerous studies have identified vaccine hesitancy as a growing concern in many SSA countries, with quantitative evidence emanating from Ethiopia, DRC, Ghana, Guinea, Nigeria, South Africa, and Zimbabwe (Masters, Tefera, Wagner, & Boulton, 2018), (Tefera, Wagner, Mekonen, Carlson, & Boulton, 2018), (Larson, et al., 2016), (Larson, Schulz, Tucker, & Smith, 2015), (Kpanake, Sorum, & Mullet, 2018), (Taylor, et al., 2017), (Wong, et al., 2016), (Gerede, et al., 2017), (Kriss, et al., 2016), (Pugliese-Garcia, et al., 2018) after their assessment of factors influencing vaccine acceptance and hesitancy in three informal settlements in Lusaka, Zambia, concluded that parents and caregivers required information on the aims of vaccines and their possible adverse effects in order to limit the spread of rumours and distrust.

3.2.2 Supply-side knowledge deficiencies and inaccuracies

On the supply side, HCW have been identified as key sources of vaccination information for parents and care givers and they play an important role in allaying fears about vaccine safety risks (SAGE, 2014), (Oku, et al., 2017)). However, (Bangura, et al., 2020), in their systematic review of barriers to immunisation in SSA, found reports where HCWs lacked knowledge of vaccine indications and contra-indications and also lacked counselling skills. (Braka, et al., 2012) found in Uganda that there was inadequate communication between HCWs and caretakers, though health care workers demonstrated knowledge about adverse events following immunisation and their management. (Oku, et al., 2017) reported that in some health facilities in Nigeria, care givers said that most of the information they received from HCWs in clinics focused on other child health strategies (nutrition, childcare, personal hygiene) and reported a paucity of information on vaccinations. (Malande, et al., 2019) attributed the lack of health worker knowledge to lack of adequate training.

Health information systems are recognised as a useful tool in improving data management but lack of the required skills to operate these systems and convey data information to the target audience has been a major bottleneck among immunisation HCWs in SSA. Inaccuracy in data is a major problem observed mainly at the health facility levels and has been traced to deficiencies in HCWs' knowledge and skills in data quality (Nicol, Turawa, & Bonsu, 2019). A review of published studies that report on pre- and in-service training

with a focus on healthcare providers' competencies and skills to manage immunisation data in LMICs analysed pre-service training in Malawi, Kenya, Ethiopia, Ghana, Lesotho, Senegal and Zambia, and in-service training of tutors and lecturers at training institutions in Cameroon, Madagascar, Malawi, Mali, Niger, Nigeria, Democratic Republic of Congo, Senegal, Tanzania, Uganda, Zambia and Zimbabwe. The findings showed that pre-service training does not adequately prepare HCWs, especially clinicians, with the necessary skills and competencies to collect, analyse and use data (Nicol, Turawa, & Bonsu, 2019). In-service training through support supervision was also found to be inadequate.

Other knowledge gaps identified among HCWs that impact on vaccine coverage related to immunisation policies and also how to identify vaccine eligible children in order to minimise **missed opportunities for vaccination** (MOV). (Olorunsaiye, Langhamer, Wallace, & Watkins, 2017) in their review of immunisation facilities in Malawi, Kenya, Tanzania and Senegal, reported high MOV prevalence, ranging from 43% to 57%, and documented multiple reasons for MOV, including healthcare providers not checking a child's vaccination eligibility during a sick child visit, false contra-indications for vaccination, and hesitancy to open multi-dose vaccine vials. A study by (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012) showed that MOV include the refusal to vaccinate due to false contradictions and a mother forgetting her child's vaccination card. Behind this are various fears and misconceptions on the part of HCWs and caregivers including that a child should not receive multiple vaccinations on the same visit, that a child over 12 months old is too old for the measles vaccination, or that underweight children should not be vaccinated (Hanson et al. 2018), (Hanson, Mirza, Kumapley, & Nandy, 2018). (Adamu, Jalo, Habonimana, & Wiysonge, 2020) found that children that accompanied a caregiver to a health facility were most often not screened for immunisation status by HCWs and presented the largest number of MOV in Northern Nigeria.

(Masresha B. G., Luce, Okeibunor, Shibeshi, & Kamadjeu, 2018), when analysing factors for MCV2 uptake in the WHO African region, confirmed the pivotal role of HCW in providing caregivers with accurate information on immunisation. In São Tomé and Príncipe, 42% of caregivers interviewed who knew about the need for MCV2 obtained this information from a nurse. However, incidences of insufficient HCW knowledge were cited; for example, in Gambia where HCWs were found to be knowledgeable about the justification, policy, and technical issues around MCV2 introduction, but some were not able to calculate coverage rates, drop-out and wastage rates. In Malawi a majority of HCWs interviewed did not have a clear understanding of the policies regarding the vaccination of "sick" children, what to do if a child is older than the target age of 15 - 23 months, whether to open a vaccine vial if only one child is present, whether to administer missing "infant antigens" to children coming for MCV2, or how to document MCV2 in the new registers by age category. (Wallace, et al., 2017) had similar findings in Nigeria, where only 55% of HCW interviewed were knowledgeable about the multi-dose vial policy for minimising vaccine wastage. Consequently, 30% of caregivers indicated that they had been turned away from vaccination at least once and the study found that 53% of these children had yet to receive the dose they had missed.

3.2.3 Interventions to address knowledge deficiencies and inaccuracies

Communication interventions are the primary strategy to address knowledge deficiencies and inaccuracies regarding immunisation. (Willis et al. 2013) pointed out the various aims of immunisation communication, including: inform or educate, remind or recall, teach skills, provide support, facilitate decision making, enable communication and enhance community ownership.

Oku et al. (2017) asserted that community attitudes are shaped by information and the methods used to deliver information to caregivers. (Manakongtreecheep, 2017) reviewed seven studies done on SMS vaccine reminders for vaccination (6) and Vitamin A uptake (1)

in five SSA countries (Kenya, Nigeria, Zimbabwe, Burkina Faso, and Senegal). Three studies considered SMS reminders as the sole intervention and four studies combined SMS reminders with an added incentive either together or as a combined intervention, or as another monitored intervention in itself, such as cash grants and training opportunities. The findings indicated that all studies showed marked improvements in different metrics for vaccination, whether an increase in vaccination coverage, decrease in dropout rates, increase in completion rate, or decrease in delay for vaccination. This method was also found to be more cost-effective when compared to community outreach visits by health workers. The shortcomings observed with this avenue were the high level of illiteracy among caregivers, language barriers, the lack of access to mobile phones and changes of caregivers' phone numbers. The obstacles could be overcome through suggested innovations like keeping messages simple, voice messaging, caregiver tracking (Manakongtreecheep, 2017). A review by (Vann, Jacobson, Coyne-Beasley, Asafu-Adjei, & Szilagyi, 2018) assessing the effectiveness of various types of patient reminder and recall interventions to improve receipt of immunisation, also found that reminder and recall systems were effective for children, adolescents, and adults in all types of medical or health settings including private practices, academic medical centres, and public health clinics.

Although internet usage in SSA in comparison to global usage is low, just above 20% and above 50% respectively, the trend is steadily increasing in the region (Mahler, Montes, & Newhouse, 2019). There is a growing use of mass media as a platform from which people in SSA access information, which makes this intervention of possible positive impact (Mahler, Montes, & Newhouse, 2019). Mass media refers to communication that is meant to reach large audiences or populations. This communication can be written, broadcast or spoken and it includes television, radio, advertising, movies, the internet, newspapers, magazines and academic publications. Mass media is an important source of information for health matters, and, in countries or settings where health systems have been weakened, it might be the only source of information (Jung, Lin, & Viswanath, 2015). Depending on how mass media is used, it can be effective in a positive or a negative manner and perceptions and behaviours about whether to vaccinate can be formed based on mass media messaging. (Oubari, Tuttle, Rath, & Bravo, 2015) found that the different forms of mass media have different influences in terms of vaccinations, with the visuals and emotional messages being viewed as the most effective. One positive example of how social media has been harnessed is the 2019 high level decision taken by social media giants Facebook, Google, Pinterest, Instagram and Twitter, in which they all agreed to only host science-based credible information about vaccinations and to remove and block anti-vaccination misinformation from their social media platforms (Lancent, 2019). Facebook, which holds the largest market share of social media users in Africa, committed to directing its millions of users to WHO's accurate and reliable vaccine information in several languages so as to ensure that important health messages reach people who need them the most.

(Ames, et al., 2017) reiterated the fact that how and by whom communication is done, matters. When HCWs give parents information about immunisation in a respectful and caring manner, parents are more likely to bring their children for vaccination.

Another approach to addressing knowledge deficiencies and inaccuracies is through social mobilisation. In the (Lukusa, Ndze, Mbeye, & Wiysonge, 2018) assessment of the effects of educating parents about immunisation in community settings and health facilities, the study found that this intervention improves vaccination coverage in LMICs regardless of whether it is in the community or at the facility. A review by (Lewin, et al., 2010) shows that there is moderate certainty of evidence that involving lay health workers in the community mobilisation process can increase the number of children adhering to their vaccination schedules. Lay health workers include community health workers, village health workers and treatment supporters. Rwanda's impact of mHealth technologies for the uptake of services other than vaccination has been shown to be enhanced when operated by well-

trained lay health workers (Ruton, et al., 2018); see (Text Box 1). (Nelson, Wallace, Sodha, Daniels,, & Dietz, 2016) showed that home-to-home social mobilisers could improve planning and monitoring by conducting a 'census' of children eligible for vaccination, identifying areas with many un-immunised children and referring people to health facilities for other basic health services. In LMICs, despite the documented positive impact of this strategy on coverage, social mobilisation efforts have been more focused during campaigns and not frequently used to promote routing immunisation. This was related to lack of funding for it in routine immunisation budgets (Jalloh, Wilhelm, Abad, & Prybylski, 2020).

(Saeterdal, Lewin, Austvoll-Dahlgren, Glenton, & Munabi-Babigumira, 2014), in their assessment of impact of communication interventions on vaccination uptake, concluded that the evidence supporting communication interventions to change pre-conceived attitudes in favour of vaccinating among parents with young children is weak. (Oku, et al., 2017) also argued that although several studies have suggested that regular exposure through mass media and community channels is key to promoting vaccination, the evidence on the effects of such community-aimed interventions to inform and educate about childhood vaccination is still quite weak. The engagement of traditional and religious institutions was seen to facilitate the delivery of communication for childhood vaccination, and particularly so in areas where resistant families and communities were commonly found; since these institutions were trusted and respected in many communities. However, an evaluation of the impact of this strategy on actual child immunisation uptake was found to be lacking. In their view there is persistent under-prioritisation of the communication aspect in immunisation programming, health workforce training and allocation, as well as budgeting.

(Oku, et al., 2017) recommended that training of health workers needs to strongly address interpersonal communication skills, so that health workers can maximise any opportunities for reinforcement on immunisation and child health more generally. Such training can help to ensure that health workers provide relevant and comprehensible information in a respectful and culturally sensitive manner. (Brown, Oluwatosin, & Ogundeji, 2017) showed that a training intervention on immunisation for primary healthcare providers improved their knowledge and self-reported practice but did not improve their actual practice of communication with mothers on immunisation. The (Pantoja, et al., 2017) systematic review assessed strategies targeted at healthcare workers by offering education materials, internet-based learning, educational meetings and workshops, feedback, and reminders. Findings of the review showed that printed educational materials slightly improved practice outcomes among healthcare providers when used alone and compared to no intervention. Combined interactive and didactic (lecture-based) educational meetings were slightly more effective than didactic educational meetings alone.

However, (Ames, et al., 2017) shows that there is insufficient evidence to determine which training strategies are more likely to be effective for improving immunisation uptake. (Oyo-Ita, et al., 2016) found that health education (evidence-based discussions, distribution of posters and leaflets, information campaigns) compared to usual care, may increase the uptake of routine childhood vaccination (low- to moderate-certainty evidence) while training of immunisation managers to provide supervision to healthcare providers had low-certainty evidence for effectiveness in improving vaccination coverage.

The 2014 SAGE review on strategies for addressing vaccine hesitancy high-lighted the need to use strategies that are multi-component (seeking to address primary determinants), but it was noted that these must be accompanied by evaluation processes. Secondly, researching, identifying and understanding the issues of target audiences is critical. A third approach suggested is dialogue-based social mobilisation – for example, dialogue with the community, religious and traditional leaders and approaches/interventions that are in line with community processes (SAGE, 2014)). The review highlighted that the use of

social mobilisation interventions for polio vaccinations were successful due to their design and application targeting population groups that were refusing the vaccines (SAGE, 2014). This approach could possibly be applied for other vaccines. Literature that informed these recommendations was from studies outside SSA as no regional specific studies had been done.

