**IMMUNISATION AND CHILD MORTALITY IN WEST AFRICA**

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(20PGEA000121)**

**BEING A RESEARCH DISSERTATION SUBMITTED TO THE**

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**DECLARATION**

I, Ojone Patience ISHOLA, an MSc. student in the Department of Economics, Landmark University, Omu-Aran, hereby declare that this dissertation entitled “Immunisation and Child Mortality in West Africa”, submitted by me is based on my original work. Any material(s) obtained from other sources or work done by any other persons or institutions have been duly acknowledged.

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Signature & Date

**CERTIFICATION**

This is to certify that this dissertation has been read and approved as meeting the requirements of the Department of Economics, Landmark University, Omu-Aran, Nigeria, for the Award of MSc. degree.

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**DEDICATION**

To God, the author and finisher of my faith.

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**ABSTRACT**

This study sought to investigate the effect of immunisation coverage on child mortality in fifteen West African countries, with interest on the Global Vaccine Action Plan (GVAP). Panel data was sourced from the World Development Indicators for the period 2000-2019. Three objectives were addressed. The first assessed the trend in immunisation coverage and child mortality in West Africa; the second examined the levels of immunisation coverage on each vaccine-preventable disease for each country in West Africa and the third objective investigated the impact immunisation coverage had on child mortality, pre- and post-GVAP. The trend analysis was used for the first objective; descriptive statistics (specifically a table) was used for the second objective and fixed effects estimation was implemented for the third objective using three models. The trend revealed increasing immunisation coverage reduced child mortality rate. From the table more countries in West Africa are above the average (percentage) level in immunisation coverage for Diphtheria, Pertussis and Tetanus (DPT), Hepatitis B3 and measles. The empirical findings show that, immunisation coverage did not significantly impact child mortality before the GVAP initiative. In contrast, for the post-GVAP era, only HepB3 immunisation coverage significantly reduced child mortality. Also, maternal literacy and improved water source were significant in reducing child mortality. Gross Domestic Product per capita was insignificant, probably due to low allocation to health. It was recommended that governments in West Africa could strengthen the impact of the GVAP initiative by ensuring an enabling environment for the initiative through its African Regional Immunisation Strategic Plan to carry out its objectives; and programmes that promote awareness for mothers could be implemented by governments within this region with the aim of achieving reduction in under-five deaths.

**CHAPTER ONE**

**INTRODUCTION**

# 1.1 Background of the Study

Health, an indispensable part in human capital, is a major determinant of economic growth and development both at the micro and macro levels. The wellbeing of individuals enhances their inputs as well as achievements within units and in the economy at large, in the long run. The future of sustainable economies is birthed from healthy populations (World Economic Forum/Bain and Co, 2016). Healthy populations arise from healthy children who are mostly present in school, attain higher education level for longer years; leading to a healthy productive workforce that will yield high returns for establishments and a steadier tax revenue for maintaining such economies (Amiri & Gerdtham, 2013).

The United Nations through its Sustainable Development Goals (SDGs) seeks to support the wellbeing of children by reducing child mortality. Child health, as defined by First Things First (FTF, 2007) coined by the World Health Organisation (WHO), refers to the wellbeing of any child physically, intellectually, socially, mentally, and emotionally and not necessarily the nonexistence of sickness.

The global decline in child deaths from 12.6 million in 1990 to 5.6 million in 2016, and 5.0 million in 2020 (UNICEF, 2021) is noteworthy, however, there are still over 12,900 child deaths daily from circumstances which could have been avoided, with more than 79 per cent occurring in Southern Asia and sub-Saharan region of Africa, and Nigeria and India accounting for about a third of this percentage (UNICEF, 2018). In sub-Sahara Africa, out of 13 children, one child does not live to witness their fifth birthday, and this death is caused primarily by many factors like undernourishment (44.99%), preterm birth complications (about 17.99%), pneumonia (about 15.99%), intrapartum-related complications (12.0%), diarrhea (8.0%), neonatal sepsis (7.0%), and 5.0% for malaria (World vision, 2018). Almost half of these under-five deaths could be prevented (with vaccinations) or treated (oral rehydration treatment) through access to skillful care pre-birth, at birth, and post-delivery care for mother and baby. Nutrition –related factors such as maternal malnutrition, poor breastfeeding practices makes the children vulnerable to severe diseases. In addition, one out of every three death is caused by pneumonia, diarrhea, and malaria which constitute about 35.99 per cent of all child deaths in Africa (UNICEF, 2019).

