Strengthening Immunity, Saving Lives:

A Literature Review on Childhood Immunisation in Papua New Guinea

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Strengthening Immunity, Saving Lives: A Literature Review on Childhood Immunisation in Papua New Guinea

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

By

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Declaration:

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Contents

Abbreviations

BCG Bacillus Calmette-Guerin

CHW Community Health Workers

DPT Diphtheria, Pertussis and Tetanus vaccine

DFAT Department of Foreign Affairs and Trade

EPI Expanded Program on Immunization

GAVI Global Alliance for Vaccines and Immunisation

GDP Gross Domestic Product

GVAP Global Vaccine Action Plan

HEO Health Extension Officers

HMIS Health Management Information System

IPV Injectable Polio vaccine

LMICs Low-and-Middle-Income Countries

MO Medical Officer

MMR Maternal Mortality Ratio

MSF Médecins Sans Frontières (Doctors without Borders)

NDoH National Department of Health

NHIS National Health Information System

NGO Non-Government Organisation

NSO PNG National Statistical Office

PHC Primary Health Care

RED Reaching Every District

SBA Skilled Birth Attendant

SIA Supplemental Immunisation Activity

UHC Universal Health Coverage

UNFPA United Nations Population Fund

UNICEF United Nations Children's Fund

VPDs Vaccine Preventable Diseases

WHO World Health organization

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Abstract

Vaccines are the most cost-efficient and effective intervention for preventing childhood morbidity and mortality throughout the world. Routine childhood immunisation rates in Papua New Guinea (PNG) are currently declining. This literature review aims to understand the reasons behind the falling vaccine uptake and explore strategies to improve coverage.

Methods
A literature review of the determinants of childhood immunisation coverage in PNG was undertaken and applied to a modified version of a vaccine coverage framework, developed by Phillips et al.

Results
The review identified numerous barriers to achieving high vaccination rates, including limited community access, facility readiness, weak governance, and poor data management

Discussion
While the national vaccination rate remains at 35.3%, clear disparities exist among regions. Inadequate healthcare access and a shortage of personnel significantly affect immunisation efforts. Poverty and gender inequity further impede vaccination progress. Poor governance, limited data capacity, and vulnerability to natural disasters compound these issues. Actions yielding multiple benefits, such as augmenting resources for skilled birth attendants, have the potential to boost maternal and child immunisation rates. Investing in road infrastructure will propel healthcare, education, and overall development. Strengthening collaboration between the National Health Department and provincial governments is pivotal for implementing effective healthcare strategies. The findings additionally highlight the importance of seeking external assistance in comprehensive population data collection, greatly facilitating future resource planning.

Conclusion
To improve vaccination rates in PNG, a multi-faceted approach is crucial. Addressing these key areas will lead to significant progress in PNG's vaccination rates and overall healthcare system.

Keywords

Papua New Guinea, barriers, childhood immunisation, vaccination, decentralisation, poverty, inequality

Word count

13,198

Glossary

TERMINOLOGIES ARE BASED OF WHO DEFINITIONS[1]

ACCESS: "Is the ability of children to easily access immunisation services to get all required doses as per the national policy."

COLD CHAIN: "is a process that aims to ensure that vaccines are properly stored and transported at the appropriate temperatures for their intended use."

COVERAGE: "It is the percentage of children who obtain one or more vaccines in relation to the eligible population"

EXPANDED PROGRAMME ON IMMUNISATION (EPI): "EPI is the program started by WHO in 1974 to support countries worldwide in their vaccination programs".

IMMUNISATION: "The process of being made immune or resistant to an infectious disease, typically by administering a vaccine. It implies that you have had an immune response."

SUPPLEMENTARY IMMUNISATION ACTIVITY (SAI)," refers to vaccination campaigns or initiatives that are conducted in addition to routine immunisation services"

VACCINATION: "The physical act of administering any vaccine or toxoid"

VACCINE: "A suspension of live (usually attenuated) or inactivated microorganisms (e.g., bacteria or viruses) or fractions thereof administered to induce immunity and prevent infectious diseases and their sequelae."

VACCINE-PREVENTABLE DISEASES (VPD): "infectious diseases caused by viruses or bacteria that can be prevented with vaccines."

INTRODUCTION AND PERSONAL STATEMENT

Growing up in Australia, I perceived our nation as a geographically isolated island situated in the southernmost corner of the world. Our education emphasised the significance of fostering relationships with neighbouring countries, particularly with Papua New Guinea (PNG), given its proximity to us, with just a few kilometres separating the two. This proximity fostered a shared environment and fauna and facilitated longstanding trade agreements between our countries. During my schooling, my interest in PNG and its surrounding regions was piqued through various research projects. Furthermore, the frequent visits of PNG exchange students to our senior school highlighted the numerous cultural similarities we possessed. Our shared love for the nature, footy, and seafood has connected our cultures over the years.

Before embarking on my Master's degree in International Health, I admittedly took my childhood immunisation for granted, giving little consideration to the intricacies of health systems and the sociocultural complexities associated with immunisation programs. However, while working as a pre-hospital emergency clinician in remote areas of Australia, I directly witnessed the persistent challenges that rural healthcare encounters. It was during this time that I developed a deep appreciation for the profound impact of vaccines, which stand as one of the most efficacious health interventions resulting from medical advancements.

Upon completion of my Master's program, my aspiration is to contribute to vaccination programs in the Western Pacific region, with the overarching goal of diminishing global disparities in vaccine access and equity. This thesis will enable me to better understand the ongoing challenges PNG is facing with immunisation programs.

To gain a thorough understanding of the factors influencing vaccination in PNG, it is crucial to outline a comprehensive background of the country and its health system network, as these elements are intrinsically interconnected. This thesis aims to deliver an all-encompassing overview of the current situation in PNG, with a specific focus on its complex health system and the ongoing immunisation program. The study will describe the methodology used for the literature review and present the findings. Moreover, a thorough evaluation of the results will be undertaken, leading to recommendations focused towards improving the existing immunisation programs.

1 OVERVIEW OF PAPUA NEW GUINEA

Papua New Guinea is an archipelagic nation in the southwestern region of the Pacific Ocean. The country consists of more than 600 islands, approximately 400 of which are inhabited. It is classified into four main geographic regions with large areas of the country only being accessible by foot, boat, or air.[2] PNG is administratively divided into four regions, as shown in figure one, 22 provinces, 89 districts, and a total of 318 rural Local-Level Governments (LLGs), along with 31 urban LLGs. The county gained independence from Australia in 1975 and is now a member of the United Nations, the Commonwealth, and the Pacific Islands Forum. The country operates under a parliamentary democracy, following the Westminster model.[3] Throughout its history, the government has faced instability, primarily due to no single party securing enough seats to attain an absolute majority.

In 1995, a decentralisation of governance for services took place, facilitated by the Organic Law on Provincial Governments and LLGs.[4] Additionally, the National Health Administration Act of 1997 paved the way for the establishment of a National Health Plan, National Health Board, Provincial Health Boards, and the approval of National Health Service Standards. Provincial and district governments play a crucial role in the delivery of health-care services.[3,5] This decentralisation has granted communities greater control over managing their healthcare needs but has also presented significant challenges. In 2022, PNG ranked 155 out of 189 countries and territories in the Human Index Development.[3]

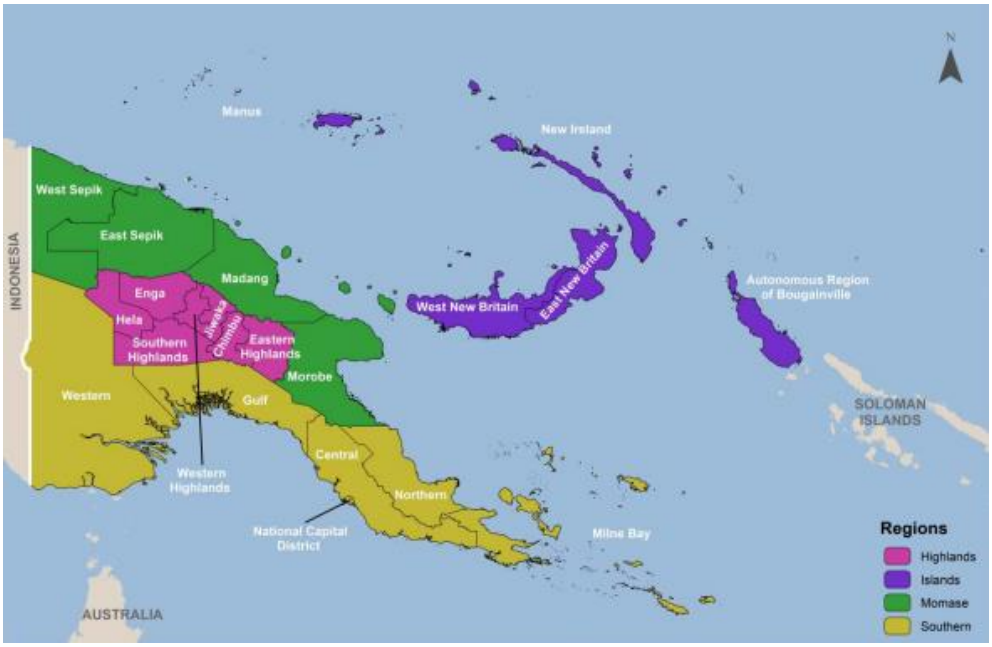

Figure 1: PNG's four regions [6]

1.1 Population

As per PNG's National Data of Statistics, the current estimated population of the country is nine million people, though the world bank predicts the population to be closer to 10 million.[7] However, whilst poverty remains, the average life expectancy has increased since 2000 from 62 to 65 years as a national average. The current population growth is at 3.1% as stated by the UNFPA. The last formal population data collection was in 2011. A national census is undertaken every ten years with the 2021 census deferred to 2024 due to the COVID pandemic. [8] The publication of the results for the

previous census in 2011 was delayed until 2014 due to a lack of capacity to carry out the analysis. PNG is currently seeing a predominant number of individuals under 25 years of age within the population. This is creating a large strain on infrastructure and delivery of public services such as health and education. A specific example provided by the UNFPA is that some children, particularly in rural areas are unable to attend school as there is no infrastructure to cater for them, creating a barrier to primary education.[9] The National Socio-Demographic and Economic Survey undertaken in 2022 with the technical assistance of the UNFPA and financial assistance from the Australian government, found that 56% of individuals living in PNG are under 25.[10] Other key findings from this report noted that 24.3% migrated from one district to another, 35% of households have no handwashing facility, yet 71% of households have a mobile phone. Between 75-80 % of the population lives in rural areas, but due to limited employment, education and poor access to services migration to urban areas is increasing.[11]

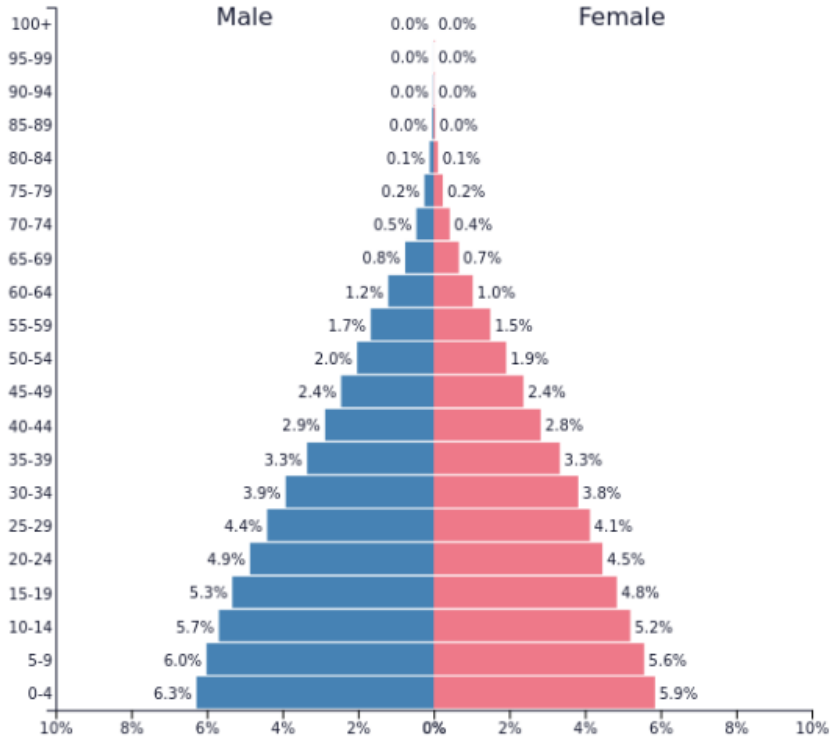

Figure 2: PNGs population Data from 2016-2018 DHS [6]

1.2 Literacy Rate

The 2022 PNGs National Review predicts average literacy rates to be around 61.6 %. English is widely spoken throughout the country, and approximately 800 languages are spoken within PNG. Urban literacy rates are significantly increased in comparison to rural.