3.2.4 Conclusions on knowledge deficiencies and inaccuracies as a root cause for low coverage and under-immunisation

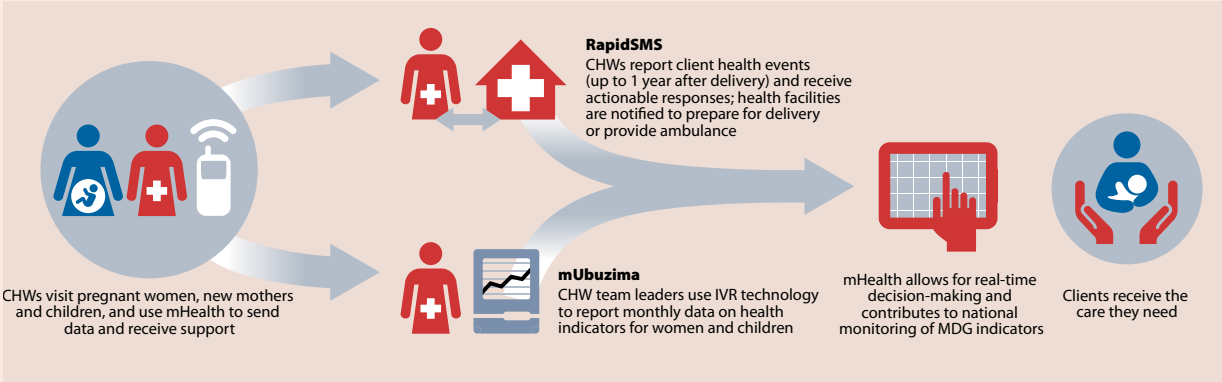
1. Lack of knowledge regarding the benefits of immunisation, and the prevalence of misconceptions about vaccination effects among caregivers and community leaders, is one of the greatest root causes of low coverage and under-immunisation in SSA.
2. This ignorance is commonly found in under-privileged community groups including younger mothers, illiterate and unschooled caregivers, people living in disadvantaged regions within a country, people with no history of contact with health facilities, and migrant and refugee communities, among others.
3. Vaccine hesitancy is a growing trend in SSA driven by fears of side effects fueled by ignorance and false information circulated in media, presenting a serious threat to efforts to increase immunisation coverage in the region. Region-specific studies on interventions against vaccine-hesitancy are lacking.
4. HCW are key resources for immunisation service provision as well as providers of accurate immunisation information for care givers and community leaders in their jurisdictions. However, the capacity of HCW to effectively deliver on these mandates is, in many instances, limited by their own knowledge deficiencies regarding vaccines and vaccine effects, immunisation policies, identification of un- and under-immunised children, social mobilisation and counselling skills, and data management. This limitation is attributed to lack of adequate pre- and in-service training underpinned by limited political investment in this area.
5. Various communication and social mobilisation strategies have been deployed to encourage immunisation uptake in SSA with various degrees of success. However, these efforts are mostly focused around supplemental immunisation campaigns and under-prioritised in resource allocation in routine immunisation budgets. Additionally, impact evaluation research of the different strategies on vaccination uptake is inadequate, with minimal literature coming particularly from the Central African region.

3.2.5 Recommendations on knowledge deficiencies and inaccuracies as a root cause for low coverage and under-immunisation

1. Funders and managers of immunisation programmes should aim to maintain a balance between investment in the essential components of an immunisation system (resources that enable programme readiness) and work force capacity to design and execute implementation strategies. This includes deployment and recurrent training of HCW to fully comprehend vaccines and their effects, the immunisation support practices and policies, and the community needs and desires. This will empower them to tailor appropriate communication and social mobilisation strategies to address knowledge deficiencies and inaccuracies among caregivers and community leaders.
2. Researchers in SSA should address evidence gaps in the areas of impact evaluations of the various communication and social mobilisation techniques employed to address knowledge deficiencies and inaccuracies regarding immunisation. This will provide the evidence base needed by policy and decision makers to select the most appropriate options for the various settings in the region. Special consideration should be made in Central African countries where evidence gaps are pervasive.

3. Text Box 1: Country experiences of mHealth for Immunisation

Rwanda, which has maintained one of the highest vaccination coverage rates in SSA, utilises two mobile health (mHealth) technologies, namely the RapidSMS and the mUbuzima applications (World Health Organisation, 2013). RapidSMS is a text-messaging tool used by community health workers to conduct routine surveillance of health events during the course of a woman's pregnancy, delivery, and for the first year of the infant's life. mUbuzima, on the other hand, uses interactive voice response technology to enable community health worker team leaders in each village to submit data on a monthly basis relating to indicators for case management of sick children, nutritional status, vaccinations, supervision, maternal health and deaths at home (World Health Organisation, 2013). Since vaccination coverage in Rwanda was already very high when the impact of RapidSMS was evaluated, this "ceiling effect" made it difficult to evaluate its impact on vaccination uptake (Hategeka, Ruton, & Law, 2019). However, both tools are assumed to have contributed in sustaining the country's high vaccination coverage levels.



Rwanda's RapidSMS and mUbuzima technologies

Source: WHO 2013 https://apps.who.int/iris/bitstream/handle/10665/92814/WHO_RHR_13.15_eng.pdf?sequence=1

South Africa has also implemented communication interventions which include MomConnect. MomConnect is a free for mobile phone-based information and messaging service, which is a project of the National Department of Health. This service supports maternal and child health through integrating mHealth technology into maternal and child health services, from pregnancy to when the child is one-year-old. One of the objectives of the service is to send targeted health promotion messages to pregnant women to improve their health and that of their infants, and this includes vaccinations (Department of Health, Republic of South Africa, 2019). In a study investigating the impact, it was found that MomConnect users had a slightly higher complete EPI attendance record compared to non-users. Furthermore, 98.2% of users said the messages they received helped them make better maternal and infant health decisions (Coleman & Xiong, 2017).

3.3 Trust – relationships and allegiances

Trust is important when there is an implicit imbalance of power due to a high level of information asymmetry, where trusting individuals accept a vulnerable position in relation to a trusted party. In the context of vaccine decisions, one chooses to trust another to help make a risk/benefit-based decision about which one has incomplete information. Lack of trust in vaccines and in the health-system has been identified as an important barrier in some settings, preventing children from receiving life-saving immunisations (Ozawa & Stack, 2013). Trust in vaccines and in the health-system is an important element of public health programmes that aim to deliver life-saving vaccines. Indeed, understanding the

contributors and threats to trust is essential to explaining vaccine acceptance. Vaccine acceptance involves multiple levels of trust: trust in the product (the vaccine), the provider (specific healthcare professionals or administrative staff that are involved in providing and administering vaccination), and trust in policymakers (the health-system, government, public health researchers involved in approving and recommending the vaccine) (Larson, et al., 2018). In a trust index survey done in different countries including Nigeria, it was found that confidence issues were the primary driver of hesitancy (Larson, Schulz, Tucker, & Smith, 2015).

3.3.1 Demand-side trust issues

A systematic review of barriers to childhood immunisation in SSA noted that parents held reservations towards the associated side effects of vaccines (Bangura J. B., 2020). Others expressed a total distrust of immunisation programmes and vaccines. The review noted that this was in line with a previous review of influenza vaccine hesitancy, which pointed out that a lack of confidence due to low perceived effectiveness of the vaccine was a hindrance to vaccine uptake. (Bangura J. B., 2020) cited a 2018 systematic review that outlined similar beliefs, including concerns about side effects, scepticism toward vaccine safety, and belief in conspiracy theories.

Socio-cultural ties, including religious and cultural affiliations, have been cited as reasons for parents to avoid childhood vaccination. Where immunisation practices conflict with religious or cultural beliefs, allegiance to one's affiliation may deter uptake of immunisation services. Weddings and funerals in some countries last up to a week and result in mothers missing vaccination appointments (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012). Certain religions and cultures encourage parents to use alternatives to vaccination. Religious objections to vaccines are generally based on a few assumptions, the first being that some vaccines are created using human tissue cells and secondly the belief that the body is sacred and should be healed by God or by natural herbs (Ozawa, Zhou, Wonodi, Chen, & Bridges, 2018). A qualitative study of apostolic communities in Zimbabwe reported that accepting vaccination services in public introduced the risk of social sanctions by the community, which contributed to clustering of under-immunisation.

Statements about sticking to one's own culture and religious beliefs are ranked to be more important than perceived benefits and risks, healthcare service, vaccine information, or opportunity costs (Ozawa, Zhou, Wonodi, Chen, & Bridges, 2018). In some traditional cultures, families refuse to take the baby out for vaccination during a period of post-partum seclusion (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012). A study using best-worst scaling to rank factors contributing to vaccine hesitancy in northern Nigeria reported that men ranked the views of their leaders and the media as most influential on their behaviour, whilst women placed greater emphasis on social perceptions and norms (Ozawa, Zhou, Wonodi, Chen, & Bridges, 2018).

Studies on vaccine hesitancy in SSA note that although HCW are essential sources of information to reduce hesitancy, some caregivers do not trust the healthcare system and frequently feel intimidated. (Costa C. J., Weber, Darmstadt, Abdalla, & Victora, 2020) studied the relationship between religious affiliation and immunisation coverage in 15 countries in SSA and found that Muslim communities were associated with lower vaccine coverage in several SSA countries even after removal of confounding factors. (Olurunsaiye & Degge, 2016) in their multilevel analysis of the socioeconomic determinants of spatial variations in child immunisation among states in Nigeria also found similar patterns among Muslims, but this was attributed to political and socio-economic climates that caused Muslims to mistrust the healthcare system, an assertion also made by (Obadare E. , 2005) when reviewing the polio vaccine boycott in Northern Nigeria.

3.3.2 Supply-side trust issues

Mistrust of the healthcare system is another cause for under-immunisation in SSA. Studies on vaccine hesitancy in SSA note that although healthcare workers are essential sources of information to reduce hesitancy, some caregivers do not trust the healthcare system, and frequently feel intimidated due to the unwelcoming behaviour of HCW during immunisation visits (Handy, et al., 2017), (Cabos Munoz, Monzon Llamas, & Bosch-Capblanch, 2015). Mothers who have demonstrated trust in the healthcare system indicated by history of contact with HCW through antenatal and post-natal visits and health facility births often have higher chances of having their infants fully immunised (Tamirat & Sisay, 2019). (Costa J. C., Weber, Darmstadt, Abdalla, & Victoria, 2019) studied the relationship between religious affiliation and immunisation coverage in 15 countries in SSA and found that Muslim communities were associated with lower vaccine coverage in several SSA countries even after removal of confounding factors. However, (Olurunsaiye & Degge, 2016) in their multilevel analysis of the socioeconomic determinants of spatial variations in child immunisation among states in Nigeria found similar patterns among Muslims, although this was attributed to political and socio-economic climates that caused Muslims to mistrust the healthcare system, an assertion also made by (Obadare E. , 2005) when reviewing the polio boycott in Northern Nigeria.

3.3.3 Interventions to build trust in immunisation programmes

UNICEF analysed case studies of efforts in two SSA countries to build trust in immunisation, addressing religious groups. It documented lessons learnt from Sierra Leone, where after just two years of activity, the immunisation programme reached its goal, moving from 6% to 75% coverage of Sierra Leone's children under one year of age (UNICEF, 2004). The take home messages from this were the importance of training HCWs to acquire the necessary skills for social mobilisation (25% of the budget was allocated to training), engagement with respected leaders of communities and facilitating them to act as change agents in a contextualised approach, thus forging ownership for the programme, and having flexibility in programming that allows for monitoring, evaluation and learning during implementation. In Angola, a country that had been embroiled in decades of civil war and with resistance to immunisation by church leaders, the approach used for garnering trust for the polio vaccination was a combination of building alliances through identification of shared philosophical goals, contextualised messaging though mass media and partnerships between community groups and HCWs for outreach services (UNICEF, 2004).

(LaFond, et al., 2015), in their assessment of drivers of improved immunisation coverage in Africa covering case studies from Ethiopia, Cameroon, and Ghana, found that proximity of HCWs through community-centred health workers and through their routine interaction with communities, built a familiarity and sense of trust among the community who referred to them for information on immunisation. The outcome was increased access to immunisation and increased use. Close co-operation between the health sector and the administrative and political structures at the district and community level was also successful. These groups jointly planned services, raised awareness, reviewed performance and defined strategies to reach remote or reluctant communities. Through these partnership mechanisms, the health system, community leaders and volunteers developed a shared sense of purpose and built credibility for immunisation. The effect of this driver was greater regularity and predictability of service delivery and improved respect for health workers for maintaining the service delivery schedule (LaFond, et al., 2015).

In an effort to improve confidence in immunisation policymakers, the GVAP set out a 2020 target for all countries to setup, or have access to, National Immunisation Technical Advisory Groups (NITAGs), which are meant to promote country ownership of immunisation programmes through the review of factors such as local epidemiology and resource availability (Duclos, 2010). NITAGs are multi-disciplinary bodies of national experts whose

goal is to give impartial, evidence-based recommendations that will guide vaccination and decision-making by policymakers and programme managers (Duclos 2010). (Wiyeh, Sambala, Ngcobo, & Wiysonge, 2018) showed that the number of NITAGs in the WHO African Region increased from 15 (28%) in 2010 to 26 (48%) in 2016 while the number of functional ones, based on the six process indicators (Text Box 2) also increased from 5 (9%) in 2010 to 16 (30%) in 2016. Of the SSA countries analysed, (Wiyeh, Sambala, Ngcobo, & Wiysonge, 2018) found that between 2010 and 2016, only Cote d'Ivoire had a functional NITAG consistently throughout while all the other countries fluctuated.