A child’s future consists of unlimited possibilities. However, a number of childhood diseases affect the learning ability of children thus limiting skills acquisition, interests and experiences. In addition, physical defects, brought about by polio, can disrupt a child’s ability to function properly and is therefore carried into adulthood. Hereafter, the physical productivity level of such an individual is restricted or diminished (Report of the Partnership for Maternal Newborn and Child Health, 2013). A healthy child makes it possible for the parents to engage in productive activities that will contribute to the family’s income as well as the national income; also, resources which would have been spent on medical treatment, could be channeled into educating the child, acquiring relevant skills, exploring different interests, thereby preparing that child to be more relevant in the society. The pursuit for improved wellbeing of the child cannot be overemphasised.

A government whose interest is centred on the health of children is seeking to enhance the economic growth of the nation drawn from healthy children who attain higher levels of education and a highly productive workforce in later years (Amiri & Gerdtham, 2013; Stenberg, Axelson, Sheehan, Anderson, Gulmezoglu *et al*, 2013). This benefit is a plausible incentive for government’s involvement in the provision of health care facilities and services.

A healthy adulthood is prepared for when a child’s health is nurtured, and opportunities to embrace good habits abound which is void of any form of abuse. Influences on a child’s health revolve around the mother’s health status, educational level, habits and the environment before and during the conception of that child (First Things First, 2007). Another determining factor of the health of a child is parents’ earnings which defines the state of health of the parents, influences the child’s feeding, hygiene, and primary health care (Gunther & Fink, 2010; Wolfgang, Veronique, Bernard, Arsène & Valentin, 2013; Boco, 2010; and Rasella, Aquino, Santos, Paes-Sousa & Barreto,2013). Individual level and government level of spending on health care is another contributing factor to a child’s health (Novignon, 2012). All these contributory factors to a child’s health are representatives of health investments at different levels. Among the different means of improving health outcomes is the extent or coverage of immunisation.

Immunisation coverage as a public health investment, captures those who accessed available vaccine-preventable disease (VPD), and monitors immunisation coverage services which is useful for eliminating diseases (World Bank, 2021).The World Health Organisation (WHO, 2015) through the Global Immunisation, Vision and Strategy (GIVS) initiative launched the African Regional Immunisation Strategic Plan from 2009- 2013 to cater for the gaps encountered in immunisation access and delivery within the region. Thereafter, the Global Vaccine Action Plan (GVAP), a follow up plan on GIVS between 2011 and 2020 was implemented to meet target of vaccine coverage in communities, countries and regions; eradicate polio; exceed the Millennium Development Goals (MDGs); meet elimination targets regionally and globally as well as develop, introduce and improve vaccine and technology. The WHO’s African Regional Immunisation Strategic Plan for the GVAP, from 2014 - 2020 was set up to improve immunisation coverage, eliminate measles, have control over vaccine-preventable disease (VPD), among others (WHO, 2015).

During the 2009 - 2013 strategic plan, in Africa, among 31 countries at risk of yellow fever, the vaccine was introduced in 23 of these countries, with 90% vaccine coverage in four of the countries; Diphtheria, Pertussis, Tetanus (DPT) and measles vaccine coverage was around 70%; polio eradication neared attainment; all countries except one witnessed the introduction of hepatitis B (Hep B) and Haemophilus influenzae type b (Hib b) vaccines, and the measles vaccination rose from 53% in 2001 to 73% in 2013 (WHO, 2015). The expectation is that these vaccines should help reduce child mortality. It is therefore important to assess whether the level of immunisation coverage in West Africa has achieved the intended purpose of reducing child mortality with the GVAP initiative.