Education has been fee-free since 2012 as part of a Basic Universal Education plan to address poor school attendance rates.[9] Within the school-age children population, particularly girl adolescents have lower chances of remaining in school. Contributing factors are the lack of sanitation facilities in schools, household obligations, and the lower value of women within PNG.[12]

1.3 Gender

Gender inequalities are significant within PNG, and gender roles are strong in society with men being the key decision-makers and women responsible for childcare and cooking.[13] In the 2021 UN Human Development Reports, PNG ranks 169 out of 191 countries in the Gender Inequality Index[14] On review of the Sustainable Developmental Goals, The PNG government reflected by stating “The stereotypical gendered roles in domestic duties along with poor access to health and education, employment and political representation limits the opportunity of women to be effectively involved in [their own development and] decision-making ”[15] In 2020 no parliamentary seats were held by women, approximately 10% of women reached secondary education as opposed to 15% of males. The adolescent birth rate is currently 52.7 births per 1000 women under 15.

Gender equality and strengthening programs have previously been implemented with little success. While legal measures have been established to protect women's rights and recognise acts of violence as criminal offences, the existing justice and law system is inadequate to enforce effective and appropriate sentencing.[16] Gender-based violence is a widespread issue throughout and is acknowledged as endemic problem. The Human Rights Watch report in 2015 stated “that two-thirds of women have experienced some form of physical or sexual violence in their lives.” Multiple reports suggest that improving gender equality will assist in economic strengthening.[17]

1.4 Religion

Christian beliefs coexist harmoniously with traditional beliefs, spirituality, and values, exerting a profound influence when individuals face life-or-death situations. The churches play a crucial role in the provision of health services, effectively managing over 50% of the rural health service network, albeit heavily reliant on financial support from the national government.[18]

The churches' current involvement in service delivery in PNG can be directly attributed to their continuous engagement since the colonial era. They have diligently filled the service gaps in remote areas and assumed governmental responsibilities in instances where the state has faltered due to governance reforms and capacity limitations.[19] Additionally, the churches oversee the operation of six out of the nine nurse training facilities and fourteen training facilities for CHWs in PNG.[20]

1.5 Geography

PNG shares its western border with Indonesia on the island of Papua and its eastern and Southern Ocean borders with Solomon Island and Australia, respectively. Approximately 73% of PNG's landmass is inhabited. The largest landmass, New Guinea, comprises extensive swampy rivers, mountainous terrain with numerous peaks exceeding 4,000 meters, active volcanoes, and rugged coastlines[21]. The region experiences significant variations in annual rainfall, ranging from over 8,000mm, often leading to continuous flooding, to as low as 1,000mm during dry seasons, resulting

in droughts. The mountainous landscape poses challenges for agricultural development due to limited available land.

It is estimated that only 3-5% of the rural roads are fully paved, and many villages are reached by foot only. Port Moresby, the capital is not linked to most of the country, travel between provinces is mostly undertaken by air. The World Bank has previously given credit to PNG to aid with the rehabilitation, upgrading and maintenance of high-priority roads and bridges within the country with the intention of improving access to health and education.[22]

1.6 Civil unrest / Natural disasters

Throughout history, PNG has faced vulnerability to a wide range of natural disasters. In the past 20 years, thousands of individuals have lost their lives due to droughts in areas situated within the 'Pacific Ring of Fire'.[23] Additionally, over one million people have been exposed to the risk of starvation caused by agricultural problems and lack of access to clean drinking water. This has a negative impact on health infrastructure and with education systems and their ability to effectively function.

The impact of natural disasters is most severe for those living in rural and remote areas. Individuals in these areas have limited opportunity to generate income when natural disasters occur as 80% of remote individual's livelihoods rely on agricultural production.[24] Wildfires, major volcanic eruptions and earthquakes have resulted in a loss of houses and infrastructure. Earthquakes are historically well known to PNG and have devastating effects by destroying healthcare posts and hospitals and disrupting the lives of patients and healthcare workers. In 1998, PNG experienced severe devastation caused by tsunamis, leading to the complete destruction of coastal infrastructure, including medical clinics and schools situated in low-lying areas. Furthermore, this catastrophic event resulted in the loss of over 2,000 lives.

1.7 Civil conflict

PNG has seen many outbreaks of civil unrest since its independence, The Bougainville civil war between 1988 and 1998 cost an estimated 20,000 lives before finally navigating a referendum twenty years later despite high levels of reported corruption and violence[25,26]. In 2018 inter-communal fighting broke out in earthquake-affected areas, destruction of healthcare facilities, and medical supplies (including vaccines) were destroyed causing intergovernmental agencies and NGOs to withdraw from areas. In 2021, 30,000 people were displaced by this violence, causing further conflict between resettling populations and host families, regardless of the cultural norms of shared land use.[27]

1.8 Economy

Figure 3: PNG's annual GDP from 1970-2020 [28]

Following independence, PNG took advantage of its natural resources and experienced a significant mining boom, mainly due to the growth of the copper mining sector. However, this period of economic growth was short-lived, and PNG faced significant economic difficulties from 1990 to 2000.[28] Economic development was hindered by weak governance, alleged corruption, political instability and decreasing commodity prices.

Between 1970 and 2020, PNG experienced a series of economic booms and downturns, as shown on figure 3, with intermittent periods of growth followed by a significant decline. This decline can be attributed to the closure of major mining operations, a severe drought, and a major earthquake in 2018.[29]

Today, PNG is classified as a lower middle-income country, the economy is reliant on the natural resources sector with petroleum and mining accounting for one-third of the GDP. In 2023 the World Bank estimates the economic growth rate to be 3.7 per cent. This growth rate has been slowed by the pandemic and is subject to global events.[30]

Translating this into social and economic development, PNG has had ongoing struggles in development since its independence. The slow pace of government development, lack of responsiveness to events, and ineffective utilisation of public expenditure can be attributed, in part, to these factors.

1.9 Poverty

Successive governments have battled with national poverty issues since independence. Whilst the proportion of individuals living in poverty has declined over time, the number of individuals living below the national poverty line was 39% in 2017.[31] This figure has had no significant change in the last ten years, though it is unreliable due to lack of updated demographic data.[15]

Despite assistance from intergovernmental agencies and large global corporations such as the World Bank, there has been very little decline in poverty. In the previous 2018 Social Demographic Household survey, 36% of households were connected to the internet. Of these individuals, access to the internet in rural areas was reduced by 50%. According to the survey, most individuals primary mode of transportation is by foot.[11]

1.10 Health Status of Individuals

Like many other counties in the Western Pacific Region, PNG is facing a triple burden of disease, with rapidly growing non-communicable and communicable diseases and health and living problems due to climate issues as explained in figure 4. High levels of communicable diseases currently dominate such as sexually transmitted diseases, mosquito-borne illnesses, and water-borne diseases such as typhoid are still causing mortality and morbidity throughout the country. PNG has reported cases of measles, yaws, leprosy, and a recent polio outbreak in 2018. Many of these conditions are diseases of poverty.[32] Secondly, there is a growing incidence of non-communicable diseases though-out the country such as diabetes, cardiovascular disease and cancers. These diseases place pressure on the health system as they require frequent, complex and at times expensive treatment.

The impact of globalisation on health has manifested in various ways, including the emergence of pandemics and the heightened prevalence of climate-sensitive diseases like malaria. Furthermore, global changes have resulted in the displacement of individuals residing in low-lying coastal regions.[33]

Over the last 25 years, there have been some noticeable improvements. Life expectancy has risen for both men and women, and there has been a consistent decline in under-five mortality since 1990. As per a World Bank Maternal report, maternal mortality has decreased from 312 to 192 deaths per 100,000 live births.[31] However, the prevalence of childhood stunting remains high at 43%.[3] Despite the ongoing yearly efforts to enhance healthcare, there has been limited headway in this area.

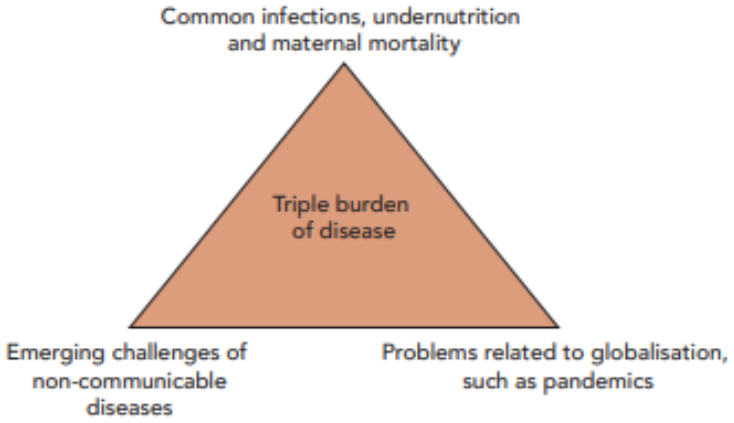

Figure 4: The Triple Burden of Disease in Developing Nations [33]

2 OVERVIEW OF CURRENT HEALTH SYSTEMS NETWORK OF PNG

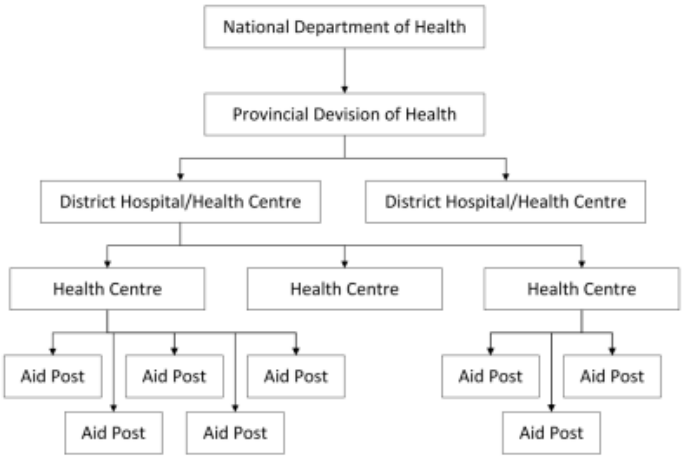

Figure 5: Structure of Papua New Guinea's healthcare system[3]

2.1 Service Delivery

PNG has a decentralised public healthcare model with a national network of 1,800 community-level facilities for a population of 9.4 million and a land mass of 4,628.402km^2. The national government, in conjunction with provincial and local level governments, are responsible for providing primary and secondary health care. Churches play a significant role (50%) in health care delivery and are instrumental in providing rural healthcare services.

The healthcare system is also dependent on medical NGOs and private for-profit organisations. Healthcare services consist of a national referral hospital in Port Moresby, four general hospitals, and 20 provincial hospitals throughout PNG. These hospitals are supported by a network of approximately 500 health centres and urban clinics. Aid posts serve a catchment area of between 500-1500 people within a community. Community Health Workers (CHWs) within these aid posts provide primary healthcare, health promotion, and disease prevention. Health centres serve around 2,000 people and offer public health and curative services. Table 1 refers to the capacity of each level of care provision.

Provincial Hospitals Level 6 & 7	All hospitals are funded by the National Government, specialists are prominently here. (One per province) Port Moresby General Hospital – main referral hospital **Staffing:** 30 Medical Officers (MO) + National specialists 5+ Health Extension Officers, 100–200+ nurses, 70–120 Community Health Workers
District / rural hospitals Level 4 & 5	24-hour emergency care, full basic services- funded by both government and church financing. **Staffing:** 1 MO, 3 HEOs, 9 nurses, 22 CHWs 70,000+ population coverage 2 per province Target population coverage 40,00 to 300,000
Health Centres/ Urban clinic Level 2 & 3	Rural health centres and sub-centres provide management of chronic and acute conditions, antenatal and paediatric care. Funded mostly by the government, smaller (sub-health clinics) are usually funded by the church. **Staffing:** 2 nurses, 5 CHWs 5,000–10,000 population coverage 400–600 inpatients/year 100–150 deliveries/year
Community Health Centre /Aid Post Level 1	70% of healthcare facilities are of aid posts, services such as maternal and childcare, immunisation services, and community-based health promotion. Staffed by community health workers who have undergone a comprehensive two-year training program. **Staffing:** 2 CHWs per clinic Target population 1,000
Outreach services	Responsible for maternal and child health, financed under health centre budget.

Table 1: Levels of Healthcare within PNG

2.2 Health Workforce

In recent years, PNG has been confronting substantial challenges in its healthcare workforce. One critical issue which has emerged is a notable shortage of skilled health workers, particularly in rural regions. The WHO has characterised this situation as deeply concerning and inadequate[31]. Currently, the PNG health workforce is comprised of 52% CHWs and approximately 40% nurses. Surprisingly, despite the majority of Papua New Guinea's population residing in rural areas (87%), only 34% of healthcare workers (HWs) are deployed there, as indicated by Table 1. Consequently, rural regions are facing severe shortages of medical officers and pharmacy professionals.

Despite the significant challenges in PNG's healthcare workforce, noteworthy efforts have been undertaken to tackle the disparities in healthcare distribution. One approach to counteract the scarcity of doctors in rural areas has involved the training and deployment of Health Extension Officers (HEOs) and Community Health Workers (CHWs).[34] These healthcare professionals have received specialised training to cater to the healthcare needs of underserved regions in the country.