Text Box 2: NITAG six process indicators

NITAG six process indicators (Bell, Blanchard, Walls, Mounier-Jack, & Howard, 2019):

1. Legislative or administrative basis
2. Formal written terms of reference
3. Membership expertise
4. At least one annual meeting
5. Agenda and background documents available to members at least a week before a meeting
6. Members to declare conflict of interest

Between 2008 and 2017, the Supporting Independent Immunisation and Vaccine Advisory Committee (SIVAC) initiative provided advocacy and support, partnership development, and strengthening and capacity development to NITAGs. (Bell, Blanchard, Walls, Mounier-Jack, & Howard, 2019) utilised the data from the SIVAC evaluation to examine NITAGs role and value, contributing factors to their effectiveness and challenges to global investment in them. With regards to effectiveness, the study found that this remains a challenge especially for recently established NITAGs. Challenges include imbalance of expertise, understaffed secretariats, conflict of interest management and unsustainable funding (Bell, Blanchard, Walls, Mounier-Jack, & Howard, 2019).

A systematic review conducted by (Larson, et al., 2018), looking at the impact of interventions deployed to garner trust in the immunisation programme, found no literature from SSA on the topic.

3.3.4 Conclusions on trust

1. Trust in the overall health care system directly impacts on the trust in the immunisation programme in SSA. The conduct of HCW during health-seeking visits, and the community's perceptions of the political and socio-economic climates affect individual and community group trust relationships with the healthcare system.
2. Socio-cultural ties and influences, including culture and religion, play a significant role in decisions regarding uptake of vaccinations and are primary causes of hesitancy in SSA.
3. While some measures of success have been demonstrated in the application of various trust building strategies – including training of HCWs, use of community change agents, building alliances and partnerships in a contextualised approach, and establishment of NITAGs – there is a consistent lack of a systematic evaluation of the impact of these approaches on the uptake of immunisation in SSA.

3.3.5 Recommendations on trust

1. Political and socio-economic leaders should be cognisant in their actions of the sensitivity of the immunisation programme to overall confidence in the healthcare system. Actions that engender trust and confidence in the healthcare systems should be promoted.
2. Researchers should conduct longitudinal studies evaluating the impact of different trust building interventions on the uptake of immunisation in SSA over time, using defined and uniform indicators in order to increase comparability. These would then benefit decision-makers to guide policy creation based on sound scientific evidence.

3.4 Convenience – access and reliability

Convenience in this case refers to ease of access to and delivery of timely and reliable immunisation services.

3.4.1 Demand-side convenience issues

Caregiver access to immunisation services is hindered in two ways: distance and time. Bangura et al. (2020), in their systematic review, cited several studies that indicated that families who needed longer travel times to access health care services, were more likely to not have their children vaccinated, with one study positing that "families whose home was at least an hour from the vaccination site were less likely to be fully vaccinated (56%) than families whose home was between 30 and 59 min away (67%)" (Tefera, et al., 2018). Geographic isolation, where populations are separated by physical barriers such as mountain ranges, rivers, lakes, or deserts, has been identified as one of the barriers to caregivers accessing health centres. Geographic barriers also include climatic, social, and economic characteristics that cluster geographically then lead to a spatial distribution of health inequity (Yourkavitch, Burgert-Bruker, Assaf, & Delgado, 2018). Both WHO and UNICEF have acknowledged the association between geographic isolation and inequitable access to vaccine interventions (WHO, 2015), (Chopra, Sharkey, Dalmiya, Anthony, & Binkin, 2012). The remoteness of communities makes it more challenging for healthcare workers to reach those locations and it is unlikely that community members will seek vaccination services ((Mbegue, et al., 2017), (Okwaraji, Cousens, Berhane, Mulholland, & Edmond, 2012), (Sally & Kenu, 2017).

In terms of time, parents who are employed stated that the waiting time at the clinic affects their adherence to vaccination schedule because vaccination could easily take one day in rural areas and they would lose potential income for the day (Antai, 2011), (Babirye, et al., 2012), (Chidiebere, Uchenna, & Kenechi, 2014). The type of employment matters too, (Bbaale, 2013) found that children whose parents were in agriculture or blue collar jobs were less likely to be fully immunised than those whose parents had white collar jobs in Uganda. (Tefera, et al., 2018) found that housewives had children with higher coverage of full immunisation status (63%) than certain other occupations such as merchants (51%) or public/private employees (56%), with mothers of incompletely vaccinated children identifying lack of time as one of the reasons. (Zewdie, Letebo, & Mekonnen, 2016) cited the high workload of women and lack of support from their partners as a reason for children missing immunisation in South Africa.

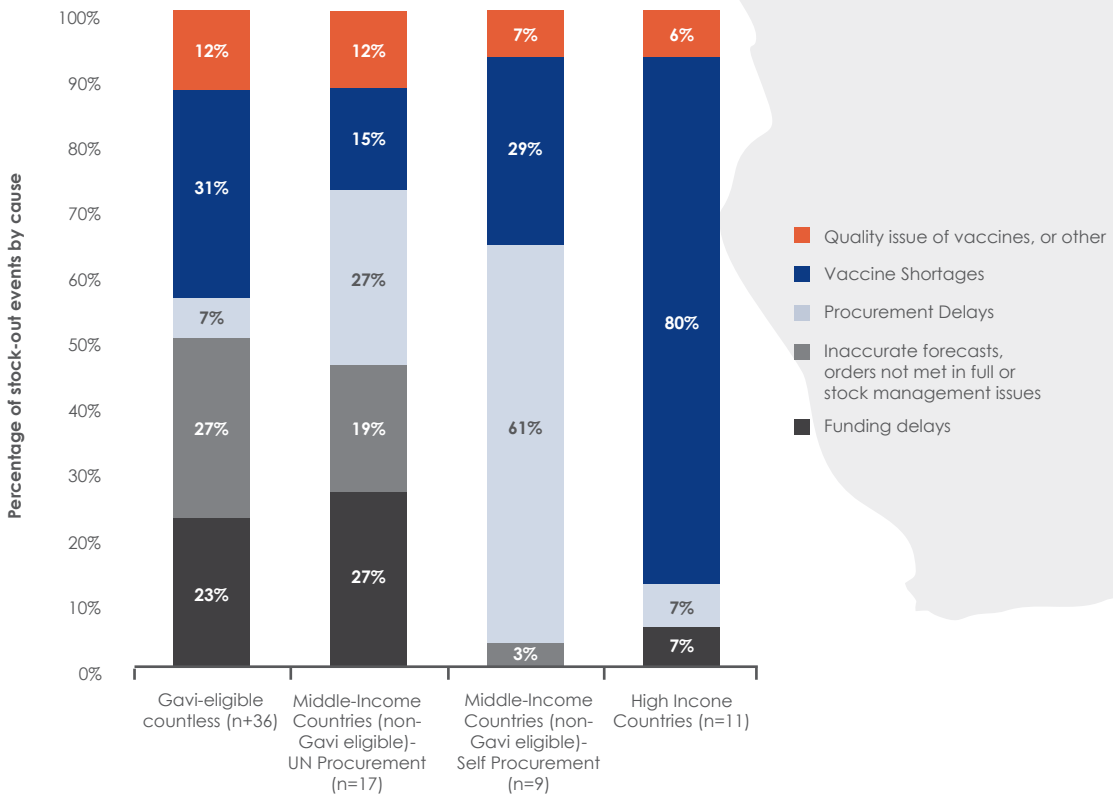
3.4.2 Supply-side convenience issues

Bangura et al. (2020) found the following health system barriers to have affected immunisation uptake: broken cold-chain, irregular supplies and distribution of vaccines, limited human resources and infrastructure, long distances separating health facilities from families, and vaccine shortages at health facility level.

According to a 2017 global stock out assessment report, the incidence of national-level stock-outs is most pronounced in the WHO African region where 38% of countries were affected (Lydon, et al., 2017). At the national level, procurement challenges are the leading cause of vaccine stock-outs. Most Gavi eligible countries in SSA procure their vaccines through UNICEF. A root cause analysis of national stock-outs in 90 UNICEF procuring countries (2011 - 2015) showed that funding delays account for 39%, while poor forecasting and stock management are at 23%, procurement delays at 18%, and global shortage at 9% (Lydon, et al., 2017). (WHO, 2017) findings concur that stock-outs in Gavi-eligible countries are primarily due to global shortages, inaccurate forecasts or stock management issues and funding delays as shown in Figure 10.

Once the vaccines are procured, the next challenge is in storage and transportation. Thermal stability (the need to continually keep vaccines in a 2°C to 8°C cold chain) is a major constraining factor in vaccine storage and in the "last mile delivery" from health centres to vaccination site (Zipursky, et al., 2014). Gavi estimates that half of the healthcare facilities in the poorest countries have no electricity supply at all, with only 10% having a reliable electricity supply to maintain a cold chain (GAVI, 2013).

Figure 10: Causes of national stock-outs adjusted by income group, 2016



Source: WHO 2017

A study by (Vouking, et al., 2019) found that, with several exceptions, iSCs in SSA face chronic difficulties in providing uninterrupted availability of potent vaccines up to service delivery levels, and many government-managed systems remained crippled by inefficiencies in vaccine storage, distribution, vaccine management and stock control. These observations were consistent with earlier reports (Ashok, Brison, & LeTallec, 2017), (Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017). A 2016 Gavi annual report similarly showed that three in four African countries lacked adequate systems for proper vaccine handling, leading to recurrent stock-outs, expired products, and stock damage during storage and transit (Gavi, 2016).

A (Mbegue, et al., 2017) study conducted in Senegal highlighted that one of the causes of low vaccination coverage is logistical challenges in moving vaccines between regions. The regions that have sufficient resources are unable to supply resources to regions that are lacking. The study showed that delivering vaccine services to Senegal's sparsely populated and arid eastern regions was a difficult logistical challenge, resulting in lower-than-average vaccination coverage rates. Similarly, survey data from Kwahu Afram Plains North, an island district in eastern Ghana, showed that vaccination coverage was worse in sub-districts that are "islands of an island" and those communities isolated by difficult terrain showed by far the lowest vaccination coverage rates (Sally & Kenu, 2017). (Akoh, et al., 2016) in a cross-sectional study in rural Cameroon, argued that vaccination teams may be deterred from visiting or revisiting remote communities because they cannot afford simple needs such as fuel for transportation.

(Lydon, et al., Vaccine stockouts around the world: Are essential vaccines always available when needed?, 2017) demonstrated that national level stock-outs can have a ripple effect, resulting in district level and health facility level stock outs and interrupted immunisation service delivery at facility level. (Burnett, et al., 2018), used a hospital-based survey in South Africa to make an analysis of the impact of stock-outs at health facilities on national vaccination coverage, and found that almost 45% of children eligible to have received all the vaccines offered in the first year of life were found to be under-vaccinated, with the vast majority of them being affected by stock-outs of the vaccines. While there were inferences that this was a result of national level stock-out, deeper analysis suggested that these were caused by human error, resulting in poor stock management occurring either at district or facility level.

(Steele, 2014) in a systematic review to understand the underlying drivers to the iSC challenges in SSA found the following underlying causes:

1. Lack of professionalisation where iSC functions are frequently performed by untrained healthcare workers such as pharmacists, clinicians and drivers.
2. Lack of training and the available training is often too rigid, distributed in a geographically uneven way, and does not prepare individuals to connect and coordinate with the key institutions.
3. Poor availability of accurate national data to enable accurate needs forecasting. A misunderstanding of the importance of SCM in relation to global health resulting in under-prioritisation.
4. Rigid supply chain management systems that have not responded adequately to meet new demands arising from issues of demographic and epidemiological change and the influx of new vaccines.
5. Lack of performance incentives to support professionalisation, accountability, and transparency.
6. Poor supply chain practices including poor monitoring systems.

(Steele, 2014) concludes that poor knowledge of both vaccines and the supply chain practises are causal factors of vaccine wastage and stock-outs. Vaccine wastage was cited as a cause for insufficient availability of vaccines in health facilities resulting in missed opportunities for vaccination by (Adamu, et al., 2019). Conversely, (Usuf, 2018) in a study on vaccine wastage in health facilities in Gambia, found that although there were some incidences of vaccine wastage, the levels of it did not significantly impact vaccine availability and overall vaccination uptake. Wastage was observed mainly through unused doses at the end of vaccination sessions. Wastage from the liquid vaccines multi-dose/single-dose vials were very minimal, with peaks due to expiry or breakage of the vaccine diluent (Usuf, 2018). Overall, expiration and breakage were found to be the main reasons for the vaccine

wastage from cold rooms. The study also interviewed 80 health workers and observed good knowledge about vaccine wastage. (Wallace, et al., 2017) undertook a study in Nigeria where they assessed vaccine wastage rates, related vaccinator knowledge, attitudes and practices in 54 health facilities. The study found that almost half of the facilities surveyed had incomplete vaccine stock data for calculating vaccine wastage rates and for those that had data, the average facility level wastage rates were between 18% and 35% with minor differences between lyophilised and liquid vaccines.

(Stokes-Prindle, undated) and (Lee, et al., 2010) argue that the single and multi-dose vial selections can have both negative and positive impacts on vaccination coverage and the "best" container choice will vary by context. For example, if vaccine wastage is not a significant problem, the vaccine is relatively inexpensive, disposing of medical waste is difficult and cold-chain storage capacity is constrained, multi-dose vials may be more favourable. (Usuf, 2018) cited a review by UNICEF on the cost-effectiveness of changing from a 20-dose vial to a 10-dose vial of BCG which concluded that it might be more cost-effective to waste vaccines than to reduce the vial size as the price difference was only 2% to 8%. Conversely, if the vaccine is expensive, vaccine contamination risk is high, and patients visit the clinic with irregular frequency, single-dose formats may be more appropriate.