**1.2 Statement of Research Problem**

Child mortality rate is still a major concern in sub-Saharan Africa, seeing that health is a necessity for promoting economic development, especially in West Africa where the member states are low- and middle- income countries, and largely dependent on agriculture and other labour-intensive endeavours. Perin, Mulick, Yeung, Villavicencio, Lopez, Strong, Prieto-Merino, Cousens, Black and Liu (2021) as regards causes of child mortality nationally, regionally and globally, stated that the decline in under-five mortality globally is primarily as a result of a fall in preventable deaths, which constitutes 63.3 per cent of the total decline, since year 2000. Majority of under-5 deaths globally, were observed to occur in Africa and Asia representing 59.5 per cent of the global mortality rate(Askeer, Lawn, Keenan, Konstantopoulos, Cooper, Ismail, Thacker, Cabral, & Bhutta, 2015).

From data in recent years, the African continent has experienced some levels of variations as regards coverage of immunisation and child mortality. There has been some improvements in Diphtheria, Pertussis and Tetanus (DPT) vaccine coverage from 57 per cent in 1999 to 71 per cent in 2011. Countries like Guinea and Mali showed improvement but there was decline in coverage in Gabon and Equatorial Guinea. In spite of this improvement, the DPT and measles coverage experienced some hindrance which slowed its progress in last three years of the 2009 -2013 strategic plan (WHO, 2015). Also, coverage for Hepatitis B vaccination in West Africa rose from almost zero per cent in 2000 to above 50 per cent in 2011 except for countries like Liberia, Gabon and Chad. In 2013, as a result of Supplementary Immunisation Activities (SIAs), measles vaccination covered 87 million children only in 16 countries in Africa, with about a quarter of these countries conducting follow up SIAs. However, the reappearance of the measles outbreak serves as an indicator of insufficient measles vaccination coverage within the region. What is the level of immunisation coverage for diseases that could be prevented by vaccines in each country within the West African region? Which countries in West Africa have fared well and which have not, in this respect? This is an important question which this study intends to answer.

The GVAP initiative was introduced to ensure the protection of all people from VPDs as a result of improving coverage for immunisation by 80 per cent in every district and 90 per cent in every country; encourage government’s continued support for protecting their citizens from VPDs; eliminate measles in minimum five WHO regions; exceed the target of reducing child mortality among others (Immunisation newsletter, 2013). This question comes to fore, has the GVAP initiative significantly contributed to increasing the level of immunisation coverage in West Africa, thus achieving one of its major objectives which is to reduce child mortality? Is there a remarkable difference in the impact exerted by the GVAP initiative in terms of immunisation coverage, on child mortality, relative to the pre-GVAP era in West Africa? This investigation is important to help determine the effectiveness of the GVAP initiative in West Africa and to help proffer appropriate policy recommendations.

**1.3 Research Questions**

The study posits the following research questions,

1. What is the trend of immunisation coverage and child mortality in West Africa?
2. What is the level of immunisation coverage on each vaccine preventable disease for each country in West Africa?
3. Does immunisation coverage have a significant impact on child mortality before and after the GVAP initiative in West Africa?

**1.4 Objectives of the Study**

The overall aim is to examine the impact of immunisation on child mortality in West Africa. The specific objectives are to:

i examine the trend of immunisation coverage and child mortality in West Africa

ii examine the level of immunisation coverage on each vaccine preventable disease for each country in West Africa

iii investigate the impact of immunisation coverage on child mortality before and after the GVAP initiative in West Africa

**1.5 Research Hypotheses**

1. H0: immunisation coverage has no significant impact on child mortality pre-GVAP in West Africa

H1: immunisation coverage has a significant impact on child mortality pre-GVAP in West Africa

2. H0: immunisation coverage has no significant impact on child mortality post-GVAP in West Africa

H1: immunisation coverage has a significant impact on child mortality post-GVAP in West Africa

**1.6** **Justification of the Study**

In West Africa, research on the relationship between health investments and child mortality are recently evolving. Consequently, it is essential that more empirical studies are carried out on the effects of immunisation on under-five mortality in West African region as well as enlighten researchers within the health sector in making informed decisions as regards investments in children’s health that would enhance and affect the future adult life. This research will also help national governments to identify the level of immunisation coverage and put appropriate policy measures where necessary.

In addition, this study is particularly important for researchers in development economics considering the rate of child mortality within the West African region, and human capital (health), which is a strong determining factor for economic growth and development, globally and specifically in the developing countries. Policy makers within the West African region can garner insights from the results of this research to improve the wellness of children across her member states, as well as proffer policy recommendations at the regional level.