Presently, 52% of the total health workforce staff (6801) are engaged in urban areas, including positions at the National Department of Health (NDoH), hospitals, and urban clinics. Conversely, only 48% of the staff reside in rural areas, where 69% are actively involved in direct service delivery.[35]

2.3 Health Information

The PNG integrated health and management information system encompasses four core national data collections, with some operating since the 1990s. The National Health Information System (NHIS) serves as the primary data collection instrument, recording monthly data from every health centre and public hospital in the country. Core inputs to the NHIS include tally sheets, registers, forms, and record books at the health facility level. Monthly summary forms are completed by health centres, subcentres, and public hospitals, sent to their respective provincial offices, and then forwarded to the centralised computer system at the NDoH.[36] Larger hospitals often exhibit poor compliance, leading to delayed or missing data submissions, which, considering their significant contribution to certain data areas, can result in notable data loss—such as underreporting of births from Port Moresby General Hospital. The management information systems primarily rely on the pharmaceutical branch for data, a human resources branch system is being implemented to manage medical supply procurement, warehousing, and distribution.[37] Vaccines are distributed from Port Moresby and directly sent to provincial EPI chain officers, who maintain their distribution records for health facilities.[38]

2.4 Essential medicines

Many concerns have been raised regarding the provincial government’s lack of attention, to funding for health services. This neglect has resulted in disruptions in supply chains, causing healthcare facilities to run out of medicines, supplies and even forced to close.[39] Consequently, this situation has created anxiety and a lack of trust in the healthcare system. Over the past ten years, the healthcare system has struggled to meet the primary health needs of the population. Widespread issues with medicine supply and storage have been reported, with drugs being damaged, expired or not able to be obtained by rural healthcare services.[40]

2.5 Health financing

PNG’s main financer in the health system is government funds from tax-based financing. It supports both governmental and church-based services[3]. Historically, the health budget has remained around

4% of the GDP external assistance NGOs and other governments still provide assistance in approximately 20% of the health expenditure.

10% of the total healthcare expenditure comes from out-of-pocket expenditure. Regional funding originates from three primary sources: own-source revenue, health function grants, and transfers to church health providers (with grants from the NDoH supporting church-run facilities). These funds are allocated to 50 members of parliament for district development programs. Development projects may be executed independently from provincial and district development plans due to external management of funds by NGOs and churches. Consequently, civil servants do not have direct control over these projects.[41]

Government expenditures on health nearly doubled around 2011. The main beneficiaries of these increases were the DOH and hospital services. This came at the expense of the rural health services and public health programs. Inconsistencies in spending and different health funding sources make the implementation of policies and programs such as the EPI difficult.[42] Barriers to an effective financial system include uneven distribution of funds, delayed payments and funds not reaching front-line services. Whilst most provinces have received an increase in funding grants, it is insufficient to cover the minimum costs of a healthcare system in rural parts of PNG.[36]

The government has declared health as a significant development priority. The main goal of the 2011-2020 National Health Plan (NHP) is to enhance primary healthcare services for everyone and to enhance service delivery. The primary strategy of the plan is to go 'back to basics,' which involves revitalising the core elements of the primary health care system. The plan places particular emphasis on enhancing maternal health and child survival, as well as reducing the impact of communicable diseases.[43] This aligns with the long-term goal of UHC with a focus on geographical equity. Long-standing bottlenecks in budget flow have been ongoing issues specifically in the financing of rural healthcare facilities. Additionally, there has been a significant disconnection between funding results and reporting. [3]

In 2020, Human Right Watch reported that corruption is widespread throughout PNG, ranging from petty corruption within the public service to significant allegations involving multiple members of the parliament. In 2018, the government launched an investigation and found nine government ministers including the Prime Minister were failing to comply with proper processes and procedures for a 1.2-billion-dollar loan. In 2019 police charged a government minister with misappropriating USD $944,331, which was set aside for health workers' accommodation. [44] PNG ranks 150th out of 176 countries on the Corruption Perception Index, with a score of 25 out of 100.[31] The index measures the level of corruption, with lower scores indicating higher levels of corruption and higher scores indicating cleaner practises. Numerous independent reports have consistently highlighted corruption as a persistent and ongoing challenges the progression of the healthcare system.[8 45]

2.5.1 User fees

User fees have been a controversial topic for two decades. They are a fee that is charged by health facilities for providing medical care and front-line services.[46] Patients who cannot afford to pay, still receive care and treatment as fees are exempt or reduced. However, the law states facilities should not be charging user fees and that the government should be providing the funding to meet the healthcare facilities requirements of all.[47] Yet throughout rural PNG this has been shown to be ineffective, as many healthcare services have been closed due to lack of funding to supply basic medicines vaccines and pay healthcare workers. Most health care facilities do not submit budget plans and funding allocation between the provinces is generally much lower than the budget. Health facilities which are church run are more likely to receive funding then those operated by the state.[48]

In the past decade, there has been a significant increase in the allocation of national budgets aimed at aiding health facilities in their fundamental operations. However, a substantial portion of this funding is not directly channelled to the facility level where it can be managed by the healthcare workers responsible for delivering services.[49] Instead, the predominant approach for supporting health facilities in service delivery is through administered assistance from funding providers. This entails the procurement of supplies or materials on behalf of health clinics, or the provision of support for health activities and programs.[3] Despite administered support being the prevailing form of assistance, it does not guarantee consistent or adequate support to meet the minimum standards of healthcare.

This initiative by the government to remove user fees was predicted by economic advisors as occurring too soon and facilities were weakened by the changes as the funding was not reliable to support front-line care and healthcare clinics.[50] There was little importance on establishing feasible mechanisms for financing the healthcare facilities and the process was more complex than putting funds into bank accounts and giving facilities access to cash.[37]

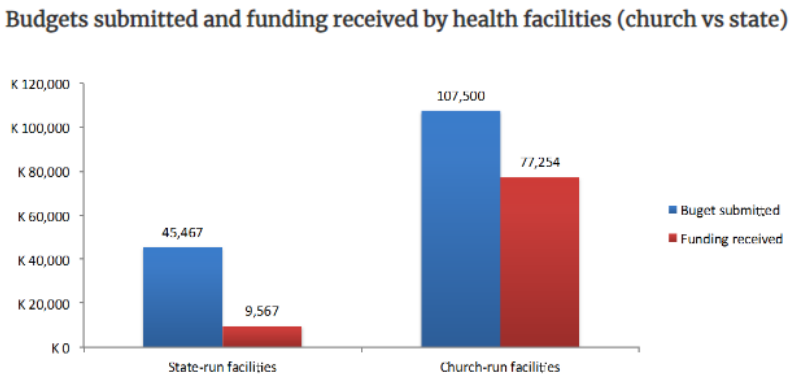

Figure 6: Healthcare facilities 2002-2012 [39]

2.6 Leadership and Governance

The dominant leadership system is the National Department of Health (NDoH), who are responsible for managing provincial hospitals, while local governments oversee all other services, such as health centres, rural hospitals, and aid posts. This arrangement was established in 1997 after the initiation of the National Administration Act, addressing issues such as cost inefficiencies, human resources, and management problems. In 2007, PNG developed a unified health system under the Provincial Health Authorities Act, wherein a single provincial health authority became responsible for both rural hospitals and health services, aiming to achieve a coordinated response to healthcare.[3] However, this rapid decentralisation meant that little thought and planning were put into creating and implementing a governance structure to support it. Consequently, human resources were taken from a central level and spread too thinly across the healthcare sector. The situation was further complicated by the New Organic Law in 1992, which added local-level governments, granting provinces control over their budgets. These attempted to integrate into rural health services, leading to the dismantling of many vertical programs.[51] Resource allocation based on a formula related to population, land, and sea area proved insufficient to meet healthcare needs.[51] The government of PNG has established targets and frameworks to address the challenges of decentralising healthcare model however, the implementation of this new approach has been slow.

2.7 The National Immunisation Program with PNG

The WHO commenced the EPI, with the goal of ensuring all children worldwide benefit from life-saving vaccines. The program saw the expansion of routine childhood immunisations beyond smallpox to include immunisations again vaccine-preventable diseases such as tetanus, tuberculosis, poliomyelitis, pertussis, measles and diphtheria. This program was launched within the country in 1977, in 2009 the pentavalent vaccine replaced the tetravalent vaccine and the pneumococcal was added to the Schedule in 2013.[41]

Vaccine type/age in month or year	Immunization Schedule							
	Birth	1m	2m	3m	6m	9m	12m	18m
BCG	✓							
Hepatitis B	✓							
Oral Polio		✓	✓					
IPV				✓				
DTP-HepB B-Hib		✓	✓	✓				
PCV-13		✓	✓	✓				
Measles					✓	✓		
Measles-Rubella								✓

Note. BCG = Bacillus Calmette-Guerin; IPV = Inactivated Polio Vaccine; DTP = Diphtheria Tetanus Pertussis; PCV = pneumococcal conjugated vaccine

Figure 7: Recommended childhood vaccination schedule in PNG[41]

A child is deemed to have received all essential vaccinations when they have been administered a BCG vaccine to protect against tuberculosis, three doses of pentavalent vaccine (DPT-HepB-Hib) to prevent diphtheria, pertussis, and tetanus, at least three doses of polio vaccine, and one dose of measles vaccine ideally within their first year of life as shown on Figure 7.

In light of the elevated child mortality rate in the Western Pacific region, the PNG government implemented a child health policy aimed at mitigating child mortality and avoiding vaccine-preventable diseases. This policy has been incorporated into the 2011-2020 National Health Plan, emphasising the enhanced significance of immunisation programs within PNG.[52]

Objectives for the EPI in PNG are clear, vaccinate 90% of the population, though-out PNG, eliminate polio and measles and neonatal tetanus, control Hepatitis B and introduce new vaccines and technologies. This is outlined in PNG's National immunisation strategy and based on the WHO guidelines, the EPI varies in performance depending on the districts.[41]

The World Bank reported that PNG had the lowest global ranking in 2019 for the immunisation of three main vaccines, including measles, DTP and Hepatitis B. Each vaccine has an average rate of 35-37% of coverage of infants within PNG.[31] The DHS 2016-2018 survey in PNG found that only 35% of children aged 12-23 months had received complete basic vaccinations. Specific vaccination rates were as follows: 69% for BCG, 64% for the first dose of pentavalent, and 69% for polio 1. Additionally, 42% of children received the required third doses of both pentavalent and polio vaccines.[6]

Routine immunisation performance in PNG is often assessed using the coverage of the pentavalent vaccine. In this case, the pentavalent one coverage rate was 64%, indicating the level of access to routine immunisation services. The utilisation of immunisation services can be gauged by the

proportion of children receiving the third dose of the pentavalent vaccine, which stood at 42% in PNG.

The accessibility of immunisation services can be inferred from the proportion of children receiving the first dose of pentavalent and BCG. In PNG, this coverage rate was suboptimal at only 64%, falling below the desired threshold of 80%.[53] Differences of more than 10% between access and utilisation rates suggest poor utilisation of immunisation services in the country. Furthermore, the fact that less than 80% of children have received the first dose of pentavalent indicates inadequate access to these essential immunisation services.

There has been a notable decline in immunisation rates since 2005, and particularly between 2013-2017. Immuisation rates across the country were notably higher in 2005 as shown on figure 8 at approximately 75%. Global awareness was raised on this issue in 2019 when it was clear routine immunisation programs were failing**.** A large-scale immunisation drive was supported by external donors, yet UNICEF, WHO and PNG immunisation data show no decline and no improvement.[54] The national government committed to the improvement of the healthcare services stated funding was spent on local projects with minimal spent on service delivery. Health budgets were cut after PNG saw the resource boom decline causing further disruptions and closures of aid posts and community health centres due to a lack of staff and supplies .[55]

2.8 Vaccination trends

Childhood vaccination rates within PNG reveal notable disparities based on location of residence, with urban areas outperforming rural regions. Urban children have a higher likelihood of receiving all basic vaccinations (49%) compared to their rural counterparts (33%).[54] The accessibility of immunisation services in urban areas is evident with an 82% coverage rate for the first dose of pentavalent, indicating good access. However, the coverage drops significantly to 57% for the third dose, highlighting a concerning dropout rate of more than 10%, suggesting suboptimal utilisation of vaccination services.[6]

The PNG Demographic and Health Survey showed regional differences evident in the vaccination rates, with children in the Highlands region lagging behind in coverage (28%) compared to children in the Islands (47%) and Southern (46%) regions.[6]

A clear association emerges between vaccination coverage and socio-economic factors. Children whose mothers have higher education levels and belong to wealthier households display improved vaccination rates.[56] For instance, the proportion of children aged 12 to 23 months who received all basic vaccinations ranges from a 15% in the lowest wealth quintile to a considerably higher 53% in the highest quintile, demonstrating the influence of household wealth on vaccination uptake.[6]