On the challenges attributed to human resources for health, a study by (Oku, et al., 2017) on vaccine perceptions in Nigeria found that poor communication skills, unpleasant attitudes, and lack of motivation among health workers played major roles in creating negative perceptions on vaccines among caregivers. (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012) reported that caregivers identified the health clinic environment, with long waiting times and poor health worker attitudes, as a major barrier to receiving vaccination information. (Chadambuka, et al., 2012) attributed these immunisation health worker challenges to inexperience, lack of sufficient training and work overload. As there were few healthcare providers available for immunisation services, shortages had a snowball effect resulting in unreliable communication channels and registers getting lost, hindering effective follow-ups. The majority of SSA countries fall below the WHO recommended threshold of 4.45 doctors, nurses and midwives per 1,000 population. (Pozo-Martin, Noye, & Lopes, 2017) (Wiysonge, Uthman, Ndumbe, & Hussey, 2012) identified factors such as insufficient knowledge of immunisation among staff, staff shortages, high staff turnover, financial constraints, poor communication among stakeholders and poor collaboration between the public and private health sectors as negative influencers to immunisation.

3.4.3 Interventions to improve convenience

To address demand-side convenience issues some interventions have been implemented, such as increasing the number of immunisation posts closer to hard-to-reach communities and outreach services. Outreach services have been used with positive impact on immunisation coverage by reaching underserved communities in SSA countries such as Uganda, Ethiopia, Cameroon, DRC, Togo, Cameroon, Malawi, Kenya, Madagascar, Zimbabwe, Angola and Zambia (Ryman, et al., 2010), (Sasaki, et al., 2011), (Nsubuga, et al., 2019), (JSI, 2012). Outreach services have particularly been beneficial in increasing immunisation coverage in refugee settlements in Uganda (Makumbi C. N., 2017). Outreach was found to be particularly successful where optimal location of health posts and timing of service delivery were well informed and contextualised to the targeted community (LaFond & Sequeira, 2012), (Malande, et al., 2019), (JSI, 2012). Outreach is also a key part of the WHO/UNICEF Reaching Every District/Reaching Every Child community level approach. Other outreach methods include supportive supervision, on-site training, community links with service delivery, monitoring and use of data for action, better planning and management of human and financial resources (Vandelaer, Bilous, & Nshimirimana, 2008). However, despite the promising nature of this model in SSA, its implementation is not fully optimised in some areas due to healthcare worker ignorance of model, lack of resources, and poor linkages

with communities (Ryman, et al., 2010), (Muchekeza, Chimusoro, Ncube, & Pomerai, 2014). On the supply side, two areas have been targeted: human resource constrains and immunisation supply chain challenges.

Addressing human resource constraints, optimising the roles of less specialised health workers – lay health workers, community health workers, village health workers and treatment supporters – "task shifting" has been used to address the shortage and mal-distribution of more specialised health professionals, and has been found to have some positive impacts in improving maternal and child care outcomes including immunisation completion (Nabudere, Asiimwe, & Mijumbi, 2011). (LaFond & Sequeira, 2012) found that recruiting locally and supporting health extension workers through local administration units had a significant impact on increasing immunisation coverage in previously poorly performing regions in Ethiopia. (Lewin, et al., 2010) showed that there is moderate certainty of evidence that involving these cadre of workers in the immunisation process, for example by using them as a source for providing information about immunisation to communities and identifying unimmunised children, can increase the number of children adhering to their vaccination schedules. A systematic review by (Oyo-Ita, et al., 2016) also showed that home visits by these cadres of workers can also increase childhood vaccination coverage in LMICs.

Task shifting has also been used in cold chain maintenance, a specialist area chronically short of skilled workers in SSA (Bangura, et al., 2020). In Mozambique task shifting was successfully used to solve the problem of maintaining the cold-chain system through training of field coordinators, who are responsible for distribution of vaccines and data collection, to also perform some basic preventive maintenance tasks during their distribution visits. This resulted in increased up time of the cold chain in participating districts averaging at 95% (VillageReach, 2014). WHO stresses that task shifting should be implemented alongside other strategies and interventions that are intended to increase the numbers of health workers (WHO, 2018). This is in line with the findings of (Anand & Bärnighausen, 2007), which showed that a higher density of nurses in developing countries increases the availability of vaccination services over time and space, making it more likely that children will be vaccinated.

Some studies go as far as suggesting performance rewards, which would require effective performance management systems in the health sector all the way down to the service delivery point (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012) (Lutwama, Roos, & Dolamo, 2013), in their district level assessment in Uganda including research from other SSA countries, found varying levels of performance management implementation – poorly implemented systems or none at all in Mali, Benin and Malawi and relatively strong systems in Kenya and Uganda. (LaFond & Sequeira, 2012), in a sub-national level study in Ethiopia, found some positive outcomes from using accountability and incentives to stimulate competition and motivate health managers and government administrators at the community level – a setting where strong emphasis is placed on measuring and openly reporting on progress in health care, including immunisation.

On addressing immunisation supply chain challenges, strategies to minimise stock- outs and strengthen cold chain systems have been applied. A review of interventions for vaccine stock management in primary health-care facilities suggested that the use of digital information systems to improve information and stock visibility has the potential to increase vaccine availability, reduce response times, and improve the quality of vaccine records (Iwu, Jaca, Abdullahi, Ngcobo, & Wiysonge, 2019).

(Lydon, et al., 2017) suggest the following interventions to address procurement delays at the national level:

1. Addressing delays in releasing national funds to purchase vaccines on time and ensure vaccine financing.
2. Improving forecasting accuracy, stock management practices and data systems for managing vaccines.
3. Addressing cumbersome national procurement processes and delays, especially in self-procuring countries.

UNICEF introduced a Vaccine Independence Initiative (VII) which is a financial mechanism designed to bridge temporary gaps when domestic budgets are not immediately available at the time of procurement. The goal is to provide short-term loans to countries and support timely procurement and reduce stock-outs. By 2015, five SSA countries had signed up for VII, namely Chad, Cape Verde, Cote d'Ivoire, Kenya and Nigeria. In December 2017, UNICEF announced a doubling in this fund to $35 million (UNICEF, 2017).

In 2019, nine middle-income countries in Africa not eligible for immunisation financing support from Gavi, the Vaccine Alliance – including Algeria, Botswana, Cabo Verde, Kingdom of Eswatini, Gabon, Mauritius, Namibia, São Tomé and Príncipe and Seychelles – agreed to work towards pooled procurement mechanisms. They argued that sharing information and ultimately pooling their orders would better leverage their individual purchasing power and thus strengthen their vaccine security and increase their access to affordable life-saving vaccines (WHO, 2019). (Seidman & Atun, 2017) in a systematic review, found no evidence to suggest that centralised procurement and tendering in LMICs resulted in reduced stock-outs or increased availability of pharmaceutical products, although most references indicated cost savings.

In 2015, global shortages of meningococcal vaccine threatened efforts to manage an outbreak of meningitis in Niger resulting in a large meningitis epidemic (Maurice, 2015). A more directed vaccine manufacturing programme in Africa has been suggested as a means of addressing the challenge of global shortage and ensuing vaccine security for African countries (Mehta, Van Duyse, & Schmitt, 2017). Vaccine supply in Africa is almost entirely externally sourced with marginal manufacturing contributed by Senegal, Egypt, South Africa and Tunisia, with Ethiopia planning to contribute in the future (Ampofo, undated). In 2010, the African Vaccine Manufacturing Initiative lobby group was created to coordinate efforts of African vaccine manufacturers and other interested parties who have a vision to see Africa produce its own vaccines and biologicals for both routine and emergency situations (AVMI, 2020). The anticipated challenges with manufacturing of vaccines in Africa include high cost as well as lack of infrastructure, human expertise and political will (Makenga, Bonoli, Montomoli, Carrier, & Auerbach, 2019). Despite these challenges, there are opportunities and indications of increasing interest in vaccine manufacturing in Africa from various stakeholders (Makenga, Bonoli, Montomoli, Carrier, & Auerbach, 2019). Of note, experiences from India show that local production is not a stand-alone solution to vaccine supply security but must be accompanied by complimentary strategies such as taking suitable (and transparent) measures to encourage the indigenous private sector, a strong disease surveillance system, and a strong emphasis on in-house research and development (Madhavi, 2005).

The following innovations to overcome vaccine cold chain constraints have been suggested and implemented:

1. Use of Controlled Temperature Chain (CTC) with vaccines that can withstand conditions outside the cold chain for a specified period, for example WHO pre-qualified CTC MenAfriVac, successfully used in a mass campaign in Chad, Cote D'Ivoire and Benin with

comparatively lower levels of confidence and success (Zipursky, et al., 2014), (Kouassi, et al., 2016). CTC has also been recorded to have indirect benefits on cold chain costs, with the Chad study showing up to 50% reduction in remote areas (Zipursky, et al., 2014). However, the downside is the risk of wastage due to untrained workers not following CTC standard operating procedures (Kouassi, et al., 2016).

2. Use of solar powered refrigerators (McCarney, Robertson, Arnaud, Lorenson, & Lloyd, 2013).
3. Developing thermostable vaccines (Chen & Kristensen, 2009), (Kristensen, Lorenson, Bartholomew, & Villadiego, 2016).

It has been noted, however, that further development and uptake of some of these innovations is hampered by a lack of transparency on the part of vaccine manufacturers regarding the true limits of their vaccine products. There is also a lack of effective communication on the part of equipment manufacturers, particularly in challenges related to their application. Weak advocacy on the part of the consumers and immunisation development partners has been perceived to condone complacency on the part of industry (Comes, 2018), (MSF, 2014).

As part of GVAP, countries pledged to strengthen their iSC by 2020 through developing robust improvement plans, designing systems that improve efficiency, implementing improved data management using electronic systems to minimise stock-outs, optimising cold chain systems, and having dedicated iSC managers at national level (WHO, 2017). In 2014, a team of Gavi partners (the Gavi Secretariat, WHO, UNICEF, and the Bill & Melinda Gates Foundation) formed the People and Practice Working Group that came together to identify the root causes of iSC failures and to propose strategies to overcome them (WHO, 2017).

Some SSA countries have piloted iSC system redesigns, the outcomes of which were subjected to systematic reviews (Vouking, et al., 2019), (Iwu, et al., 2020). The Ministries of Health in Benin, Nigeria, Mozambique and South Africa undertook system redesign activities to address the longstanding underperforming iSC systems (Vouking, et al., 2019), (Iwu, Jaca, Abdullahi, Ngcobo, & Wiysonge, 2019), (Iwu, et al., 2020). In the intervention areas, a simulation-modelling tool was used to identify the most suitable design for improving the performance of iSC in terms of vaccine adequacy and availability, logistics, cost per dose administered, and vaccination coverage. The system redesigns were preceded by infrastructure and human resource remedies including stocking the right cold chain equipment and training personnel in iSC management.

Benin's redesign was done in 2013. Vaccine storage was consolidated from the sub-district to the district, and the delivery was transformed to an informed push model[4] using delivery truck loops to deliver vaccines directly from the district store to the health facilities using real-time data from the health facilities, and delivery routes carefully planned to maximise health facility reach and truck storage space (Prosser, et al., 2017). A 2014 assessment of pilot district performance using the Effective Vaccine Management (EVM) criteria showed that pilot district scores were significantly higher than those in the control district in all criteria, with unmatched differences in distribution (100% versus 32%), vaccine management (94% versus 63%) and maintenance (79% versus 6%), (Prosser, et al., 2017), (Vouking, et al., 2019). In Mozambique, the alternative design eliminated the district level as a distribution point, which became a warehouse for emergency stock only. Deliveries were made monthly from the provincial level directly to the health facility using delivery loops designed to

[4] 'Informed Push' supply chain models (IPM): commodities are distributed to health clinics on a predetermined delivery schedule without first requiring an initiating order from clinics. Delivery trucks are loaded with quantities of commodities that anticipate specific needs, often based on data derived from previous usage and/or forecasting of near-future clinic needs

take into account geographical terrain and population distribution patterns. At the end of the Mozambique five-year pilot in 2008, DTP3 coverage in children aged 12 - 23 months increased by nearly 24 points, rising from 68.9% in 2003 to 92.8% in 2008 compared to the control province that rose from 54.6% to 71.9%. Concurrently, drop-out rates between DTP1 and DTP3 fell from 12% to 3.8%. Stock-out rates were reduced from 79% at baseline to less than 1% (Prosser, et al., 2017).

In Nigeria's pilot, which started in January 2013, stock holding levels at some local government areas in Kano state were eliminated. Instead, an informed push model, known as "PUSH Plus", was recommended for testing in public health facilities in three government areas. Vaccine distribution to these facilities was outsourced to a private transporter, who, in turn, conducted bi-weekly deliveries of vaccines and vaccination consumables directly from the state cold store to the target facilities (Aina et al., 2017). After 20 months of implementation (in September 2016), stock adequacy improved from 54% to 68% and stock-out rates dropped from 41% to 10% (Aina, et al., 2017).