**1.7 Scope of the Study**

This study aims to explore the effect of immunisation coverage on child mortality in West African countries. The 15 West African countries to be considered are Benin, Burkina Faso, Cape Verde, Cote d’Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The study covers the period of twenty years, from year 2000 to 2019, which captures the commencement of the Millennium Development Goals (MDGs) and the current Sustainable Development Goals (SDGs) set by the United Nations, as well as the GIVS (2006-2015) and GVAP (2011 -2020) initiatives. The end period is based on the availability of data on all variables to be used as sourced from World Bank’s World Development Indicators (2021). Immunisation coverage for this study will be captured by measles, DPT and hepatitis-B vaccines based on data availability.

**1.8 Outline of the Study**

The study contains five chapters. Chapter one is the introduction which includes the background of the study, statement of research problem, research questions, objectives of the study, research hypothesis, scope of the study, limitation of the study and the significance of the study. Chapter two is the literature review which includes the conceptual issues, theoretical review, and review of recent literatures involving different health investments and outcomes. Chapter three involves the research methodology used in the study. Chapter four captures results and discussions. Chapter five includes the summary, conclusions and recommendations.

# CHAPTER TWO

# REVIEW OF RELATED LITERATURE

**2.1 Introduction**

This chapter involves an overview of conceptual issues, review of theories and empirical studies. It wraps up with the research gap.

**2.2 Conceptual Issues**

**2.2.1 Child Mortality**

UNICEF (2021) defines child mortality also known as under-five mortality, as the probability of a child dying from the time of birth to five years of age, which is expressed per 1,000 live births. This definition is also in agreement with the UN inter-agency group for World Bank (2021), as the probability per 1,000 that a new born will die before getting to five years. The definition of the probability of death of children under-five (5) years of age will be adopted for this research as also adopted by Roser *et al*. (2013); this is the death that occurs between the first and the fifth birthday (Monnier, 2001). This comprises neonatal mortality and infant mortality. Neonatal mortality refers to death within the first twenty-eight (28) days of a child’s life while infant mortality refers to the death of young children less than one years of age (WHO, 2019).

Child mortality rate is the measurement used to capture the percentage of newborns that die before reaching five (5) years which is expressed in units of death per 1,000 live births yearly. It is the share of children born alive that die before the age of five. Perinatal mortality rate refers to deaths less than one week after birth divided by the number of births in total. Neonatal mortality rate captures deaths within the first twenty-eight (28) days of life divided by the total number of births. Infancy mortality rate measures the number of child deaths within the first twelve (12) months of life dividing it by the total number of births. Under- five mortality rates captures the number of child deaths within the fifth birthday divided by the total number of births (WHO, 2015).

**2.2.2 Immunisation**

The Centres for Disease Control and Prevention (CDC, 2021) define immunisation as the process by which a person is protected against a disease by being vaccinated. Immunisation, also referred to as vaccination or inoculation, is the protection given to someone against diseases or infection by administering vaccine (WHO, 2022). The World Bank (2021) defines child immunisation as the percentage of children, below one year, who have received complete doses of vaccinations. Immunisation coverage for children below one is measured as the number of children fully immunised divided by total number of children under one years of age (Babu & Gajanan, 2022). It is the proportion of eligible children who have been vaccinated (Edelstein, 2017).

## 2.3 Review of Theories

## 2.3.1 Grossman’s Health Demand Theory

The Grossman model of health demand (1972) considers health as a durable capital good and as an investment. The economic approach to the model views individuals demand for health as a commodity. This Grossman health production function is a human capital model implemented to observe several relationships with health such as education, uncertainty, inequality, socioeconomic status (Cropper, 1977; Phelps, 1976; Case & Deaton, 2005) among others. Health as a durable good is a stock of human capital which depreciates over time with age and appreciates as a result of investment. Health investment can take the form of medical care, income, nutrition, environment and time. The efficiency of the aforementioned inputs can define the effect of an individual’s access to formal education, sanitation, among others. The investment effect of health demand increases healthy time for profitable activities or non-market activities.