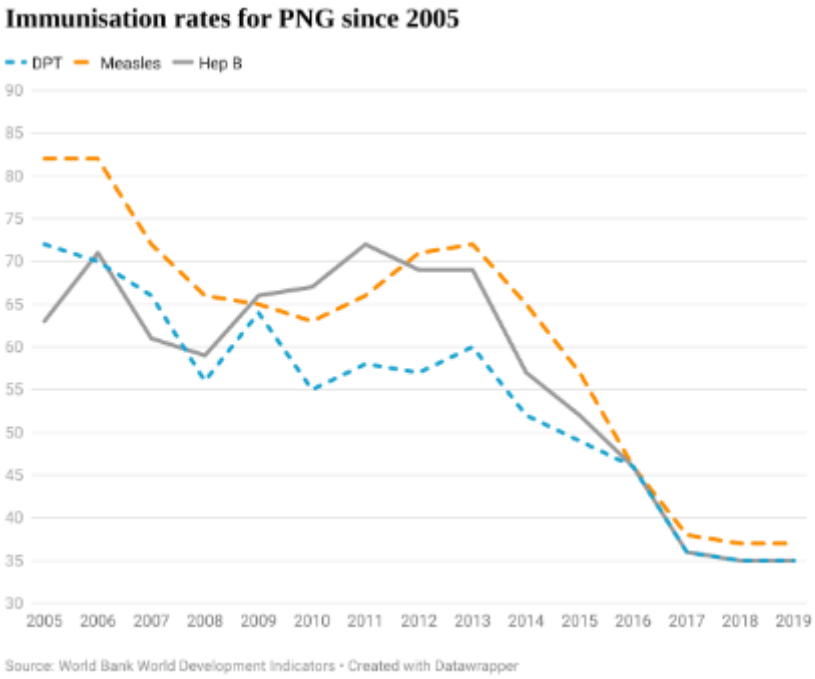

Figure 8: PNG childhood immunisation rates 2005- 2019 [54]

3 PROBLEM STATEMENT, JUSTIFICATION AND OBJECTIVES

3.1 Problem Statement

Immunisation programs are one of the most effective interventions in medical history, both in terms of cost-effectiveness and efficacy.[57] In 1974, WHO established an expanded immunisation program by creating and developing immunisation programs world worldwide. The success of these programs has led to a decrease in many diseases globally, including polio, whooping cough, and tuberculosis, and is credited with the 1980 eradication of smallpox.[58] The WHO's Immunisation Agenda has ambitious goals and is predicted to prevent approximately 50 million deaths in the next decade through strategies focused on maximising the impact of vaccines. Targets include achieving a global vaccine coverage of 90% for children and adolescents thereby ensuring herd immunity in the population, halving the number of children missing out on vaccines and boosting under-utilised vaccines such as those targeting rotaviruses.[59] While some progress has been made, many low-and middle-income countries are still falling short of the targets set by the WHO and the Global Vaccine and Alliance program (GAVI). This research proposal seeks to identify the barriers to achieving the 95% national vaccination target across PNG.

Among the 9.4 million individuals in PNG, a significant 90% of the population lives in rural areas. In these remote regions, the provision of healthcare is a complex issue, posing challenges for both the

government in delivering services and the communities in accessing them, mainly due to financial constraints and logistical hurdles. Additionally, the country has a long-standing history of civil unrest, poverty and natural disasters affecting progression and economic development, which has flow on effects for healthcare access, social determinants of health and health literacy.[6] In the past ten years, PNG has seen a resurgence of measles outbreaks, along with poliomyelitis, a disease thought to be eliminated by vaccination in Asia. These outbreaks were a direct result of low immunisation within the country.

Childhood immunisations have been declining in PNG for the past ten years, and while the NDoH acknowledges this, response to this falling vaccination rate has been slow. PNG's 2016-2020 targets from the National Immunisation Programme were to raise the vaccination rate from 63% to 95%.[18] A preliminary literature search demonstrated several factors relating to this low vaccination rate including vaccine hesitancy, lack of knowledge regarding vaccine importance, political instability, and natural disasters disrupting immunisation programs. Immunisation coverage varies greatly between regions, Immunisation rates are significantly lower in rural and remote regions when compared to urban areas.[60] Cold chain supply, service delivery, access, population data, and planning are all considered to be salient factors in this variation.[61]

PNG's terrain in rural areas is mountainous and remote. As a result of this access to primary health care is complex and costly to individuals with travel time and distance to health facilities contributing to lower vaccination rates.[10] Additionally, rural and remote, communities often labelled 'hard to reach' struggle with limited healthcare infrastructure affecting accessibility and storage of vaccines along with a lack of healthcare staff to deliver them.[62] Ultimately, it was found that PNG's methods for gathering and overseeing population data, as well as their utilisation of information technology for the purpose of strategising and documenting vaccination programs, were ineffective.[49] This led to the production of inaccurate population data.

3.2 Justification

The NDoH is aware of the insufficient vaccination rate within PNG. Previous literature has examined individual factors related to access, lack of supply, and vaccine hesitancy in PNG. However, it is important to note that these findings cannot be considered in isolation and therefore cannot be generalised to the entire population of PNG, particularly those residing in rural areas. No previous study looks holistically at the health system and identifies reasons for the decline of the vaccination rate in PNG. Therefore, gaining a comprehensive understanding of the factors contributing to barriers to immunisation is crucial for designing more effective interventions within PNG.

3.3 Overall Objective: To identify the key issues surrounding low childhood immunisation rates within PNG.

The specific objectives have been formulated with the use of the conceptual framework as described below.

Specific Objectives:

1. Examine the underlying social and cultural issues influencing the intention to vaccinate

2. Explore the fundamental elements that influence community access to immunisation coverage within PNG

3. Conduct an analysis of facility readiness across PNG and identify the main issues impacting healthcare facilities.

4. Assess the impact of information technology and governance on immunisation rates.

5. Provide specific recommendations to overcome vaccination barriers and improve the childhood immunisation rate in Papua New Guinea

3.4 Framework

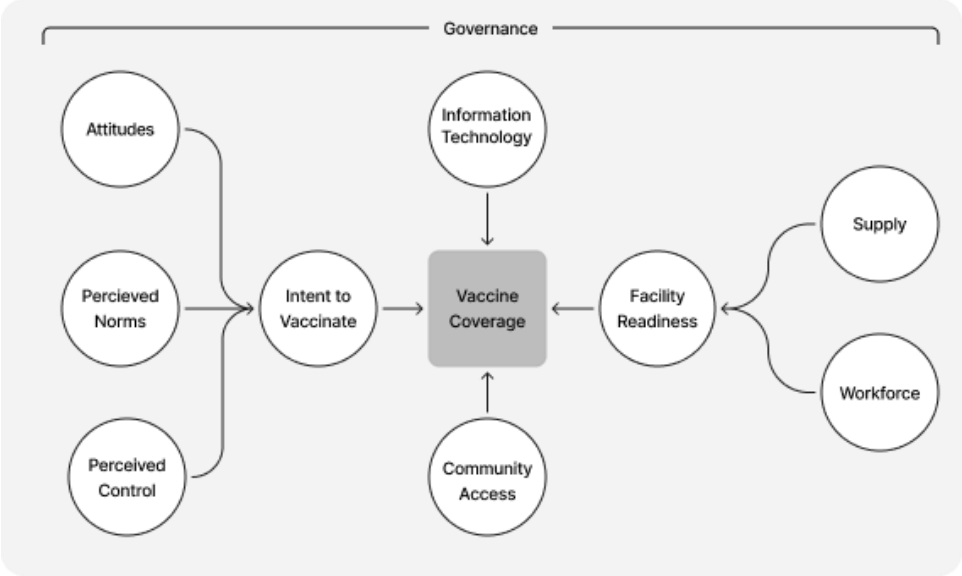

Figure 9: modified framework based on Determinants of effective vaccine coverage in low and middle-income countries by Phillips et al.

The initial framework was designed after a review of many different determinants. It was specifically created with the factors of LMIC by looking at reasons for non-vaccinations and vaccine failure in a simple form. [63] Theories of maximising utilisation of a health service were broken into three different constructs. They include intent to vaccinate, health facility readiness and community access. Although the initial framework was advantageous because it allows us to systematically identify, categorise, and address the factors that hinder vaccine uptake, it lacked two important concepts. These include clinical governance and information technology. These concepts were added and adapted to the framework to form a holistic view of the situation within PNG.

The initial framework by Philip at al was designed after a systematic review and interpretive synthesis of the factors that influence vaccine coverage and uptake within Low- and Middle-Income Countries (LMIC).[63] The analysis of over 1,600 articles investigated the causes of non-vaccinations and vaccines failure in a range of LMICs to ultimately develop a framework that outlined three central constructs affecting vaccine coverage. These constructs include intent to vaccinate, health facility readiness and community access, each of which will be explored.

The construct of intent to vaccinate is based on the (1991) Theory of Planned Behaviours, a model based on behaviour change theory and highly regarded when predicting or changing health utilisation patterns.[64] Complex challenges exist in PNG regarding social and cultural perceptions of vaccinations, with research showing that the vaccination behaviour of residents is influenced by beliefs about efficacy and actual and perceived knowledge of side effects, risks and benefits of individual vaccines.[65] Furthermore, perceived norms such as a parent's knowledge of the need for vaccines have been found to influence in a parents or guardian's decision to vaccinate their children.

Hence, within the framework, this construct looks at the perceived norms of family, friends, healthcare professionals, community leaders and society at large. [30] Behaviour control analyses individuals' views on access to vaccination.

Facility readiness is a concept taken adapted from the WHO Health System Building Blocks Framework, which acknowledges that supplies of essential medicines and vaccines in conjunction with the health workforce are fundamental requirements of an effective healthcare system.[66] WHO states that basic equipment and amenities such as power, water, communication equipment, medicine fridges along with the human resources to provide care.[32]

Community access encompasses geographical issues of vaccines being taken to the healthcare facilities or directly to the communities, individuals having to walk 2-4 hours by foot to receive primary healthcare.

To conduct this literature review effectively, the framework was adjusted to include clinical governance and information technology. This adjustment was made because a preliminary analysis uncovered significant issues related to these specific factors.

This framework is advantageous for use as it has been designed by integrating different existing frameworks, with the concepts designed to be succinct, exhaustive, and testable.[28]

Appendix 2, contains an evaluation of the strengths and weaknesses of two additional frameworks, namely the Global Routine Immunisation Strategies and Practices (GRISP) and the Global Immunisation Strategic Framework 2021-2030.[6768]

4 RESEARCH METHODOLOGY

To address the objectives, relevant literature was examined, encompassing published articles as well as grey literature, like national statistical data, independent evaluations, and agency reports. A review was conducted in a systematic manner using an electronic database search to identify the key issues surrounding low childhood immunisation rates within PNG.

4.1 Data Sources

4.1.1 Published Literature

The following databases, PubMed and Vrije University (VU) online library were used to find the available published literature. It was assumed that the use of additional keywords would risk missing relevant literature seeing the broad range of factors that play a role in vaccine coverage. This initial search yielded a 'manageable' number, and further refinement was achieved through a manual check of the title and abstract using the inclusion and exclusion criteria and terms as listed in table 2. Duplications were also removed.

Data included observational, mixed method and qualitative study designs and literature reviews related to PNG routine childhood immunisations. Articles published to1998 were included, this is to allow for an understanding of the history of the vaccination programs over the past two decades whilst ensuring relevance to the current situation.

Articles meeting both the inclusion criteria and demonstrating relevance, while not fulfilling the exclusion criteria, were included in the study for further analysis.

To broaden the literature search and uncover additional pertinent studies, a snowballing technique was used to adopt a comprehensive and inclusive approach towards collecting relevant literature for

this review. This was performed by scrutinising the references of articles in the final selection of articles. Articles were organised onto data extraction table with objective themes identified and analysed.

4.1.2 Grey Literature

An additional Google search was completed for grey literature. Data from relevant organisations such as the UNICEF, GAVI Annual Progress Report, and PNG National Health Report and Strategies were reviewed and included in the report. Data regarding national population, vaccination programs and population health status were collected from sources such as National Statistical Office of Papua New Guinea, WHO and UNFPA. Relevant independent health reviews of the PNG health system and agency reports were also included in the literature review.

Inclusion Criteria	**Exclusion Criteria**
Peer-reviewed. Identified bottlenecks/ issues with childhood vaccinations for: Social and Cultural Norms Community Access Facility Readiness Information Technology Governance	Articles published prior to 1998. Research conducted outside of PNG. Studies that look review adult vaccinations Articles not in English
Included Terms	**Excluded Term**
Routine childhood Immunisation Outbreaks Disease prevalence Hepatitis B Vaccine coverage Oral vaccine (Cholera and Polio) Health data analysis Vaccine hesitancy Remote and rural areas of PNG Disease elimination/ eradication Barriers to delivery Maternal health Human resources for health Maternal education Immunisation policy and strategies National Immunisation Child health services Perception of vaccination	Vaccine efficacy Pharmaceutical trials Safety and immunogenicity Japanese Encephalitis and Pigbel (enteritis) Travellers' vaccines Human Papilloma Virus Randomised control trials Neonatal tetanus COVID 19 Pneumococcal conjugate vaccine trial Monkeypox
Strategy for analysis	
• Each report and article underwent meticulous thorough reading, comprehensive analysis, and categorisation based on their alignment with specific objectives as defined by the framework. • Both national reports and independent reviews of the health system were included, with special attention given to critically appraising governmental reports. • The results were methodically collected and synthesised for each objective, following the guidelines set forth by the conceptual framework.	