Anthropological studies showed improved frequency of vaccination services attributed to improved vaccine availability and staff time to care for patients (Vouking, et al., 2019). On the financial side, the cost-efficiencies found in these pilots suggest that system redesign can improve supply chain performance while reducing overall logistics costs (Vouking, et al., 2019). The systematic review also compared performance of in-house run versus outsourced-to-the-private-sector delivery systems. Results showed that in South Africa EVM scores for the "outsourced" iSC segments exceeded 80% as opposed to 63% in the segment managed "in-house".

In Nigeria, with the private sector system, the percentage of facilities with vaccine stock-outs dropped from 43% to 0%. At the same time, vaccination coverage in these facilities rose from 57% to 88%. (Molemodile, Wotogbe, & Abimbola, 2017) reviewed the same pilot in Kano State, Nigeria with the aim of understanding the underlying drivers of its success. Their findings attributed the success to improved ownership and accountability for immunisation by sub-national governments, and their improved capacity for generating resources and management of data and the supply chain. The successes of these iSC system redesigns notwithstanding, some challenges remain. Funding challenges, management capacity, and staff motivation at the federal and state levels remain impediments to sustained progress particularly as GAVI graduation is coinciding with a significant economic downturn (Sarley, et al., 2017).

A systematic review (Seidman & Atun, 2017) looked at the changes in the supply chain system and its impact on drug and vaccine availability in LMICs (with 12 of 15 studies selected from SSA). The review found contrasting outcomes from the different supply chain models (for example the informed push used in Senegal and informed pull[5] used in Uganda and Tanzania) with both achieving improved results. These results underscore the need for policymakers and programme managers to examine the root causes of inefficiencies in pharmaceutical supply chain and procurement processes in order to determine how best to improve health systems performance in their specific contexts.

3.4.4 Conclusions on convenience

1. Physical barriers that create longer travel times from communities to health facilities make it inconvenient for communities to access immunisation services and for health workers to deliver immunisation services to underserved communities. Socio-economic barriers, including heavy workloads and inflexible working environments (particularly for blue collar workers) and lack of family support, make it difficult for caregivers to take time off to access immunisation services. Considering that a majority of workers in SSA are blue

[5] commodities are distributed to health clinics by first requiring an initiating order from clinics.

collar and considering the large populations of displaced persons with no family support, there exists a significant challenge to immunisation service provision in the region.

2. Poor service delivery on the part of healthcare workers, exhibited as poor customer services, long waiting times, and inconsistent availability of immunisation services deter immunisation service uptake. Underlying this poor service delivery are systemic challenges such as heavy healthcare workloads due to low health-worker to population ratios, lack of motivation, poor remunerations and resulting high staff turn-over, and limitations within the immunisation supply chain.
3. Strategies deployed aimed at bringing immunisation services closer to communities through establishment of more community-based immunisation posts, conducting outreaches, task shifting, and use of community-based healthcare workers, have shown anecdotal improvements in immunisation coverage.
4. Interventions aimed at improving vaccine security, including re-designs in the immunisation supply chains, use of controlled temperature chains, local manufacturing, and pooled financing and procurement mechanisms, though fairly recent, have been shown to have positive impacts on immunisation coverage based on early implementation stage assessments. However, a lack of comprehensive information on the part of the manufacturing industry has been identified as a challenge to the sustained implementation and scalability of these interventions.

3.4.5 Recommendations on convenience

1. District level leadership should own and support the implementation of the WHO/UNICEF designed Reaching Every District/Reaching Every Child (RED/REC) strategy to reach every child with immunisation services implemented at the sub-national level through lobbying for sufficient fund allocation, progress monitoring, and supporting community engagement.
2. National level immunisation sector leadership should ensure that healthcare workers at service delivery points are sufficient (based on task requirements and populations served) and well-motivated. Innovations such as task shifting should be encouraged and supported at district levels through regular training, supervision and, where feasible, monetary compensation. Additionally, they should prioritise immunisation supply chain (iSC) management through capacity building of iSC experts and their involvement in top management decision making.
3. Regional level leadership, including WHO AFRO and African Union, should encourage national leaders to commit to the long-term vision of local vaccine manufacturing as a means to ensure sustainable vaccine supply for the region by putting in place the necessary foundational structures, including building local expertise, incentives for private sector investment, strengthening in-house research and development, and requisite infrastructure developments.
4. Immunisation development partners and Civil Society Organisations should incentivise and lobby for greater transparency from industry partners in order to support iSC innovations such as controlled temperature chains, and alternative energy sources.
5. Researchers should further study and evaluate impacts of innovations aimed at securing vaccine supply such as pooled procurement and longer-term implementation of immunisation supply chain re-designs on vaccination coverage.

3.5 Political ownership – financing, community ownership, and enabling environment

African Academies of Sciences, in their joint publication on drivers to ensure African countries achieved globally agreed development agendas post-2015 era, ranked highly the issue of country ownership. They defined country ownership as leadership and participation — at all levels and in every sector of society — toward achieving a unified goal, where individuals have a stake in and a shared responsibility for delivering the common development agenda (UNAS, 2014). Country ownership is also one of the four effectiveness principles of the Global Partnership for Effective Development Cooperation. Others are focus on results, inclusive partnerships, and transparency, as well as mutual accountability (OECD, 2020).

Political commitment towards immunisation was made clear in 2017 when the African Heads of States endorsed the Addis Declaration on Immunisation (ADI) at the 28th African Union Summit. It is comprised of ten commitments (Text Box 3) whose aspiration is to reach every child with lifesaving vaccines and to ensure there is universal access to vaccinations in order to decrease child mortality (ADI, 2019).

Text Box 3: Commitments of the 2017 Addis Declaration on Immunisation

2017 Addis Declaration on Immunisation Commitments

1. Keep universal access to immunisation at the forefront of efforts to reduce child mortality.
2. Increase and sustain domestic investments and funding allocations for immunisation.
3. Address persistent barriers in vaccine and healthcare delivery systems, especially in the poorest, most vulnerable and most marginalised communities.
4. Increase the effectiveness and efficiency of immunisation delivery systems as an integrated part of strong and sustainable primary healthcare systems.
5. Attain and maintain high quality surveillance for targeted vaccine preventable diseases.
6. Monitor progress towards achieving the goals of the global and regional immunisation plans.
7. Ensure polio legacy transition plans are in place by end-2016.
8. Develop a capacitated African research sector to enhance immunisation implementation and uptake.
9. Build broad political will for universal access to life saving vaccines.
10. Promote and invest in regional capacity for the development and production of vaccines.

3.5.1 Immunisation financing

(Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017) posited that funding the commitment of national governments for immunisation is perhaps one of the most important challenges facing immunisation programmes in the WHO African Region. Whilst noting that a significant part of immunisation funding in the region comes from development partners – mainly Gavi the Vaccine Alliance[6] – the report asserts that there is a dire need for a paradigm shift for governments to begin to take more responsibility for immunisation to ensure sustainable

funding. Similarly, Bangura et al.'s (2020) systematic review found that financial limitation was a major barrier that hinders childhood immunisation in SSA. They recommended that countries should increase government financial GDP allocation to their health sectors, consistent with the recommendation in the Abuja declaration[7] (WHO, 2011) arguing that increased financial resources would enable countries to equip and upgrade existing health facilities and to increase their numbers. They hypothesised that targeted resources may motivate and enable staff deployed in remote areas for effective outreach activities to maximise coverage of immunisation. (Madhi & Rees, 2018) point to government political commitment as the key to securing local country ownership of the entire immunisation programme, reiterating earlier calls by (Machingaidze, Wiysonge, & Hussey, 2013) that demanded that African leaders must be held accountable for meeting agreed country targets and honouring international commitments made.

(Kamara, et al., 2008) reviewed financial sustainability plans (FSPs) from several low-income Gavi-supported countries including twenty-seven countries in the WHO African region, and found that, generally, country strategies fell in three categories: (1) mobilising additional resources, (2) increasing the reliability of resources, and (3) improving programme efficiency.

In mobilising additional resources, most SSA countries' FSPs looked at advocacy for increased central government allocation, with some also looking into contributions from sub-national authorities, private sector sources, and a few considering sourcing from within communities for example through community insurance schemes. Notably, 21/27 countries planned to lobby for more donor funding with 10/27 targeting Gavi, the vaccine alliance (Kamara, et al., 2008).

In practice, in a bid to mobilise additional resources from central governments, countries have employed different innovations with varying success and progress. These include ring-fencing traditional vaccine budgets as well as enacting immunisation legislation, including a financing obligation from governments in countries such as Senegal, Uganda, Madagascar and Cameroon. However, as of 2016, no funds were actually flowing in any of these countries. In Ghana, which has broader earmarks for health, the Ministry of Health used a portion of the value-added tax revenues that fund the National Health Insurance Scheme to fund vaccine purchases to meet the country's Gavi co-financing commitment in 2016. Global experience suggests that earmarking for health can be effective if health services are a high national priority, the purpose is broadly defined (such as for national health coverage), and there is some flexibility to reallocate from earmarked funds if other urgent priorities emerge. But the effectiveness of an earmark can diminish over time, with the budget rigidity it creates leading to inefficiencies (Kamara, et al., 2008)

According to (Kamara, et al., 2008) some countries have explored the option of establishing a trust fund, including Cameroon, Nigeria, Senegal, Kenya, Mali, the Republic of the Congo, Sierra Leone and Uganda. Inspiration has been taken from the Zimbabwe National AIDS Trust Fund that was set up in 1999 and which provides 50% of national spending for antiretroviral therapies, accounting for about 10% of Ministry of Health spending on HIV/AIDS. The fund raised US$2.6 billion between 2000 and 2006 and another US$26 million in 2011. The funding source is a 3% AIDS levy charged on incomes and profits in the formal sector. On the other hand, trust funds can be costly and challenging to manage, and much has yet to be learned about governance and managerial structures in relation to immunisation funding. Trust funds could use up more political capital than is justified by the pay-out, while not necessarily

[5] Gavi offers financial support to countries for 17 different vaccines, primarily new and underused vaccines, including pneumococcal conjugate and rotavirus vaccines. Gavi does not support 'traditional' vaccines, such as Bacille Calmette Guerin and oral polio vaccines. Countries receiving Gavi vaccine support are obliged to co-finance a fraction of the vaccine costs for routine immunisation by co-procuring a portion of vaccines (Henderson, Gouglas, & Craw 2016).

[7] In April 2001, heads of state of African Union countries met and pledged to set a target of allocating at least 15% of their annual budget to improve the health sector. At the same time, they urged donor countries to "fulfil the yet to be met target of 0.7% of their GNP as official Development Assistance to developing countries."

meeting all of the funding needs for immunisation. The effectiveness of immunisation trust funds has not been extensively assessed as most countries are still in the early stages of the process (Kamara, et al., 2008).

(Lydon P, et al., 2008) analysis showed evidence that the existence of a specific line in the national budget is associated with increased governmental budget allocations for vaccines and routine immunisation financing, and yet (Griffiths, et al., 2020) analysis of 33 African countries' national budgets found only 19 of the 33 (58%) countries that were assessed as meeting the criteria of a budget line item for the purchase of vaccines, and only a few countries included line items for activities essential to vaccine delivery. Two countries had a budget line for cold chain (Niger and Zambia, 7%), five countries included vaccination campaigns (17%) and three countries had surveillance (CAR, Congo and Madagascar). Kenya, Nigeria, and Senegal have successfully sought to increase immunisation financing by conducting regular immunisation budget advocacy using economic evidence (Sabin Vaccine Institute, 2019). In addition to using evidence, engaging at a high level with both the Ministry of Health and Ministry of Finance was associated with positive outcomes (GAVI Alliance, 2007). (Petu, 2018) argued that having a comprehensive multi-year plan enables the Extended Programme on Immunisation(EPI) to go through a process that ensures priority-setting, and, on the basis of that, argue for government budget allocation. This is because the process establishes a matching of resource with expected cost to determine gaps, and to the extent that costing and planning are fundamental, subsequent government funding based on the plans and cost will assure sustainability.