At a given level of education, the Grossman model shows how health inputs determine health outcomes. For the sake of this research, education is conceived in terms of the literacy of mothers as this in one way or the other has implications for the health outcome of their children. The interaction between health demand function and health production function results in a consumer attaining equilibrium when his health demand equals his health inputs. Considering the budget constraints, the consumer seeks the highest indifference curve obtainable in order to derive maximum utility.

This model infers that healthy individuals require less medical care than less healthy individuals. On the macro level, countries having less health problems require lesser health investments compared with those having a relative less healthy population (Yashim, 2014). Also, from the macro perspective, West African countries are largely developing countries with more health challenges, therefore increases in health investments, are expected to help improve health outcomes, in this case, reduce child mortality.

## 2.3.2 Mosley-Chen Conceptual Model of Mortality

## This model attempts to intermediate between the approaches of social sciences and the medical sciences, and their research methods in the study of determinants affecting child survival in developing countries (Mosley & Chen, 1984). Mosley and Chen (1984) argue that a health status and mortality outcome is brought about by causal effects of socio-economic factors, proximate determinants and the risk of diseases. Socio-economic determinants, otherwise known as background factors involve individual level factors (such as maternal literacy, child characteristics, nutrition), household level factors (economic status), and community level factors (such as health care facilities, basic sanitation facilities, safe water supply, transport services, ecological setting, political economy, among others).

Nutrients insufficiency (calories, protein, and micronutrients), control of personal illness (medical treatment, preventive measures taken personally), contamination in the environment (air, food, fingers, soil, inanimate objects), injury (accidentally, intentionally) and maternal factors (age, interval in births, parity) comprise the proximate determinants. Children can move from a healthy state to a sick state caused by nutrients inadequacy, injuries, contamination in the environment and maternal factors, however, personal illness control aids prevention and treatment. In order to arrive at health outcomes (child mortality), the model recommends that the interrelationship and the direction of causality from the socio-economic factors should be investigated.

Mosley and Chen model (1984) was criticised on the grounds that modeling proximate factors on socioeconomic factors do not provide any direct evidence to possible health improvements; contamination in the environment are not easy variables to be satisfactorily measured. Secondly, in adopting a model that incorporates socio-economic factors and proximate determinants of child health, it is difficult to interpret the residual effect of socio-economic factors after controlling for proximate determinants. Finally, the reduced form approach of socio-economic factors and child mortality does not make available what can be focused on by health systems to improve health status (Hill, 2003).

**2.3.3 Economic Growth-Oriented Theory**

Filmer and Pritchett (1999) in this model analysed the relationship between health care expenditure and health results from an economic perspective. The authors opine that there is no significant effect of public health care expenditure on health outcomes. However, empirical literature linking public health expenditure on health status reveals positive significant effects. Hamner *et al* (2003) in adopting this school of thought reinforced the importance of public health spending and contradicted the view of economic growth as a major determinant of child health. Rajkurmar and Swaroop (2008) give insight to the variations in observations brought about by the quality of effectiveness of governments’ involvement and the quality of bureaucracy which makes the difference in the health outcome.

**2.3.4 Demand for Health Theory**

Economic approach by Wagstaff (1986) lays emphasis on the part played by economic forces in determining health-related outcomes, individuals demand for a commodity-health. This theory is founded on three concepts: the indifference map, health production function, the budget constraints. The indifference map assumes that people value their health but they do not take the required steps to improve their health; the health production function sees individuals as producing their health status when they take necessary steps such as exercise, diet, in order to improve their health outcome. The budget constraints views individuals as having limited income that may not be sufficient to support their health production. Therefore, the government through its budgetary allocations makes provisions for health care facilities and services and the required medical personnel in order to improve their health status, thus resulting in reduction in mortality.

Wagstaff analysed the connection of health socio-economic determinants with socioeconomic inequalities in health and prevention policies design. This theory views health care as an input in the health production function, out of the numerous inputs, which results in low mortality rates. The theory predicts that an increase in education will result in better health conditions as fewer health inputs will be required. However, not enough empirical studies have used this theory and more empirical studies are required to support or refute the predictions of this theory.