Table 2: inclusion, exclusion criteria and analysis strategy

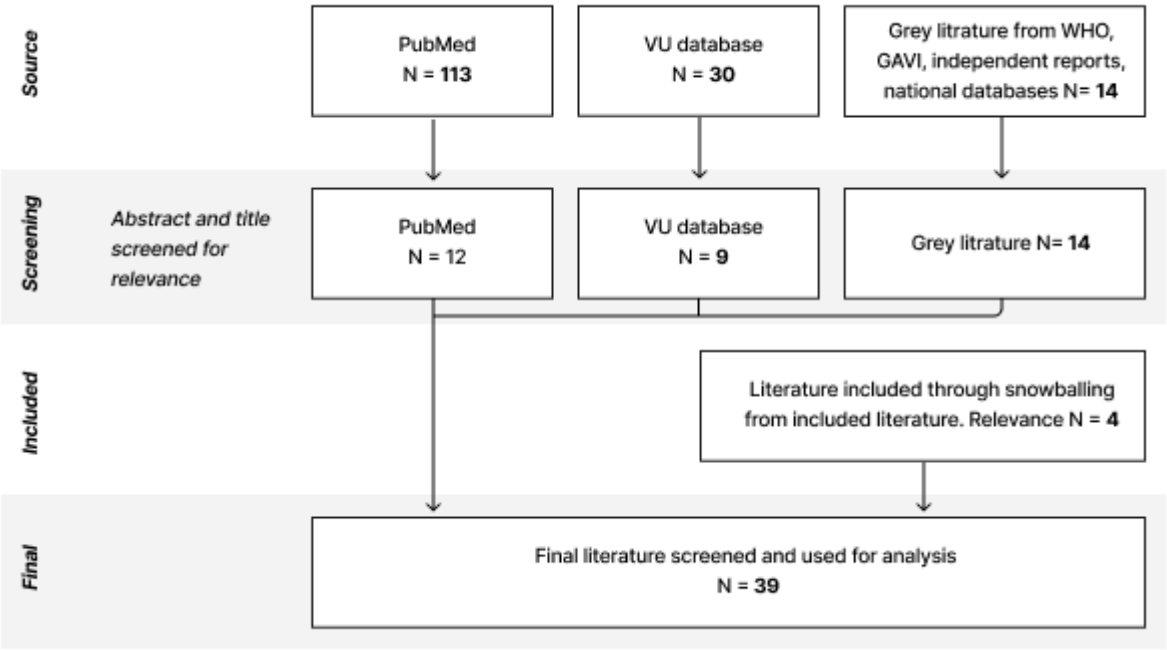

Figure 10: search strategies

4.2 Study Limitations, Ethical Considerations and AI Tools

Many articles recently published focused on the vaccination schedule of the COVID-19 vaccination. Whilst the COVID-19 pandemic caused further issues in the immunisation program within PNG, the specific problem of the decline in vaccination rate was occurring before the 2020 outbreak and for potentially different reasons. Ethical approval was not required for this literature review as no original research was conducted. Artificial Intelligence was used as a tool for proofreading and editing the literature review prior to submission. The list of prompts used can be referred to in Appendix 3.

5 RESULTS

The literature review revealed numerous articles on community access, supply, and workforce aspects, however there was notable absence of data concerning vaccination intent in PNG. To address this gap, PNG policy documents, agency reports from WHO and UNFPA, as well as independent reviews from intergovernmental agencies were utilised to supplement the missing data and enhance the overall findings.

5.1 Intent to vaccinate

5.1.1 Underlying social and cultural issues

The theoretical framework of this study is grounded in the theory of planned behaviour, which suggests that attitudes play a central role in determining human behaviours. It particularly

emphasises the significance of beliefs pertaining to vaccines and highlights the influence of cultural and socioeconomic factors on these beliefs. This notion finds support in the work of Mazige et al., who highlighted the importance of addressing these factors to enhance vaccination rates effectively.[69] The World Bank Report accentuates that behaviours are dependent upon an individual's intention to engage in a specific activity, and this intention is shaped by their unique perspectives.[46] Therefore, it becomes imperative to investigate how the information provided to individuals can shape their attitudes towards vaccination and subsequently promote a positive adoption of vaccination practices.

It is pertinent to highlight that PNG's National Immunisation Strategy and National Long-Term Health Plan lack explicit consideration of vaccine attitudes, hesitancy, and misinformation.[70] As such, addressing these aspects within the context of the proposed framework may yield valuable insights and contribute to the successful promotion of vaccination in the region.

5.2 Attitudes

5.2.1 Understanding of vaccine importance

Gowin et al. conducted a study that revealed a limited understanding of childhood immunisations, particularly in rural areas of PNG. Parents, especially in these regions, lacked knowledge about how vaccines work, though some awareness was present regarding polio and TB vaccines being preventive measures for specific diseases.[18] Some mothers expressed negative attitudes towards immunisations, fearing that their children received too many injections when not sick, leading to concerns about unnecessary medication. Additionally, reported side effects of vaccines on babies also contributed to these worries. Despite these concerns, there were no opposing opinions from mothers about vaccinations.

Several studies have noted that females are mainly present during immunisation clinic visits and outreach programs in communities.[18,65] The national education and literacy rates in PNG are generally low, and females often have limited access to education. Consequently, information about vaccinations is primarily spread through word of mouth. Decision-making responsibilities within families are typically assumed by men, but interestingly, men are rarely present at vaccination clinics. Research in PNG and other Western Pacific countries consistently shows a strong correlation between women's educational attainment and childhood immunisation rates.[60,71] The accessibility of health and education services is impeded by poor road access in some areas, which affects information dissemination.[3] Many women rely on health professionals for vaccination information, given the average literacy rate of about 60%. It is important to note that there is a lack of available information on attitudes towards vaccination prior to COVID. The literature highlights the knowledge gaps and concerns surrounding childhood immunisations in PNG, particularly in rural areas. Female participation and educational attainment were found to be crucial factors influencing vaccination rates, and improvements in information dissemination and accessibility to healthcare services are needed to address challenges in the current vaccination landscape.[65]

5.3 Perceived Control

The negative impact of unreliable healthcare services can influence people's attitudes and perceived control, subsequently affecting their intention to get vaccinated. Moreover, research has indicated that the lack of preparedness in healthcare facilities significantly hinders vaccination rates.[71] As seen in access communities, they lose trust in healthcare clinics that turn them away due to vaccination shortages or require lengthy wait times. Whilst there has been much research globally by

researchers into understanding the barriers of immunisation for those who choose to seek immunisation for their child, a study by Namugi, found that limited access to information is largely due to low literacy rates, and cultural beliefs.[65]

5.3.1 Community satisfaction with healthcare services

The National Health Plan 2011-2020 emphasised the distribution of community health posts (or aid posts). Increasing accessibility strengthens communities and supports individuals to take responsibility for their health. However, increased accessibility to primary health care, such as immunisation programs, does not always mean increased utilisation. According to the Independent Health System review, in the context of the health plan, the effective utilisation of health services hinges on several critical factors.[3] These factors include individuals' awareness of their health needs, their knowledge about available services, and the level of trust they place in the provided healthcare services. Failure to address these aspects may result in suboptimal utilisation of healthcare resources and potential waste.[56] Strategies aimed at promoting health literacy, community engagement, participation, and empowerment play a crucial role in creating 'demand' for healthcare services. However, these strategies are not adequately outlined in the policies and programs of the health sector. The country's health planners and managers face a deficiency of information concerning patient information, patient choice, and community empowerment.[36]

The Ministerial Taskforce on Maternal Health in 2009 observed a lack of confidence and trust in the current health system, with concerns raised about disrespectful care. It stated regarding maternal care: "Maternity care for women can be disrespectful and contingent upon payment of fees. Offensive and demeaning language by health personnel, and ridiculing of women's poverty, clothing, parity, smell, hygiene, cries of pain, or desire to remain clothed is not only disrespectful but abusive".[72] If women are experiencing this when seeking maternity care, they are unlikely to return to other healthcare facilities or seek out vaccinations from healthcare providers for their children.

Barriers encompassing community access include the distance to health facilities, resource scarcity resulting from poverty, and insecurity due to conflict; these factors may also contribute to a feeling of diminished control over vaccination behaviour.

5.4 Perceived Norms

According to the Theory of Planned Behaviour, perceived norms represent individuals' beliefs about whether others approve or disapprove of certain behaviours, influencing their motivation to follow those recommendations. In childhood immunisations, this concept involves individuals' perception of how many community members adhere to immunisation schedules, which can encourage and promote immunisation uptake. The perception of vaccinations among healthcare workers is also vital in shaping these social norms. However, a study conducted by Downing et al. in several major governmental-run hospitals in PNG revealed limited vaccine awareness among healthcare staff.[73] This lack of awareness is concerning because healthcare workers play a crucial role in influencing social norms related to immunisations. The study identified a significant knowledge gap regarding healthcare workers' perceptions of vaccines, which is problematic as they are the primary source of information about vaccines. The church plays a significant role in funding healthcare facilities, including immunisation programs, yet little research has been conducted to understand the attitudes of community leaders, faith-based organisations, and PNG society as a whole towards childhood immunisations. Understanding the attitudes of PNG communities could provide insights into social norms related to immunisations.

5.5 Elements that influence community access

5.5.1 Road Infrastructure

Road access has been identified as a major barrier to accessing primary healthcare services in several studies.[74] [75] Gibson and Rozelle state that it is one of the most proximate causes of poor education, healthcare, and overall country development.[76] Presently, only 68% of the country's population lives within two kilometres of an all-season road, leaving communities cut off during heavy rains. Moreover, the existing roads are in extremely poor condition, with only 13% evaluated as being functional.[60] While the PNG government has received financial assistance from the World Bank and Department of Foreign Affairs and Trade (DFAT) to develop roads and improve nationwide access, the high costs associated with road maintenance have hindered effective upkeep.[22] Historical underfunding of maintenance, compounded by current fiscal challenges within the government, exacerbates the situation.

Ishida et al. found that physical access to healthcare facilities negatively affects a child's immunisation status, mainly when travel time, healthcare and education costs are high. In the highlands region, individuals may have to walk for up to four hours to access the nearest road.[60] Additionally, when natural disasters occur in PNG, delays in road repairs cause disruptions to communities. Notably, the capital city, Port Moresby, currently needs to be linked by road to the rest of the country, posing a significant issue.

Alternative access methods, such as waterways and light planes, also face ongoing maintenance challenges, with docks and airstrips being costly to maintain.[76] For instance, the Goilala province, despite its proximity to Port Moresby, lacks road access, resulting in low vaccination rates in the region. Ishida et al. found that a child residing three hours away from a health facility is 16% less likely to complete vaccination compared to a child living closer.[60]

Figure 11 depicts overall low vaccination rates for basic vaccinations, with significant differences observed between provinces. Provinces like Milne Bay and New Ireland have vaccination rates of almost 80%, while Hela, Gulf, and ARoB provinces have rates as low as 20%. This disparity is a prominent issue in PNG and is consistently highlighted in governmental reports. Ongoing projects funded by organisations like the World Bank and DFAT aim to improve access. NGOs like Médecins Sans Frontières are trialling drones for medicine and pathology transport in hard-to-reach areas in PNG.[77]

The challenges of road access extend beyond vaccine distribution, also impacting on data collection, healthcare worker mobility, outreach programs, and the provision of essential supplies for services such as education. While multiple studies note that access is not the sole barrier to receiving immunisations, it remains a significant factor affecting vaccination coverage throughout PNG and constrains overall development. [70,76]

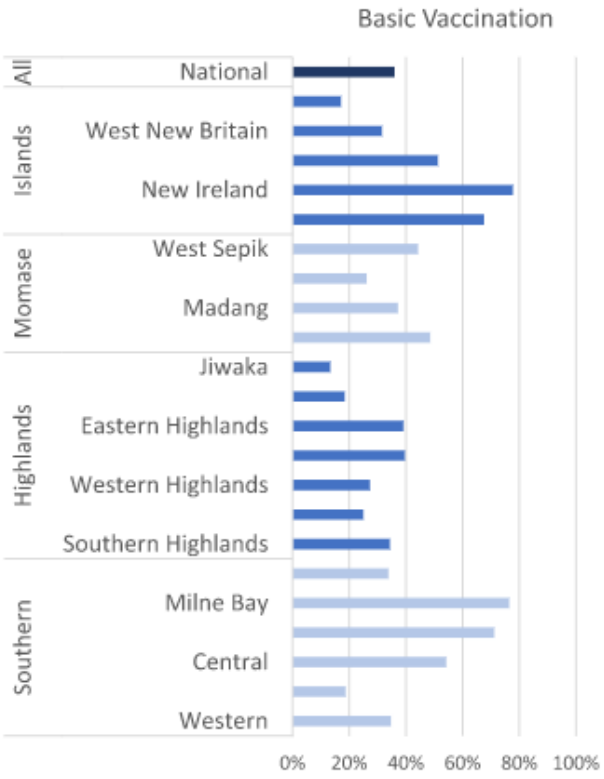

Figure 11: Interprovincial Differences of Basic Vaccination by Region, in Papua New Guinea, 2016–2018 [60]