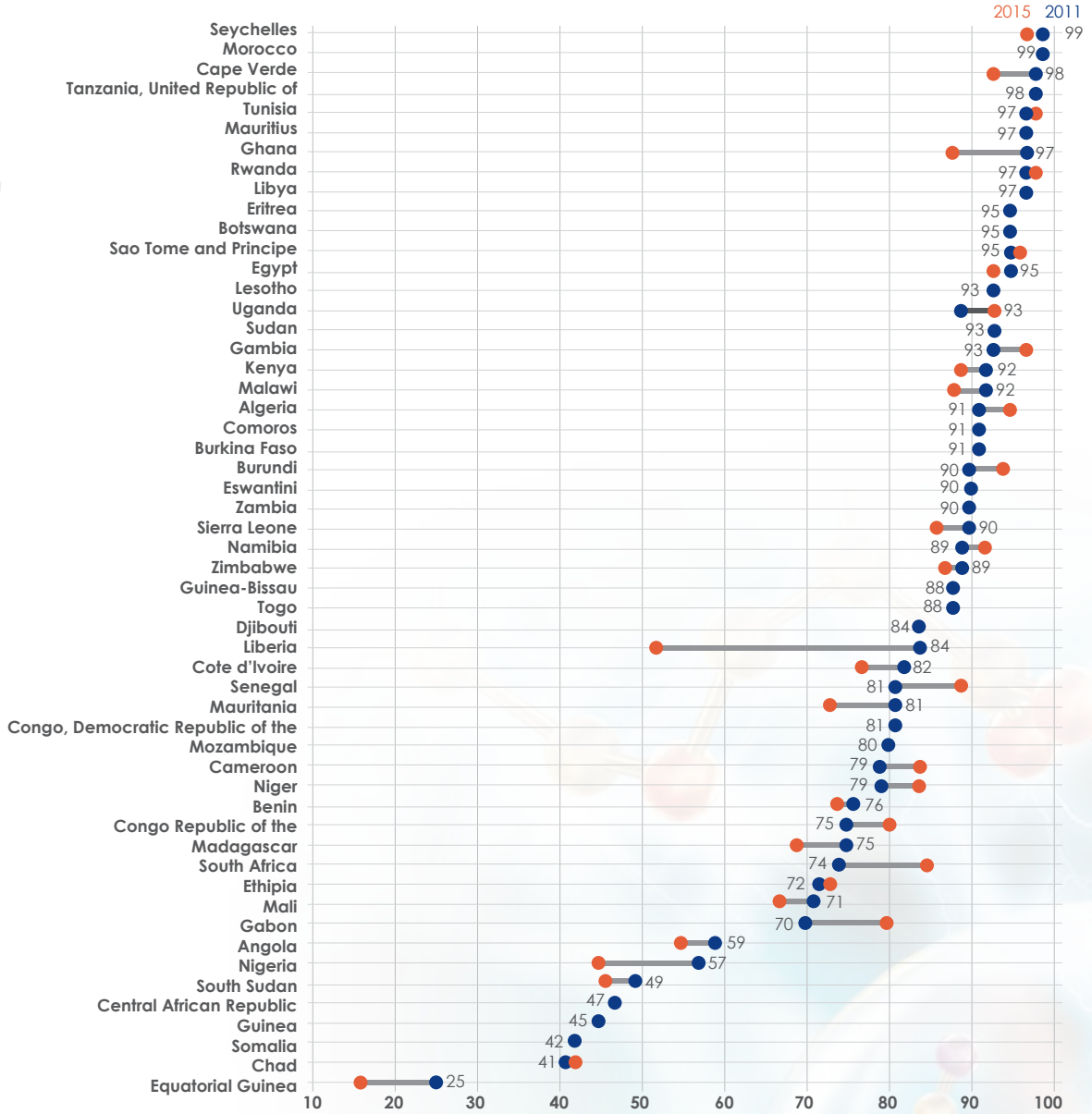
The ADI 2019 progress report shows (Figure 11) that as of 2018, six countries were 100% funding their immunisation programmes while 15 countries funded more than 50% of their programmes. In addition, 19 countries have increased their contribution for their immunisation programmes (ADI, 2019).

Regarding increasing the reliability of resources, (Kamara, et al., 2008) found that country FSPs cited strategies such as budgeting and financial management, negotiating for longer term commitments from donors, and decentralisation to quicken disbursements. Increasing reliability of funding helps to improve the predictability of resources from which to plan and implement immunisation activities. With more predictable resources, gaps in financing can be identified and steps taken to plan within constraints or to seek additional sources of funding. Experience from the Democratic Republic of the Congo showed that donor confidence is facilitated by a high absorption capacity of funds allocated, having a transparent accounting and budget management system, equitable distribution of funds to the subnational level, and government commitment demonstrated by increasing domestic investment over time (Le Gargasson, Breugelmans, Mibulumukini, Da Silva, & Colombini, 2013). Decentralisation gives the programme greater ownership at the subnational level and can result in increased transparency and accountability as was demonstrated in Kenya, where local governments achieved improvements within 100 days by engaging front-line workers in the planning process and providing them with clear goals and intensive monitoring and feedback (McQuestion, et al., 2011).

On improving programme efficiency, country FSP strategies included management and planning, reduction of vaccine wastage, review of the rationale for new antigen introduction, cold chain maintenance, strengthening of vaccine procurement service delivery/coverage improvement, reduction of drop-out rates, improvement of social mobilisation, and integration with other programmes (Kamara et al. 2008). In order to get the most out of efficiency interventions, focus needs to be put on the biggest cost drivers. The (Brenzel, 2015) analysis of cost drivers for routine immunisation in Gavi-eligible countries found that among African countries, vaccines continued to be the major cost driver (51%) followed by immunisation-specific personnel costs (22%). Introduction of new vaccines had a significant impact on routine immunisation costs (3 new vaccine introductions increasing

costs by 141%), as did non-vaccine delivery costs/health system costs. One of the strategies employed for controlling vaccine price is pooled procurement, which yields lower prices for vaccines than those paid by individual countries on their own. UNICEF supply division provides a platform for pooled procurement for Gavi supported countries. African countries outside of Gavi support are also coming together to harness the benefits of pooled procurement (WHO, 2019). Experience has shown that although passive pooled procurement may have advantages, particularly better price and lower procurement transaction costs, its use creates risk of supplier exit and/or poor investment in capacity, which can lead to supply shortages and/or higher prices in the long term. A better approach is one of strategic pooled procurement, which includes elements to ensure supply sustainability and to better coordinate matching of supply and demand. This requires ensuring that the buying power and price reducing effects of pooled procurement do not shift market balances and endanger the health of the market (WDI, 2015).

Figure 11: WHO African countries' percentage government contributions to their immunisation programs 2015-2018



Source: Addis Declaration on Immunisation Progress report, 2019 (ADI, 2019).

(Yip & Hafez, 2015) showed that countries have used policy reforms to improve health system efficiencies. Burundi instituted a system of performance-based financing explicitly linking benefits packages to improved quantity and quality of services, and thus increased

uptake of maternal and child health services. Ethiopia introduced a task-shifting policy from physicians to mid-level professionals and provided regional quotas for physicians from disadvantaged regions. Democratic Republic of the Congo introduced a single management and donor harmonisation policy to address health system challenges such as fragmentation of health financing and service delivery, high management costs, duplication and waste of resources and misallocation of resources. They introduced a single national steering committee, a common manual of procedures agreed upon by the government and all partners, single operational district plans, and a joint financial management system. Reduced fragmentation resulting from the reforms decreased the management costs of internationally funded projects from an average of 28% in 2005 to 9% in 2011. Between 2009 and 2014, better coordination resulted in savings of more than US$56 million. Greater transparency in planning and budgeting enabled some provinces to increase their operational budgets by 30%. Reform of the pharmaceutical sector and pooling of resources for drug transport by the regional distribution centres of the National System for Procurement of Essential Medicines resulted in annual savings of more than US$3.5 million. The funds thus released were used to pay the remaining staff, increasing their motivation and productivity. Kenya conducted an analysis of its public health care expenditure and found that increasing allocative efficiency, which is the mix of services or interventions that maximises health improvements, both within disease entities (such as prevention through immunisation versus behavioural change strategies combined with treatment) and across them (i.e.: how the health of a population can be most improved with existing resources), and found cost savings and funds reallocated (World Bank Group, 2014).

3.5.2 Community ownership

(Mihigo, Okeibunor, Anya, Mkanda, & Zawaira, 2017) fronted community ownership of the immunisation programmes as a means to create sustainable demand for immunisation services, particularly for increasing demand for and uptake of available services through social and behavioural change interventions. There intervention would ensure government transparency and accountability, support resource mobilisation, influence national health policies, and support the monitoring and evaluation of effective programmes.

A key interlocutor facilitating both communities and governments to fulfil their mandates in the immunisation landscape are CSOs. CSOs utilise their unique capacity to forge connections between communities, health services, and the governments responsible to those communities. At the Ministerial Conference on Immunisation in Africa, held in Addis Ababa, Ethiopia in 2016, over 80 organisations endorsed the CSOs' declaration on immunisation to show their commitment to their role in holding governments accountable to improve vaccine access and coverage in Africa in line with the Global Vaccine Action Plan and other supportive roles as outlined in Civil Society Declaration for Equitable Access to Immunisation in Africa (WHO Ethiopia, 2016), (WHO Africa, 2017). In this declaration, CSOs outlined the ways in which they can support governments and communities, Text Box 4.

Text Box 4: Civil Society Declaration for Equitable Access to Immunisation in Africa 2016

Civil Society Declaration for Equitable Access to Immunisation in Africa: CSO Commitments (2016)

1. Support government efforts in delivering vaccination, ensuring that these services reach communities in hard-to-reach locations and marginalised communities.
2. Support efforts to increase the acceptability and uptake of vaccines in these communities through demand creation activities.
3. Deliver immunisation services in emergency and crisis contexts where appropriate.

4. Assist governments to improve the performance and management of the systems that deliver vaccination.
5. Participate in the elaboration, implementation, and monitoring of health and immunisation policies.
6. Hold governments accountable to deliver the immunisation services needed by their entire populations, especially the poorest and most marginalised members of society.
7. Raise the voice of communities by supporting and empowering them to participate in immunisation processes and accountability mechanisms.
8. Hold donor country governments and multilateral institutions accountable to fulfil the pledges they have made to deliver funding and support for immunisation and ensure this is aligned with national health plans and priorities

(Catholic Relief Services, 2019) provided documentation of CSO activities in SSA that showed that they have made significant contributions towards increasing immunisation uptake in the region. Examples cited in areas of operation include:

1) Coordination and surveillance:

a) In Ethiopia health extension workers were facilitated to train community volunteers in surveillance and recording, resulting in 71,904 children who had defaulted on their immunisation schedule within their first year being identified and put back on schedule.

b) The Cross Border Initiative in the Horn of Africa had community volunteers trained in surveillance methods to work with mobile border communities conducting advocacy and sensitisation activities.

c) In Sierra Leone, CSOs conducted a knowledge, attitudes and practices survey that showed that 30% of children had missed a scheduled vaccination due to fear of contacting Ebola virus. A social behaviour change campaign was conducted to restore confidence in the health system in general and the immunisation programme in particular.

d) In South Sudan, CSOs conducted independent monitoring of immunisation campaigns resulting in improved speed on providing data to stakeholders and adding an extra layer of credibility to the data.

e) In Zambia, Churches Health Association of Zambia's HPV Project was developed to complement the Government of Zambia's efforts to reach out to caregivers of girls aged 9 – 11 in the districts of Lusaka. They trained community volunteers to conduct door-to-door campaigns, drama skits, radio engagements, and school parent-teacher engagement. This resulted in 94% of eligible girls in Lusaka districts being vaccinated.

2) Social behaviour change:

a) A CSO in Nigeria, targeting male Muslim heads of families, enlisted the support of Muslim leaders in vaccine-hesitant communities to disseminate information on the importance of immunisation to male household leaders during Iftah prayers at the breaking of the fast each day. In 2017, the Strategy resulted in more than 90% of children from non-compliant households receiving vaccinations.

b) In Togo and Madagascar, CSOs used father role models to raise immunisation awareness serving as champions and role models in their communities, while women immunisation champions were used in Guinea to address myths about infertility among vaccinated Wahabi women, resulting in nearly 100 children from hesitant families being vaccinated against polio.

3) Stronger community level systems and services:

a) In Zambia, CSOs were involved in taking immunisation to hard-to-reach areas by encouraging local institutions like schools to serve as mobile outreach service points on pre-determined days and encouraging the health care works to provide integrated services during outreach to include topics of interest such as nutrition.

b) In Uganda, CSOs partnered with local health authorities to introduce the use of community-owned child registers as an efficient tracking system for finding unimmunised children and those who had missed follow-up doses, as well as to improve the consistency of immunisation data between health facilities.

4) Advocacy:

a) In 2013, the Malawi Health Equity Network conducted budget allocation and used research findings as evidence to advocate with national-level stakeholders, including parliamentarians, for increased budget allocation towards immunisation efforts. The outcome was a 1% increase for health care, approximately a $17 million boost, including $2.1 million earmarked specifically for immunisation in the 2014-15 budget.

b) In Madagascar, a CSO involved the local community to improve immunisation service delivery at health centres and to foster community confidence. They did this by engaging locals in drafting a set of nine articles explaining how the health centre should be run and what local people could expect from it. These articles were based on the people's right to health, which is enshrined in national legislation.

3.5.3 Enabling environment

Socio-political environment has been observed to significantly impact the feasibility of implementing immunisation programmes. This is mostly evident in armed conflicts, humanitarian emergencies, and disease pandemics.

3.5.3.1 Armed conflicts, humanitarian emergencies, and immunisation

Political violence has been fundamental to Africa's post-colonial political history. Although large-scale organised political violence is on the decline and large areas are stabilising, in the post-2000 era, armed conflict in SSA has been characterised by contemporary insurgencies targeting civilians and fighting on the periphery of fairly well consolidated states, as in Senegal, Nigeria, Angola, Namibia, Mali, Sudan, and Uganda. Also on the rise are election related violence and territorial fights for natural resources. Geo-political shifts are the likely cause of declines and changes in war patterns in the region (Straus, 2012).