5.5.2 Access to clinics

Numerous articles have indicated that the expenses related to transportation act as a hindrance to accessing vaccination at healthcare clinics. As mentioned previously, the longer the travel distance, the higher the associated costs. A study by Namugi, in the Eastern Highlands province found transport costs were listed as a non-vaccination reason 18% of time. Additionally, the study showed that after long waiting times for vaccinations at the clinic parents are being sent away (45% of the time) and being told to return the next day (45%) which impacted on access to the measles vaccine service.[65] Mobile clinics have been operating in PNG since the EPI began, in the Goroka district during times of mobile health clinics vaccination rates were seen to be 70%, when funding was reallocated elsewhere, and mobile clinics were not present in the area, the vaccination rate dropped to 30%. Poor transport was found to be a documented contributor to low coverage in rural areas, and lack of funding for fuel in outreach programs was additionally cited.[78] Toikilik et al. discovered that 20% of women, whose children had incomplete or no immunisations, attributed the reasons for this to be related to distance, travel conditions, and transportation costs.[79]

In 2005, a study conducted in the Goroka district, Namugi found that restricted access to health centres was mainly due to the time cost incurred, which took away time from essential activities such as gardening, cooking, and taking care of children.[65] Participants in the study identified transportation costs as a significant barrier to accessing clinics for vaccinations. Moreover, long waiting times at the clinic or being asked to return the next day due to insufficient vaccination stocks were reported by 55% of the participants. Several articles highlight various barriers preventing mothers from bringing their children to healthcare facilities.[40,61,73] These barriers include fathers not giving their consent (noted by 20% of the participants), the absence of family members to help care

for other children during travel, and the need to attend community funerals. Additionally, local and national elections were also cited as barriers to vaccinations.[65]

5.5.2.1 User fees

User fees have been highlighted in several articles as a significant barrier to accessing healthcare services. While the vaccination itself is provided free of charge, some clinics still impose fees for appointments, particularly for maternal services across PNG. As depicted in Figure 12, 47% of deliveries are reported to incur user fees.[18] Wiesen et al. reports that 60% of children are not born in a healthcare facility in PNG, and only a small percentage of births are attended by skilled birth attendants.[80] Kitau et al. found that lack of transport and long distances to health facilities were the primary reasons for this situation.[74]The Maternal and Newborn Health Indicators 2008-2018 report noted that the figures of skilled birth attendants at a birth (either healthcare facility or home) have remained relatively unchanged (53.2% in 1996, 53% in 2006, 56.% 2018) in 25 years.[11]

In their study of user fees across PNG, Sweeney and Mulou discovered that almost one-third of facilities charge fees, which contradicts the National Health Policies.[81] Furthermore, 21% of individuals surveyed stated that user fees prevented them from seeking necessary healthcare. The article also revealed that fee exemption policies were inconsistently applied.

5.5.2.2 Access to Maternal services

Despite efforts, the maternal mortality rate in PNG has stagnated in the past decade, with an alarming rate of around 775 maternal deaths per 100,000 live births. This puts PNG on par with well-known fragile states like Afghanistan.[54] Wiesen et al have shown that children born in a health facility have a higher likelihood of receiving the Hepatitis B vaccination at birth.[80] However, Lee et al. identified that women who give birth without a skilled birth attendant face challenges in timely delivery of the Hepatitis B vaccine.[82] Toikillik et al. found that distance from a health facility was a significant reason for delays in receiving the BCG vaccine, especially when the child had missed it at birth, with only 74.2% of urban infants receiving a dose of BCG vaccine compared to 57% of rural infants.[79] Both Toikillik and Wiesen et al noted a critical lack of skilled birth attendants throughout PNG.

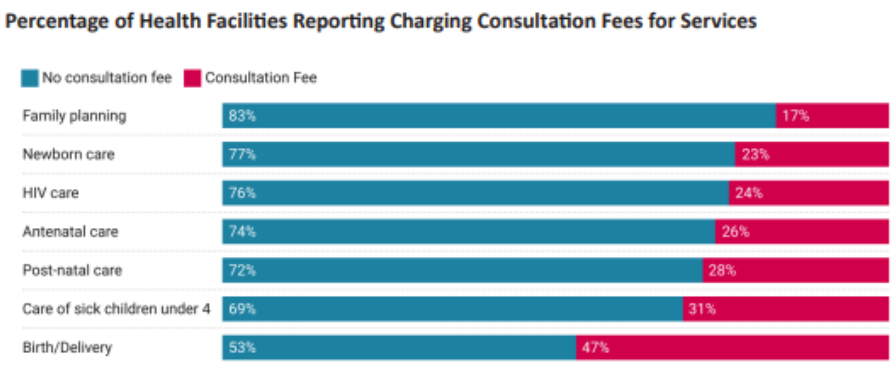

Figure 12: The UNFPA's survey: facilities in 2021 reported roughly 50% of clinics are requesting user fee for birth delivery, user fees vary per clinic

5.5.3 Geographic inequity

Addressing geographic inequity within the health system is a fundamental component of the national health plan. However, numerous assessments and evaluations have highlighted the misalignment of resource allocation with this policy. Healthcare facility closures, inadequate distribution of healthcare resources to accommodate population growth, and inconsistencies in funding allocations directly impact equity.[83] The government acknowledges and supports the notion that reaching rural communities is crucial to achieving a 95% vaccination coverage rate. However, a concerning issue which has emerged is that Supplementary Immunisation Activities (SIAs), while aiding in improving coverage, tend to demotivate healthcare workers (HCWs) in terms of focusing on and enhancing routine delivery. SIAs have been evaluated to disrupt the health system, leading to short-term increases in vaccinations but an overall decrease in immunisation coverage. During SIA years, there are sufficient resources available for the programs. However, in non-SIA years, the motivation of HCWs declines without external support in terms of logistics and finances, resulting in programs having to wait until the following year.[3]

A specific instance involving a church hospital further illustrates the impact of SIA funding. The provincial health advisor informed the hospital to suspend its immunisation program to receive SIA funds. Consequently, immunisation programs in that area collapsed.[84]

Datta et al. discovered that SAIs (Supplemental Immunisation Activities) incurred expenses three times higher than conventional outreach immunisation services. The study focused on a Pertussis outbreak in Goilala, an area with no road access from Port Moresby.[75] The cost analysis revealed that hiring staff, helicopters, and personnel from other districts amounted to USD$12.62 per child, in contrast to the routine immunization services cost of USD$3.80 per child. Given the province's already strained budget, this substantial disparity in expenses has significant implications.

5.5.4 Civil conflict and natural disasters

Tribal clashes have been noted as an issue in rural areas that impact provisions of immunisation programs. In the Anogram district, healthcare workers became fearful of violent clashes, and several facilities closed for over three years in 2011.[85] Tribal classes were found as a barrier 13% of the time in the Eastern Province. Lehmann et al. highlighted that conflict resulted in mothers being unable to travel and nurses being unable to access the clinic.[86] Natural disasters were cited as a barrier to vaccinations in four studies; Gowin et al. reported that an earthquake in 2018 damaged 18 of the 86 health facilities across four provinces.[18] UNICEF estimates this resulted in only 10% of the target population receiving pentavalent, measles and rubella vaccination in the timeframe.[18]

5.5.5 Lack of Facilities

The analysis by Independent Health Systems Review revealed a deficit of 3,891 aid posts, 143 health centres, and 74 district hospitals for them to be fully functional, adequately staffed, and operational.[3] Multiple studies report clinics were required to close due to a lack of healthcare staff, particularly in rural areas.[18,60] The PNG national strategic plan estimates 2,672 aid posts in the country were closed in the past ten years and 30% of clinics were not operating at full capacity.[3] While there is little data available on the plans to accommodate the growth of the population with health facilities, Razee et al. found securing sites for healthcare facilities is complex and timely due to land ownership disputes as there is no official land title system[87] In numerous instances, publicly operated healthcare facilities are situated on customary land, potentially leading to their closure in the event of land ownership disputes[3]. The PNG Development Strategic Plan 2010-2030 outlines the

need for an estimated 7500 aid posts (also cited as community health posts in literature) throughout PNG by 2030 to meet the need for the growing population, most recent available data from 2008 suggest there were 1,870 nation-wide.[88] Additionally, it outlined that 50% of district health centres are required to be updated to health centres. Figure 13 demonstrates the sparsity of healthcare facilities particularly in the eastern Province.

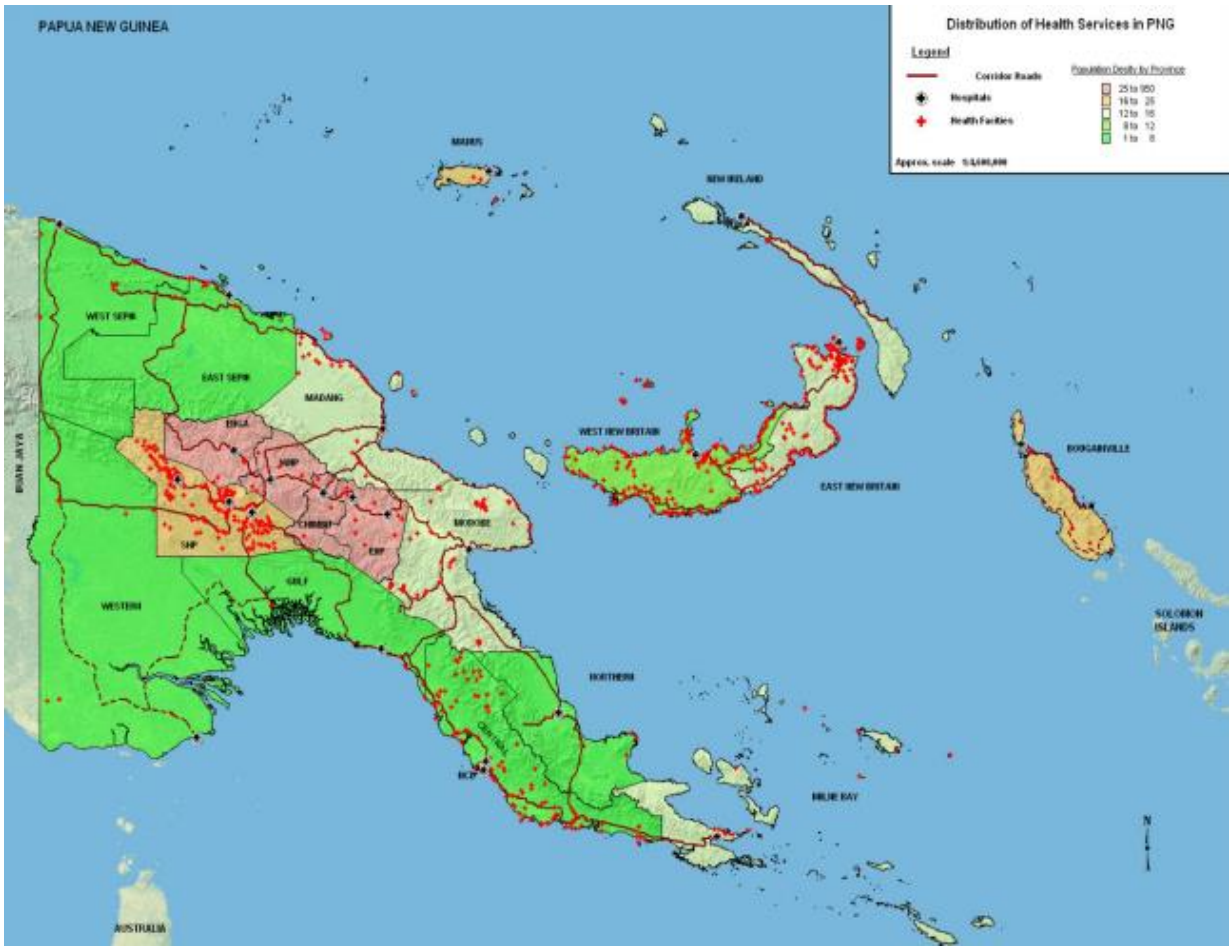

Figure 13: Distribution of health facilities within PNG[8]

5.6 Analysis of facility readiness

5.6.1 Workforce

For the past several years, PNG has been experiencing major difficulties in the human resources for health. PNG has seen a decline in skilled health workers, particularly in rural areas.[82] This has led to inequitable access to health services, poor productivity of remaining workers, and challenging conditions for management and governments. Based on a regional comparison, PNG has the lowest ratio of physicians per 1,000 population of just 0.055, which is significantly lower than in countries such as the Solomon Islands (0.191). The healthcare-professional ratio is currently low at 5.3 nurses/midwives and less than one doctor per 10,000 people.[89]

Morgan et found that healthcare workers reported the most important issue was the lack of healthcare personnel.[78] Vince et al. stated that the lack of healthcare workers causes aid posts and health centres to collapse, staff turnover is high and human resources are disproportionate to the population, with human resources focused in urban areas while the population requiring healthcare is living in rural areas.[70] Approximately 80% of all healthcare staff work in urban areas, disproportionate to population density.[83]

Duke found that in the 1990s, there was a lack of formal maternal and child health training opportunities outside of the University of PNG in Port Moresby.[61] This limited training capacity was insufficient to address the growing population needs in PNG. This led to a shortage of healthcare staff in the early 2000s and had a flow-on effect on with lack of senior staff and training for new staff. Current targets for 2030 are 20,000 CHWs within PNG.[8] The most recent data from 2009 was found to be 4419; there was little increase in the number of CWHs between 1988 and 2009, considering the population growth of 3.1%

Healthcare workers, including CWHs nurses and midwives, form the backbone of rural primary healthcare services in PNG, as suggested by Howes et al.[39] Over the years, they have received inadequate support and little incentive to work in rural areas, often facing challenging circumstances. The government has not ensured sufficient provisions for housing, safety, financial incentives, and staffing numbers for these healthcare workers.

Historically lack of sufficient healthcare workers has forced many aid posts to close. Rural healthcare facilities cannot retain staff, with several articles reporting low staff motivation to work remotely, financially unstable conditions and poor training opportunities. Pilang et al. outlines that one reason for the lack of healthcare workers is education.[34]

A recent evaluation of nursing schools by the PNG human resource policy has identified several challenges that hinder expanding student enrolment. These obstacles include inadequate infrastructure, deficiencies in information technology, and a shortage of teaching positions and instructional resources.[89]

The distribution of healthcare staff in PNG is highly unequal, and this inequality is attributed to provincial administrators' responsibility for recruiting and placing healthcare workers.[90] However, there are no established minimum levels of healthcare workers, and monitoring and evaluation systems are lacking to assess resource standards.

Razee et al. l found there is a willingness by HCWs to provide care in the communities stating that they feel respected within the community, which is important.[87] Due to current population data and predicted growth, there is a large proportion of young people to work within the health sector though several barriers inhibit this.

5.6.2 Migration of Healthcare workers

Several articles state the numbers of skilled healthcare workers migrating to Australia and New Zealand, reasons cited are lack of facilities to provide basic healthcare services, lack of financial incentives, some healthcare workers reporting they are working free of charge or on a minimal wage.[70] Security issues were cited to be an issue, Razee et al. found healthcare workers feeling unsafe due to tribal fighting or domestic crime, particularly when travelling to and from work.[87]

5.6.3 Supply

5.6.3.1 Cold chain logistics, vaccination

Significant concerns for the use of expired or improper storage of medicines and vaccines were found. The UNFPA report stated that in the past two years, 90% of facilities had not conducted inventory checks, and expired medicines and vaccines were taking up space in medical storage areas due to a lack of clear instructions from the NDoH. Teams found adult vaccines that expired in 2013 were still found stored in the cold chain at the facility. The 2017 National report on service delivery in Health facilities additionally reported that church- run facilities performed better when surveyed though there is a generally high number of expired vaccines. [91] The report states that 89% of the health facilities have an electric fridge, with 50% of these fridges being run of the national power grid with the remaining using solar. The remaining use ice boxes or gas system fridges predominantly used for the national EPI.[91] Gowin et al. reported that 30%. Most health facilities have a vaccine fridge thermometer within the health facility.[18] However, there was no link between this factor keeping temperature logs resulting in the potential for drugs to be inactive if the cold chain has been broken. The lack of adequate medical waste facilities, specifically sharps management, was identified as a barrier to efficiently function.

5.6.3.2 Infrastructure of facilities

In a 2012 Howe et al. survey conducted on 142 health facilities, it was discovered that approximately two-thirds (67%) of clinic rooms and three-quarters (77%) of health worker accommodations needed renovation.[39] The report stated only 55% of the facilities had a year-round water supply, while 41% of the clinics had refrigeration, 40% had access to electricity, and 50% were equipped with toilets. Wiltshire found that women were turned away in the Abau region if they did not bring their own bucket of water for delivering their child[36]. Morgan et al. cited the most significant recommendation from a national study was to ensure the reliable supply of vaccines and facility readiness.[78]

5.6.3.3 Vaccination books

Vaccination books - Several studies have identified issues with vaccination recordings and the availability of vaccination books. Research in the Eastern Highlands and found that vaccination books were supplied free of charge to only 49% of parents in state-run services and 18% in church-based services, with an average cost of around 2.4 Kina (approximately €0.60) for those who had to purchase them.[65] The study also revealed that the availability of these books was limited. There was no evidence to suggest that no book resulted in no vaccination.

Additionally, Morgan et al. found that recording future vaccination dates in the book led to higher compliance in completing the vaccination schedule. This was particularly an issue for illiterate women, as they were less likely to recall the long interval between vaccinations.[79]

5.6.3.4 Vaccine waste and improper use

Vaccine distribution in PNG follows a process where vaccines are transported by air from the manufacturing country to Port Moresby, from where they are further distributed by road or sea to various locations. However, in three provinces, air transportation is primarily necessary, leading to an exceptionally high cost of vaccine distribution.

The government covers the cost of all vaccines included in the routine immunisation schedule, such as BCG, Hep B, Measles, and tetanus Others are co-financed by GAVI and the government. While no articles cited specific data regarding national stock storages, the issue of vaccine supply shortage is attributed to underordering and wastage.[41] According to the WHO, it is predicted that 50% of vaccine doses worldwide are wasted during the National Expanded Programme on Immunisation (EPI), significantly driving up the cost of the national immunisation program.[68]

During the 2014-2015 measles outbreak, Kamac et al. found that 55% of the vaccines were wasted, resulting in a total cost exceeding USD$196,000.[84] Several factors contributed to this wastage, including the lack of refrigerators in more than half of the healthcare facilities in the Madang province and improper training of 40% of the staff leading to incorrect dilution and injection techniques. In contrast, Morgan et al. reported no expired or damaged vaccines in the 2015 EPI program.[78]

The procurement of all drugs and supplies, including vaccines, is handled by the government since PNG lacks local vaccine manufacturing capacities. Relying on international organisations such as WHO, GAVI, and UNICEF for their vaccines, the country has been procuring routine immunisation vaccines through the UNICEF SD mechanism since 2016. This mechanism ensures timely delivery, supply reliability, and fair pricing.[68]

However, there are collaboration, knowledge, and organisation challenges concerning vaccine stores and cold chain supplies at all levels. The distribution of vaccines and safe injection supplies lacks a systematic plan at the national level, and staff, while aware of the importance of cold chain supply, do not always adhere to it the cold chain is often insufficient, leading to vaccine spoilage, damage, or breakage. Additionally, vaccine wastage is not being adequately recorded or calculated.[61]

5.8 The impact of information technology and governance

5.8.1 Information technology

PNG is operating a proximately paper-based system for healthcare records as infrastructure is underdeveloped.[88] A radio-based communication network was set up to connect >1,000 health facilities nationally. However, there has been a loss in the capability for this system to operate due to maintenance issues. A lack of reliable methods to define population rates, coverage rates and critical problems within the national immunisation program[3]. There is no current system in place to identify track defaulters (children who have received no immunisations), resulting in a high missed opportunity of child vaccination.[10]

PNG birth and death registration systems cannot model population growth and provide strategic planning for vaccination programs. Vince et al. found that populations are growing rapidly. The NDoH comprehensive multi-year plan states a lack of reliable methods to define actual population numbers of coverage rates have resulted in the inability to predicate and plan for the increasing population.[70]

The National Health Information System encountered significant challenges in effectively monitoring immunisations nationwide. As a result, the EPI faced difficulties in making well-informed decisions and formulating strategies to achieve adequate coverage targets[92]. Morgan et al. stated that a lack of accurate population data led to healthcare staff in numerous facilities being uncertain about the demographics they served. Consequently, provincial authorities and healthcare facilities had to rely on estimations from census data dating back over a decade. This outdated data further compounded the difficulties faced by the EPI in its efforts to optimise immunisation efforts and ensure comprehensive healthcare coverage.[78]

The PNG independent health review identified that the health centre record book can document a diverse range of health-related data and effectively visualise this information to identify emerging trends and patterns. However, in practice, using the health centre record book for such purposes is infrequent.[3] The staff typically lacks formal training on how to efficiently utilise the book, including data plotting and analysis techniques, as well as applying their own data for meaningful insights.[36]

The NDoH initiated an Epidemiologist training program in 2013 to address communicable diseases. Students who were initially healthcare professionals from provincial or district health departments, underwent the two-year training within their provinces. This approach proved advantageous as it facilitated swift responses to outbreaks and public health emergencies, given their presence in the communities during such events.[43] Additionally, these trained epidemiologists were able to provide instruction to other healthcare workers, enhancing the accuracy of population and health data recording. The evaluation conducted by Ropa et al. revealed positive outcomes, including strengthened local health system capacity, establishment of partnerships with external organisations, and improved data management systems[93].

5.8.2 Governance

None of the above findings can be addressed unless the underlying issue of governance is analysed and addressed. In the past 30 years, there have been major changes in power, responsibility, and funding to the health sector. Several concerning factors were found in the review; the introduction of the Organic Law resulted in health budgets now being controlled by the Provincial Administration, not the health sectors; concerns were raised regarding this, there was a distinct lack of funding to

the provincial health services due to a lack of awareness/ attention by the provincial government.[3] Vince et al. cited that rapid population growth in unplanned areas adds additional issues to population data collection and community development.

The long-term national strategic report from 2010-2030 identifies that key health indicators and vaccination rates worsened that coinciding with the transfer of responsibility for rural health services to local-level government.[47,51]

There was little peer-reviewed data literature that reviewed the strengths and weakness of a decentralised health system within PNG, though many articles note the correlation between health system decline and decentralisation. Numerous studies and research highlight that decentralisation plays a crucial role in promoting quality and accessibility within health systems.[3,8,51] By enhancing efficiency, responsiveness, and accountability, decentralisation becomes a valuable strategy for improving healthcare services.[51]

The decentralisation process has resulted in a higher need for administrators and managers at the district level. This has led to the reassignment of skilled health extension officers (HEOs) from front-line services to administrative roles. Consequently, approximately 30% of all clinically skilled health workers are now occupying administrative or management positions instead of actively attending to patients.[43]

In order to make the system responsive to the communities, PNG decentralised their 22 provinces responsible for health, and this has created many difficulties in implementing the health policies made by the NDoH. Pritchett, Woolcock and Andrews state that 'implementation is often the weak link connecting a policy's conception to realistic outcomes.[94]

Wiltshire, in his research, found a significant gap and disparity exist in the allocation of funds for different provinces, irrespective of their actual needs and population. Urban healthcare facilities receive the bulk of the funding, with targeted improvements to increase service delivery.[36] Unfortunately, this allocation does not align with the distribution of the population, as the majority of the nine million people reside outside the cities. The government's focus on urban centres neglects the importance of adequately allocating resources to areas where most of the population resides.

6 DISCUSSION

The review has identified a significant body of relevant literature and documents which when considered collectively, offers a comprehensive understanding of the various factors contributing to barriers in vaccination coverage. In the subsequent discussion, these factors have been organised into distinct themes.

The Impact of Factors on Vaccine Coverage in Papua New Guinea

The literature review explores the multitude of factors that influence vaccine coverage in PNG. Significant obstacles within the country hinder the achievement of high childhood immunisation rates. These obstacles encompass community access challenges, a shortage of human resources, inadequate fund distribution, and insufficient population data. These issues are further exacerbated by difficulties linked to decentralisation, natural disasters, and civil conflict. The severity of the situation becomes evident through the prevalent low childhood immunisation rates.

Closing the Knowledge Gap and Enhancing Engagement

While attitudes toward childhood immunisation generally appear favourable, there is a knowledge gap concerning perceived vaccine necessity and attitudes. To bridge this gap, it is imperative to bolster community engagement and undertake additional research, particularly in rural areas. Addressing concerns regarding healthcare accessibility and maternal services is crucial to increase mothers' willingness to vaccinate their children, thus resulting in enhanced public health outcomes overall.

Improving Service Delivery and Strengthening Facility Readiness

To elevate service delivery and boost vaccination rates, focusing on facility readiness is essential. Inadequate service delivery dissuades women from seeking healthcare facilities, with issues like extended waiting times, limited vaccine availability, user fees, and transportation expenses as deterrents. Furthermore, negative childbirth experiences or lack of postnatal access can impact return rates for child vaccinations. Augmenting the number of skilled birth attendants reduces maternal and neonatal mortality rates and provides an opportunity for early vaccinations and parental education on vaccine importance.

Geographical Disparities and the Role of Access

Disparities in vaccination coverage between urban and rural areas are discernible. Despite improved access to immunisation services in urban regions, full coverage remains low, notably regarding pentavalent first doses. The reason behind this coverage gap is the lack of comprehensive documentation. Low vaccination rates are prevalent in densely populated rural areas with restricted and unreliable access due to factors like inadequate human resources, socio-economic disadvantages, limited education, and poverty.

The Significance of Road Access and Socio-economic Development

One of the prominent challenges causing disparities in healthcare access between rural and urban areas is the state of road access within PNG. Multiple sources highlight this issue as a bottleneck to development throughout the country. Enhancing transportation infrastructure would yield multifaceted benefits by improving healthcare and education facilities while fostering overall socio-economic development.