(Sato, 2019) analysed the linkage between armed conflict and immunisation and found a large negative effect of conflict events on the likelihood of vaccination. If an armed conflict occurs within 10 km of where a child resides, the odds that child will receive any vaccination are 47.2% lower. Children that are affected by conflict suffer disproportionately from Vaccine Preventable Disease (VPD) outbreaks. For instance, out of about 3,400 cases of polio reported globally between 2010 and 2016, 70% were in conflict-affected countries. As a result of conflict, an outbreak of polio in the refugee camps along the Kenya-Somalia border in 2013 later spread into the surrounding communities. Similarly, in Somalia, low vaccination coverage caused by the conflict in 2010 and 2011 led to a massive measles

outbreak, and the number of cases increased from 145 to 1562 cases per million children under 5 years. The arrival of refugees from Somalia into the Dadaab refugee camp in Kenya and the Dollo Ado refugee camp in Ethiopia in 2010 and 2011 led to a devastating measles outbreak (Ngo, et al., 2020). (Grundy & Biggs, 2019) similarly found that low immunisation coverage and VPD outbreaks are of major concern in conflict-affected countries, especially in the sub-regions most affected by conflict. They asserted that the concentration of poor immunisation coverage and disease outbreaks in conflict-displaced populations reinforces the notion that there is an intertwining of political and health security agendas. Their study showed that conflict affects immunisation in several ways, including human resources availability, retention, competency, and distribution.

(Ngo, et al., 2020) reported that in Cote D'Ivoire – a country that has been divided between the rebel-held north and the government-controlled south – many HCW have fled the north. Conflict also leads to the destruction of health-care facilities, disruption of vaccine cold chain management, crippling of the healthcare system, killing of health-care personnel, obstruction of humanitarian access, poor hygiene and nutritional status, and displacement of people internally, into the bushes and across borders.

In Cameroon, attacks on medical facilities and health workers were recorded in the conflict in the northwest and southwest regions of the country. Sixty-three hospitals were deliberately attacked or occupied by fighting groups; ambulances were destroyed, patients or victims taken away, and summarily executed, health workers were threatened, abducted, subjected to violence, or killed. By 2020, over sixty-one attacks on health-care facilities and thirty-nine against medical professionals had been documented.

While effective delivery of immunisation services to populations in these settings may be fraught with varied levels of risk, experiences in several geographical settings indicate that, with a good understanding of the nuances of the conflict and a great deal of operational flexibility, reaching and immunising eligible populations in these settings may continue to be operationally viable (Nnandi, et al., 2017).

Most countries describe a mix of strategies for service delivery in conflict-affected areas including campaign and outreach services, supported by civil society partnerships and volunteer networks that are tailored to local security conditions. Lessons from Nigeria and Somalia illustrate effective operational tactics such as: negotiating secure physical access, engaging local communities, collaboration with military or other security personnel, and coordinating humanitarian aid deliveries, transit or cross-border vaccination strategy (Ngo, et al., 2020). Other tactics successfully employed in the polio eradication strategy include use of geographic information systems technology to assess population sizes and locations in conflict zones, and flexibility around vaccine scheduling and dosing options. Advocacy with local traditional and religious leaders, information sharing with communities, training of local residents as vaccinators, and building community mobilisation networks with support from community "gatekeepers" may help shed light on the felt needs of the communities and build trust between the community and the programme (Nnandi, et al., 2017).

In Somalia, negotiated cessation of conflicts between armed parties allowed physical access to populations in conflict settings, with a number of vaccination rounds and polio surveillance conducted during the ensuing period. In northern Nigeria, the Volunteer Community Mobiliser programme – a focused initiative that recruits and trains local community women as social mobilisers and vaccination workers – is considered to have bolstered participation in house-to-house polio and other routine immunisation programs, especially in security-compromised and hard-to-reach communities.

In the Central African Republic, use of 'low-tech' vaccination systems have been successfully used. Vaccines are being mainly stored in kerosene fridges to maintain the cold chain, and

healthcare workers travel by foot, on bicycles, or in wooden canoes to reach the children in the furthest parts of the country for home visits to deliver vaccines, which they carry in cooler boxes (UNICEF Connect, 2015).

Prioritising flexibility around age and other eligibility criteria for receiving the vaccines is a key strategy used in conflict-affected Borno and Yobe states of Nigeria. Additionally, in the face of potential supply shortages, the use of fractional-dose vaccines in these settings may be key to improving coverage (Nnandi, et al., 2017). Opportunistic vaccination during days of tranquillity, establishing barrier vaccination zones, strengthening vaccination activities at transit and border-crossing sites, and vaccinating at camps for refugees and internally displaced persons and other sites of mass gathering through "hit and run," has been used during conflicts in the Democratic Republic of the Congo, Southern Sudan, Angola, and Nigeria. (Peyraud, et al., 2018) report that in a chronic humanitarian emergency in the Central African Republic, preventive multi-antigen vaccination campaigns resulted in a substantial and rapid increase in vaccine coverage after three vaccination rounds. Conversely, (Nnandi, et al., 2017) reported that public trepidation and reluctance to use health services delivered by foreign agencies presented as a common barrier accounting for lower-than expected coverage of some interventions. In the Lake Chad region, efforts have been made to integrate nutritional assessments and interventions with polio vaccination (Nnandi, et al., 2017) .

Beside armed conflict, there are other humanitarian emergency-spurring events that result in mass population movements, such as: sudden deterioration of nutritional status, natural or industrial disasters, and/or sudden breakdown of critical administrative and management functions. These events result in large-scale disruption of public health and related services (WHO, 2017)

Migrant communities are more susceptible to challenges of accessing vaccination services associated with health policies, organisation of health systems, legal and financial restrictions (Rechel, et al., 2011). (Antai, 2011) conducted a quantitative study in Nigeria to assess the individual and community level explanatory factors related to low childhood vaccinations rates in migrants and non-migrants. Due to migrant mothers likely to give birth at home as opposed to a hospital to avoid confrontation regarding legal documentation, the study found vaccination coverage to be low for children whose mothers did not receive prenatal care and those who were delivered at home. Some of the foregoing strategies for immunisation of displaced populations – such as border crossing vaccination, prioritising flexibility around age and other eligibility criteria, vaccination at refugee camps, and mass campaigns – are applicable in these cases as well (WHO, 2017).

(Meteke, et al., 2020), in their systematic review on delivering infectious disease interventions to women and children in conflict settings, identified a gap where strategies focus on those who manage to reach refugee camps during conflicts with less attention to those in the bushes and those who escape into other cities or countries unrecorded. Their study identified an urgent need for the expansion of vaccination coverage during conflicts to include non-camp populations. They also emphasised the need for health actors to educate those around them while maintaining the perception of their impartiality and neutrality.

3.5.3.2 Immunisation in pandemic situations

Disease pandemics disrupt health service provision and can lead to a decline in immunisation coverage as evidenced in Liberia and Guinea where, due to an Ebola outbreak, there was a sharp decline of more than 25% in the monthly number of children vaccinated against measles in 2014 and 2015 as compared to the previous years (Masresha B. G., et al., 2020). Even after the outbreak and conducting of mass immunisation campaigns, immunisation coverage figures continued to decline or stagnate (Delamou, et al., 2017).

In the case of the 2020 COVID-19 global pandemic, the indirect costs of the pandemic, related to the measures implemented to deal with the spread of the virus, such as lockdowns and social distancing were predicted to negatively impact immunisation coverage in Africa due to its weak health systems and shown to have resulted in a 50–80% drop in vaccination in 2020 compared to the previous year in rural Sierra Leone, despite continued service delivery operations at health facilities (Adamu, Jalo, Habonimana, & Wiysonge, 2020) (Danilo, Bianca, Ngaima, & Francesco, 2020). A modelling study by (Abbas, et al., 2020) found that the deaths prevented by sustaining routine childhood immunisation in Africa outweigh the excess risk of COVID-19 deaths associated with vaccination clinic visits, especially for the vaccinated children.

The justified need to continue with routine immunisation during the pandemic has called for development of standard operating procedures to minimise risk of COVID-19 transmission during routine immunisation visits. WHO issued guidelines that called for the maintenance of immunisation services while keeping the following in mind: local mandates for physical distancing and health system context, the local burden of VPDs, and the status and anticipated status of local COVID-19 transmission.Where health system capacity was intact and essential health services operational (for example adequate human resources, adequate vaccine supply), WHO recommended that fixed site immunisation services and VPD surveillance should be executed, while maintaining physical distancing measures and appropriate infection control precautions (WHO, 2020b).

NITAGs were considered critical in contextualising the global WHO recommendations, and the NITAGs in South Africa and Zimbabwe issued guidance documents for short- and medium-term country implementation (NITAG Resource Center, 2020). (Adamu, Jalo, Habonimana, & Wiysonge, 2020) using a causal loop approach, demonstrated the multifaceted impact of increased COVID-19 infections on immunisation in Africa, showing that there would be a decrease in the number of health workers that would be available to provide routine immunisation services as they would be redeployed to COVID-19-related tasks. Similarly, it would decrease available health facilities, as hospital and clinics would be converted to COVID-19 treatment and isolation centres. In addition, immunisation funding would reduce, as funds were diverted to the COVID-19 response. All of these would contribute to a decrease in the availability of immunisation services. The study thus recommends the use of systems thinking and implementation science concepts to support immunisation system redesign to adjust to the pressures of COVID-19 by accelerating the uptake and utilisation of multifaceted evidence-based strategies in policy and practice. Examples cited include use of personal protective equipment to protect health workers from infection; ensuring critical consideration of context in COVID-19-related policies, such as a special transportation scheme to improve the mobility of health workers; and permitting caregivers seeking immunisation services to use identifiers, such as child health cards at roadblocks during lockdown (Adamu, I., Habonimana, & Wiysonge, 2020).

Pandemics and epidemics are also driving the invention and development of new vaccines at much faster rates, increasing hesitancy because of the dangers – whether real or perceived – of a fast-tracked vaccine. (Bunch, 2021).

3.5.4 Conclusions on Political Ownership

1. The immunisation programme in SSA is still largely dependent on external funding for its operations, putting the programme in a risky and unsustainable position. While there has been an overall positive trend in national government commitments in taking on greater ownership for immunisation financing, translating this into practice has not been uniformly realised. Of particular concern is financing for newly introduced vaccines, that have been observed as the biggest cost driver for incremental immunisation financing needs in the region.

2. Civil Society Organisations are key interlocutors in facilitating ownership at the national level by holding governments accountable to their mandates, and at the community level by fostering participatory inclusion and accountability of sub-national governments and the populace.
3. SSA has been historically vulnerable to disruptive environmental forces such as political and civil unrest, natural disasters, and disease outbreaks resulting in armed conflicts, mass population movements, flooding, droughts, famines, and humanitarian emergencies. These negative environmental events are disruptive to the region's fragile health systems and especially to the highly sensitive immunisation programme, putting the region at a risk of vaccine-preventable disease outbreaks and loss of immunisation gains already made.

3.5.5 Recommendations on political ownership

4. National governments, being held accountable by regional bodies and national institutions such as the African Union and National Parliaments, should act upon financing commitments made in the Addis Declaration on Immunisation to gradually and impactfully increase their budgetary allocations to immunisation and provide the requisite oversight to the transparent and equitable use of funds provided.
5. National and sub-national immunisation programme managers, with the support of Civil Society Organisations, should provide the enabling financing advocacy and decision support frameworks required by decision-makers. They can do this by developing and making available clear and timely planning, budgeting, and accounting documents; making use of standard tools such as country multi-year plans that outline the country's contextual priorities; as well as demonstrating value for money invested in the immunisation programme.
6. National political leaders should be cognisant of the inevitable intertwining of political and health security agendas and should thus ensure peaceful and secure communities through application of democratic principles of governance and equitable share of national resources. This will minimise incidents of conflict, which have significant negative impacts on the immunisation programme. In cases of humanitarian emergencies, lessons learned from the region to ensure continued vaccination of children should be applied.
7. The Africa Centres for Disease Control and Prevention should provide evidence-based technical tools and measures that can be adapted to ensure that the contextual dynamics in individual African countries are taken into account in all disease pandemic mitigation responses in order to minimise adverse effects on healthcare programmes including immunisation.

3.6 Overarching conclusions and recommendations

SSA is predominated by countries categorised as low-income, a rapidly growing population with low levels of education, a significant burden of displaced persons, and a weak healthcare system. Still, some recognisable progress has been made thanks to the concerted efforts of immunisation stakeholders ranging from technical staff at all levels of government, researchers, civil society organisations, and development partners. Based on the region's demographic challenges, it comes as no surprise that the root causes of low coverage and under-immunisation are summarised under deficiencies in knowledge, shortage of trust, and difficulties in accessing reliable immunisation services. The identified strategies to address these challenges (including increasing access to accurate information, building trust, and removing barriers to accessing reliable immunisation services) centre on national political commitment and ownership of the immunisation programme. Whilst the study identified some significant shortages in empirical research evidence, particularly in the area of effectiveness of strategies deployed to respond to identified root causes for low coverage and under-immunisation in SSA, the lack of such evidence should not be used as a defence for inaction. Where contextualised anecdotal evidence exists, this should continue to inform decision makers as researchers conduct more systematic studies that will inform scaling initiatives.

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ANNEXURES

Annex 1: List of committee members with short biographies

1. **Prof Shabir Madhi (South Africa), Co-chair**
   Prof Madhi is Professor of Vaccinology at the University of the Witwatersrand, the Director of the South African Medical Research Council's (SAMRC) Respiratory and Meningeal Pathogens Research Unit (RMPRU), Chairperson of the South African National Advisory Group on Immunisation (NAGI) and member of SAGE (since 2019). He is the former Executive Director of the National Institute for Communicable Diseases (NICD). He is a Member of the Academy of Science of South Africa (MASSAf).

2. **Prof Harriet Mayanja-Kizza (Uganda), Co-Chair**
   Prof Mayanja-Kizza is the Dean of the School of Medicine at Makerere University, Uganda and an Honorary Lecturer at Case Western Reserve University, Cleveland, Ohio, USA. (Adjunct appointment). She is a World Health Organisation Advisor in TB and HIV immunopathogenesis. Prof Harriet Mayanja-Kizza is a Fellow of Uganda National Academy of Sciences.

3. **Prof Richard Adegbola (Nigeria)**
   Prof Adegbola is a Consultant and a Research Professor at the Department of Microbiology at the Nigerian Institute of Medical Research, Lagos, Nigeria. He previously worked for GlaxoSmithKline Vaccines as Global Director, Scientific Affairs & Public Health and for the Bill & Melinda Gates Foundation, USA. He was a member of the WHO's Meningitis Vaccine Project Advisory Group. He is a Fellow of the Nigerian Academy of Science (FAS).

4. **Dr Juliet Kiguli (Uganda)**
   Dr Kiguli is a Senior Lecturer, at the Department of Community Health and Behavioral Sciences at the College of Health Sciences, Makerere University, Uganda. She is an anthropologist and gender analyst, teaching and carrying out community-based research and is also a consultant on several bilateral and multilateral projects in gender, culture and health. Her work explores major debates in gender, power and cultural modernity, policy, social theory, contemporary anthropology and health.

5. **Dr Annet Kisakye (Uganda)**
   Dr Kisakye is the EPI team leader at the WHO Uganda office, and she is also the WHO liaison representative on the Uganda National Immunisation Technical Advisory Group (UNITAG). She also provides technical support to the Ministry of Heath/UNEPI and provides management, supervision and coordination within the WHO country office immunisation unit, including external counterparts from the unit at IST, AFRO, HQ and MOH.

6. **Prof Sileshi Lulseged Desta (Ethiopia)**
   Prof Lulseged is Professor of Paediatrics and Child Health at Addis Ababa University and Senior Associate Research Scientist at Columbia University's Mailman School of Public

Health, New York, USA. He is also Senior Advisor at ICAP Columbia University Program in Ethiopia. He has previously served as Head of the Department of Paediatrics and Child Health and Director of Clinical Epidemiology Service at Addis Ababa University.

7. **Dr Helene Mambu-Ma-Disu (Democratic Republic of Congo)**
   Dr Helene Mambu-Ma-Disu is currently a Senior Programme Officer for the Sustainable Immunisation Financing Programme of the Sabin Vaccine Institute, for whom she co-ordinates field activities in Democratic Republic of the Congo, Republic of the Congo and Madagascar. She served as a Regional Adviser for the African regional office of the WHO and was a WHO Resident Representative in several countries in the region, before retiring in 2008.

8. **Prof Jeffrey Mphahlele (South Africa)**
   Prof Mphahlele is the Vice-President of the South African Medical Research Council (SAMRC). He is also the former Head of the Department of Virology, former co-director of the SAMRC's Diarrhoeal Pathogens Research Unit and co-founder of the South African Vaccination and Immunisation Centre (SAVIC) at Sefako Makgatho Health Sciences University. He is a member of the National Advisory Group on Immunisation (NAGI) as well as Member of the Academy of Science of South Africa (MASSAf).

9. **Ms Diana Kizza Mugenzi (Uganda)**
   Ms Diana Kizza Mugenzi is a Senior Programme Manager for the Sustainable Health Financing Programme at the Clinton Health Access Initiative (CHAI). Currently, she coordinates and provides strategic oversight for the CHAI SIDA-funded project for the identification and implementation of more cost-effective approaches to universal healthcare delivery at all tiers of eSwatini's health system. She previously worked as an ODI Fellow with the Rwanda Ministry of Health.

10. **Prof Helen Rees (South Africa)**
    Prof Rees is the founder and Executive Director of the Wits Reproductive Health and HIV Institute (WRHI), South Africa. She is an ad hominem Professor of Obstetrics and Gynaecology at the University of Witwatersrand, South Africa and an Honorary Professor at the London School of Hygiene and Tropical Medicine. She is a former chair of the WHO Strategic Advisory Group of Experts on Immunisation. She is a Member of the Academy of Science of South Africa (MASSAf).

11. **Prof Charles Shey Wiysonge (Cameroon and South Africa)**
    Prof Charles Shey Wiysonge is the Director of the South African Cochrane Centre at the SAMRC and a Professor at both Stellenbosch University and the University of Cape Town in South Africa. He is a former member of the WHO Strategic Advisory Group of Experts on Immunisation and the Gavi Independent Review Committee. He is a member of the WHO Measuring Behavioural and Social Drivers of Vaccination Working Group and a Member of the Academy of Science of South Africa (MASSAf).

Annex 2: Symposium Programme (South Africa, 30-31 July 2018)

Root Causes of Low Coverage and Under-Immunisation in sub-Saharan Africa

HOSTED BY: ASSAf at Crowne Plaza Hotel, Johannesburg, South Africa

DAY ONE: 30 JULY 2018	
09:00 – 10:00	**Registration with tea/coffee**
Session One: Opening Session and Setting the Scene **Facilitator: Professor Helen Rees - *Wits Reproductive Health and HIV Institute & WHO Regional Immunisation Technical Advisory Group***	
10:00 – 10:15	**Opening and Welcome Remarks** **Prof Himla Soodyal**l, General Secretary: Academy of Science of South Africa Council **Mr Christian Acemah**, Executive Secretary: Uganda National Academy of Sciences (UNAS)
10:15 – 10:30	**Purpose of the Symposium and the Consensus Study** **Prof Shabir Madhi** (South Africa), Prof Harriet Mayanja-Kizza (Uganda), Study Co-Chairs
10:30 – 11:00	**Keynote: Country Ownership of Immunisation in Southern Africa** **Dr Nonhlanhla Dlamini**, Chief Director: Child & Youth, National Department of Health (South Africa)
11:00 – 11:30	**Interactive Question and Answer Session**
11:30 – 12:00	**HEALTH BREAK**
12:00 – 12:30	**Keynote: Vaccine Strategies, Policies & Access to Immunisation in sub-Saharan Africa** **Dr Richard Mihigo**, Regional Advisor: Immunisation and Vaccine Development Programme, World Health Organisation AFRO Region
12:30 – 13:00	**Interactive Question and Answer Session**
13:00 – 14:00	**LUNCH**
Session Two: Challenges to Vaccine Delivery and Immunisation Coverage **Facilitator: Dr Annet Kisakye, World Health Organisation** ***Presentations (20 minutes per speaker)***	
14:00 – 14:20	**United Nations Children's Fund (UNICEF)** **Dr Mariame Sylla**, Chief for Health and Nutrition: UNICEF (South Africa)
14:20 – 14:40	**WHO Regional Immunisation Technical Advisory Group (RITAG)** **Prof Helen Rees**, Chair: WHO RITAG
14:40 – 15:00	**Immunisation Implementation Research** **Prof Charles Shey Wiysonge**, Director: Cochrane South Africa
15:00 – 15:30	**Discussion**
15:30 – 15:50	**HEALTH BREAK**
15:50 – 16:10	**Creating an Enabling Legal Environment for Immunisation through the Uganda Immunisation Law** **Ms Dianna Kizza Mugenzi**, Clinton Health Access Initiative (eSwatini)
16:10 – 16:30	**Socio-Cultural Aspects** **Dr Joan Awunyo-Akaba**, Executive Director: Future Generations International (Ghana)

16:30 – 16:50	**Vaccine Hesitancy** **Prof Rose Burnett**, Sefako Makgatho Health Sciences University (South Africa)
16:50 – 17:20	**Discussion**
17:20 – 17:30	**WRAP-UP & CLOSURE FOR DAY ONE**
DAY TWO: 31 JULY 2018	
09:00 – 09:30	**Arrival tea/coffee**
Session Three: Effective Interventions and Opportunities **Facilitators: Professor Shabir Madhi & Professor Harriet Mayanja-Kizza** ***Presentations (20 minutes per speaker)***	
09:30 – 09:50	Poverty and Inequity (including rural vs urban disparities and displaced communities) Mr Thulani Matsebula,Senior Health Economist: World Bank (South Africa)
09:50 – 10:00	**Discussion**
10:00 – 11:00	**Key Effective Interventions** **1. Health Information Systems** **Dr Vincent Shaw**, Executive Director: Health Information Systems Programme (Namibia & South Africa) **2. Business Engagement** **Mr Neren Rau**, Director for External Affairs, Public Policy & Communications: Merck Sharp and Dohme (South Africa) **3. African Vaccine Production** **Dr Morena Makhoana**, Chief Executive Officer: Biovac Institute (South Africa)
11:00 – 11:50	**Discussion**
11:50 – 12:20	**BREAK**
12:20 – 12:40	**Role of the Media and Communications** **Ms Mia Malan**, Executive Director: Mail and Guardian's Bhekisisa (South Africa)
12:40 – 13:20	**Overarching Facilitated Discussion & Wrap-up**
13:20 – 13:30	**Closing Remarks: ASSAf & UNAS**
13:30 -15:00	**LUNCH & DEPARTURE**

Annex 3: Symposium Programme (Uganda, 27-28 February 2019)

DAY ONE: 27 February 2019	
08:00 – 09:00	**Arrival and Registration**
Session One - Opening and Setting the Scene **Moderator: Sarah Kiguli, Fellow, Uganda National Academy of Sciences (Uganda)**	
09:00 – 09:15	**Opening and Welcome Remarks** **Nelson Sewankambo**, President, Uganda National Academy of Sciences (UNAS) **Himla Soodyall**, Executive Officer: Academy of Science of South Africa (ASSAf)
09:15 – 09:30	**Purpose of the Symposium and the Consensus Study** **Harriet Mayanja-Kizza** (Uganda), Study Co-Chair
09:30 – 10:00	Keynote Address: Owning our Immunisation Systems Jane Ruth Aceng, Minister of Health, Uganda
10:00 – 10:30	**Interactive Question and Answer Session**
10:30 – 11:00	**HEALTH BREAK**
11:00 – 11:30	**Keynote Address: End of Decade of Vaccines; Which way Africa?** **Hon Huda Oleru** WHO/SAGE DoV Working Group Expert Member
11:30 – 12:00	Interactive Question and Answer Session
12:00 – 12:30	**Keynote Address: Civil Society Organisations in Immunisation Systems** **Emmanuel Mugisha**, Country Director, PATH Uganda Office
12:30 – 13:00	**Interactive Question and Answer Session**
13:00 – 14:00	**LUNCH**
Session Two: Drivers of Success in Vaccine Delivery **Moderator: Grace Ndeezi, Fellow, Uganda National Academy of Sciences (Uganda)** ***Presentations (20 minutes per speaker)***	
14:00 – 14:20	**Lessons from Development Partners, United Nations Children's Fund (UNICEF)** **Viorica Berdaga**, Chief of Health, UNICEF Uganda
14:20 – 14:40	**Lessons from West Africa** **Issa Ouedraogo**, EPI Manager, Burkina Faso
14:40 – 15:00	**Lessons from Southern Africa** **Joan Marembo**, EPI Manager, Zimbabwe
15:00 – 15:30	**Interactive Discussion**
15:30 – 16:00	**HEALTH BREAK**
Session Three: Challenges in Immunisation Systems in Different Economic Conditions **Moderator: Diana Kizza Mugenzi, Clinton Health Access Initiative (Kingdom of Eswatini)**	
16:00 – 16:20	**View from Uganda** **Alfred Driwale**, EPI Manager, Uganda
16:20 – 16:40	**Interactive Discussion**
16:40 – 17:00	**WRAP UP FOR DAY ONE**

DAY TWO: 28 February 2019	
09:00 – 09:00	**Arrival and Registration**
Session Four: Vaccines Industry, Leveraging Lessons Learned for Sustained Success **Moderator: Annet Kisakye, World Health Organization Uganda** ***Presentations (20 minutes per speaker)***	
09:00 – 09:20	Developing the National Vaccine Industry Oyewale Tomori, Chairman, Biovaccines, Nigeria
09:20 – 09:40	The Global Vaccine Industry in Sub-Saharan Africa Nekoye Otsyula, GSK, Medical Manager - Vaccines, Kenya and East Africa
09:40 – 10:00	**Discussion**
Session Five: Stakeholder's Talking Point– Creating Solutions Together **Moderator: Jeffrey Mphahlele, Medical Research Council (South Africa)**	
10:00 – 10:30	**BREAK**
10:30 – 12:00	**Presentations (20 Mins per Speaker, with 10 mins Q and A)** **Health Workers in Immunisation** **Ombeva Malande**, Director East African Center for Vaccines and Immunisation (Kenya) **Immunisation Hesitant Communities** **Alima Essoh**, Director, Agence Medicine Preventive AMP (Cote d'Ivoire)
12:00– 12:30	**Overarching Facilitated Discussion & Wrap-up** **Harriet Mayanja-Kizza** (Uganda), Study Co-Chair
12:30 – 13:00	**Closing Remarks** **Himla Soodyall**, Executive Officer: Academy of Science of South Africa (ASSAf) **Nelson Sewankambo**, President: Uganda National Academy of Sciences (UNAS)
13:00 -14:00	**LUNCH & DEPARTURE**

PO Box 72135, Lynnwood Ridge 0040
Pretoria, South Africa

Tel: +27 12 349 6600
Fax: +27 86 576 9520

Email: admin@assaf.org.za