Education for Healthcare Workers and Sustainable Solutions

Although access to education for healthcare workers has improved, it remains insufficient to meet the expanding needs of the population and replace the ageing workforce. To incentivise rural healthcare workers and discourage migration for opportunities abroad, the government could offer free tertiary education in exchange for service in rural areas, accompanied by suitable housing provisions. This strategy would particularly aid healthcare workers and nurses crucial for effective immunisation programs. The successful Epidemiologist program could serve as a model and be extended to skilled birth attendants, CHWs, and other frontline healthcare staff, especially in rural regions.

Healthcare Policies and Immunisation Prioritisation in PNG

A comprehensive array of healthcare policies in PNG is designed to achieve extensive vaccination coverage. These policies aim to acknowledge and address bottlenecks, mitigate geographical

inequalities, and identify critical internal issues. The government significantly emphasises childhood immunisations due to their recognised cost-effectiveness and prioritises them accordingly. However, the decentralisation of the healthcare system has led to a disconnection between policy formulation and local council implementation. Consequently, this mismatch challenges the NDoH in effectively executing health plans and policies.

Population Data Challenges and Disparities

The literature review highlights the absence of accurate population data in PNG, with no official census conducted since 2011. Existing studies reveal weaknesses in the available data, especially concerning rural areas that have experienced population surges, further complicating the reliability of figures provided by governmental and non-governmental bodies like the PNG National NSO and the UNFPA. Despite the widely accepted growth rate of 3.1%, there is a discrepancy in reported population figures. The NSO reported 11.7 million individuals residing in PNG in 2023, while the UNFPA estimated 10.3 million in 2021. The NSO's calculation method, factoring in the growth rate, yields around 12.4 million, notably differing from the UNFPA's estimate of approximately 1.5 million people.

Implications of Population Disparity on Immunisation Programs

This significant variance in population figures holds implications for managing and planning immunisation programs. The uncertainty surrounding population data diminishes the effectiveness of procurement and distribution efforts, thereby impeding the success of immunisation initiatives. Urban and rural healthcare facilities and government services display limited reporting to the birth registry, particularly in cases where children are born outside healthcare facilities without skilled birth attendants. High illiteracy rates contribute to low birth registration rates, creating multifaceted challenges in planning, providing, and evaluating the nationwide immunisation program. It becomes evident that the presence of inaccurate population data highlights an unmet need for long-term strategic planning.

6.1 Study Limitations

The literature review undertaken by a single researcher had several limitations, which are noted below.

6.1.1 Interpretation Complexity of Framework

While the framework served its purpose of simplifying the understanding of the issues, it also introduced potential misinterpretations, especially because certain elements within the framework overlapped. An example of this complexity arises with the concepts of ‘perceived norms’ and ‘community access.’ Additionally, there exists a grey area between ‘perceived norms’ and ‘perceived control.’

6.1.2 Sustainability of ‘Intent to Vaccinate’

The notion of ‘intent to vaccinate,’ although valid at the time of the study, may not be a sustainable concept in the long term. Evidence indicates that mothers primarily influence whether a child receives vaccinations, and it is discussed in the original paper by Phillips et al. However, current national strategies aim to educate men and encourage their active involvement in the child's

healthcare as they are, at large, the decision-makers of the household, suggesting a potential shift in this influence.

6.1.3 Barriers

The analysis of barriers affecting vaccination coverage in PNG was conducted based on available resources and their relevance to the study's objective. Nevertheless, it is important to acknowledge the possibility of bias since not all barriers were thoroughly examined.

6.1.4 The gap in Available Data

Limited availability of peer-reviewed articles about immunisation in PNG posed a significant challenge. As a result, the study relied on nationally representative surveys such as DHS, other available reports, external evaluations, and independent information. Population data was also problematic due to unreliable sources, with lengthy periods between official censuses leading to estimates based on household surveys, the 2011 census, and data dating back an average of 10 years. Furthermore, there was a considerable lack of evidence regarding attitudes towards vaccination and perceived norms related to immunisation practices in PNG.

7 CONCLUSIONS AND RECOMMENDATIONS FOR POLICY MAKERS

To achieve the PNGs 2030 target of an improved vaccination rate, aiming to reduce infant mortality, prevent diseases, and alleviate the strain on health treatment services, significant changes need to be made at each level of the health system, as outlined in the PNG development strategic plan spanning from 2010 to 2030.

7.1 Recommendations

7.1.1 Increasing the funding and support for road infrastructure and maintenance

PNG must prioritise efforts to enhance accessibility across the country, connecting the capital city of Port Moresby with rural populations. A robust national government approach should prioritise the development of road infrastructure, major ports, and airstrips on smaller islands. Proper resource allocation is essential to cover maintenance costs and secure funding before commencing these projects. While initially strengthening partnerships with external donors, PNG should work towards self-funding ongoing expenses. Improving nationwide access will have a multifaceted impact, not only improving healthcare accessibility but also creating better education and development opportunities throughout the country.

7.1.2 Enhance backing for provincial health services to bolster, sustain, and enhance service delivery.

This encompasses funding healthcare infrastructure like clinics (equipped with dependable medical supplies sources), outreach programs, and prioritising cold chain storage facilities. Incorporate human resources planning in national strategy plans, and allocate resources to train doctors, nurses, and community healthcare workers. While access to education in healthcare settings has slightly improved, it remains insufficient to meet the growing needs of the population and replace the ageing workforce. To incentivise rural healthcare workers and reduce the likelihood of seeking international opportunities, the government could consider providing free tertiary education in exchange for working in rural areas and offering suitable housing options.

7.1.3 Enhance data management, strengthening and surveillance

Ensure that every child is registered immediately after birth to facilitate effective planning of immunisation programs. Develop vaccination records that are culturally appropriate yet comprehensive enough to identify any children who may have been missed during previous vaccination efforts. Enhance existing programs, like PNG's epidemiology training program, to bolster the response to disease outbreaks and address issues related to EPI. This should also include improving the collection, analysis, and interpretation of data to establish a robust immunisation program at the provincial level.

7.1.4 Community engagement and strengthening outreach immunisation programs

Ensuring skilled birth attendants are at every birth, will assist in neonatal hepatitis and BGC vaccination coverage and provide parents with knowledge regarding the importance of vaccines. Strengthening the capacities and education of community leaders to address vaccine hesitancy and reduce the spread of misinformation. Strengthening outreach programs to address the geographical barriers of vaccine inequality.

7.2 Conclusion

The review of vaccine coverage challenges in PNG underscores how insufficient healthcare access and a shortage of personnel have a substantial impact on immunisation efforts. These issues are compounded by weak governance, limited data capabilities, and susceptibility to natural disasters. Strategies that bring multiple benefits, such as increasing resources for skilled birth attendants, can elevate rates of maternal and child immunisation. Investing in road infrastructure will assist advancements in healthcare, education, and overall development. Strengthening collaboration between the NDoH and provincial governments is vital for effective healthcare strategies. To enhance vaccination rates in PNG, a comprehensive approach is imperative. Tackling these key areas promises significant progress in both immunisation rates and the overall healthcare system.

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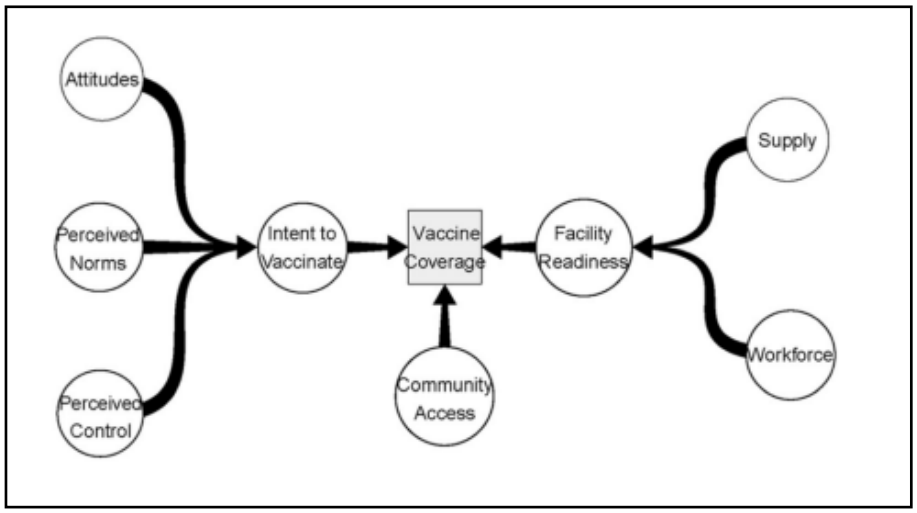
9 APPENDICES

Appendix 1



The conceptual and analytical framework adopted for this study was based on Phillips et al. "Determinants of effective vaccine coverage in low and middle-income countries"

Appendix 2

Framework	Strengthens	Weaknesses
Global Routine Immunisation Strategies and Practices (GRISP)	Identifies eight key points Identifies the need to find unvaccinated persons and look at interventions to reach them	Does not demonstrate interlinkage. Missing governance Facility readiness and access
Global Immunisation Strategic Framework 2021-2030 health services use.	Three simple goals, prevent detect respond. Simple to comprehend	Not Comprehensive Does not include health systems
Determinants of effective vaccine coverage in low and middle-income countries	Simply, easy to understand. Analysed 78 articles, integrating three existing conceptual frameworks. Designed specifically for LMIC	Does not acknowledge or include governance or Information technology Perceived norms and perceived control are not intuitive and require explanation

Strengthens and weaknesses of the potential frameworks

Appendix 3

Chat GPT Prompts

An Artificial intelligence program, Chat GPT was used as a tool to assist in proofreading, ensuring clarity of writing.

The following dot points were used as prompts with my own work into the program:

- Provide me a list of words and phrases which were repeatedly / more than 3 times used: [PARAGRAPHS]
- I want you to act as a proof-reader. I will provide you with texts and I would like you to review them for any spelling, grammar, or punctuation errors. Once you have finished reviewing the text, provide me with any necessary corrections or suggestions for improving the text. [PARAGRAPHS]
- Scan for repeated words or phrases and rephrase or replace them. [PARAGRAPHS]
- Look for and correct all misspelt words and grammatical errors. [PARAGRAPHS]
- Suggest ways I can improve sentence structure in the following text: [PARAGRAPHS]
- Highlight any readability issues. [PARAGRAPHS]

Appendix 4

Data extraction table

Author	Year	Type of study	Objective number(s)	Keywords
Lehmann et al. 2005		Retrospective cohort study	3	Civil fighting, access issues
Morgan et al. 2020		Cross-sectional study	2 3 4 5	EPI child health books, vaccine wastage
Gowin et al. 2021		Cross-sectional study	2 3 4	Data analysis, cold chain Access, vaccine knowledge
Ishuida, et al. 2022		Cross-sectional study	2 3 4	Community engagement education of mothers, corruption
Vince et al. 2014		Cross sectional study	3 4	Aid post closure, administrative bottlenecks, brain drain
Samiak et al	2017	Observational study	2 4	Vaccine knowledge urban resources outreach programs surveillance
Ropa et al	2019	Observational study	4 5	PNG field training, epidemiologists
Wisen et al	2014	Mixed methods study	2 4	Hepatitis B, skilled birth attendants, cold chain
Budu et al	2020	observational cohort study	4	Handheld records, child mortality, missed children
Lee et al	2020	Cross-sectional study	1 3	inadequate refrigeration Skilled birth attendant, lack of knowledge
Downing et al	2008	Observational study	1 2	Staff attitudes/ knowledge towards vaccine, lack of vaccine stock
Kitau et al	2015	Cross-sectional study	1 2 3	Transport, distances vaccination cards lack of vaccine in maternity units cold chain
Sutanto A	1998	Mixed method study	4 5	Cold chain, skilled birth attendants/ midwives
Riddel et al.	2012	Retrospective cohort study	4 5	Health financing SAIs vs EPI

Field et al. 2018	Mixed Methods Evaluation	2 3 4	Health systems healthcare worker accommodation vaccine storage
Thomason et al. 2009	Literature review	4	Decentralisation Organic Law
Blyth C 2017	Cross-sectional study	2 3	Health books access, supply, parental education
Datta et al 2012	Cross-sectional study	1 2 3	Road access, SAI cost outbreaks
Kaind et al 2020	Observational study	3 4	Access, healthcare infrastructure
Kamac et al 2017	Cross-sectional study	2 3	EPI vaccine wastage, incorrect usage, cold chain
Brennan E, 2023 Abimbola S.	Systematic literature review	4 5	Decentralisation, financing capacity
Mazige et al - 2016	Systematic literature review	1 2 3	Hard to reach, determinants vaccine attitudes/knowledge gender, poverty
Duke et al 2004	Literature Review	2 3 4	Cold chain logistics Governance, training/ education population data
Razee et al 2014	Qualitative cross-sectional	1 2 4	Knowledge, attitudes population data, outreach crime gender
Gibson, J Rozelle S 2003	Literature Review	2 4	Road, maintenance, poverty development
Namugi P 2005	Cross-sectional study	1 2 3 4	Access, vaccine knowledge health workforce
Bourke et al. 2021	Literature Review	4	Population birth registry gender census