**2.3.5 Wagner’s Law**

Wagner (1893) postulated the “law of increasing state activity”, which explains that rising real per capita income results in rising public expenditures. This is based on increased activities of the public sector over the private sector; the need to oversee welfare functions such as public health, education, environmental safety; and technological change brought about by industrialization will cause governments to supply merit and social goods. There have been different observations to the validity of this law. Some studies using different analysis carried out by Demirbas (1999), Henrekson (1993) found no relationship between public expenditure and the Gross National Product, whereas some others had mixed evidence in multi-dimensions (Bohl, 1996; UKEssays, 2018).

The reviewed theories above provide a broader interpretation on theories that support this study, however, this research will adopt the Grossman’s health demand theory being that it is widely accepted by health economists and modifications can be made to suit macro data (Hartwig & Sturm, 2017).

**2.4 Review of Empirical Studies**

Many studies have been carried out in investigating different aspects of investments or expenditures as it relates with child health, both economically and medically. This review involves previous studies that generally analysed the effect of health investments on child health, and in particular under-five mortality. The empirical review is grouped into three categories: based on developed countries, developing countries except Africa, and developing countries in Africa.

**2.4.1 Empirical Studies on Developed Countries**

Raeesi *et al* (2018) examined the effects both private and public health expenditures had on infant mortality, child mortality and life expectancy in 25 countries having different health care systems from 2000 to 2014. Random effect model and multivariate regression model was used to analyse the time series and pooled cross-sectional data, which showed that health expenditures from both public and private sectors had significant impact on these health outcomes in countries having a national health care system and mixed health financing system respectively. In order to improve the health status of individuals, policies that promote the best combination of public and private health expenditures should be adopted. This research was based on developed countries and as such the findings may not be applicable to developing nations.

Bennet, Gumus and Vishwasrao (2018) investigated the effectiveness of specific public health expenditure on infant mortality using Florida as a case study between 2001 and 2014. The Generalized method of moments was used to estimate the longitudinal data set, which revealed that significant inverse relationship exists between targeted government health spending and infant mortality rates. The research concluded that governmental health allocations should be geared towards specific infant programmes that will enhance the health status of children. This research was limited to Florida, a state in the United States of America and may not be generally applicable to countries in developing countries.

Linden and Ray (2017) explored the effects of life expectancy of public and private health expenditures in 34 Organisation for Economic Co-operation and Development (OECD) countries from 1970 to 2012 using panel unit root test, impulse response analysis and panel VAR models. The results show that there is a positive significant relationship between public health expenditures, private health expenditures and life expectancy; this implies that larger expenditures in public health serve as a launching pad for increased life expectancy and also a drive for private expenditures, especially in highest public share clusters with the exception of USA. This study focused on developed nations and thus the conclusions may not apply to developing countries.

It can be deduced that child mortality in the developed countries seems not to be a burden, hence the scanty literature.

**2.4.2 Empirical Studies on Developing Countries Excluding Africa**

Bulus and Bakirtas (2021) investigated the effects of public health spending on child mortality between 2000 and 2019 in Next-11 countries. Pooled ordinary least square and generalized method of moments were used to analyse the dynamic panel data. Discoveries from the research show that health expenditure reduces child mortality in these countries, increasing per capita GDP also resulted in a drop in under-five mortality. However, this study was not based specifically on West African countries, therefore, the findings may not be applicable.

Ali, Gilani and Abdin (2020) conducted a study in Pakistan assessing the impact of government healthcare expenditures on health outcomes. The ADF test and ARDL model was used in analysing data from 1982 to 2016, which reveal that in the long run, public healthcare expenditures was significant in reducing infant mortality. It was concluded that government’s intervention in increasing the number of skilled medical personnel, improving health facilities and services would help reduce infant deaths. Low income countries will however require fund assistance for provision of resources. Such funds will require proper allocation, and utilisation to bring about enhanced well-being.

Ray and Linden (2019) explored the effects of private and public health expenditure on life expectancy at birth and infant mortality from 1995 to 2014. The dynamic panel model estimators was used in the analysis and revealed that for most countries, public health expenditures enhance health more than private expenditures. Although, the effects of primary education surpassed that of health, increases in public health spending reduced infant mortality. Due to the unavailability of life expectancy and infant mortality data for poorest countries, the research could not establish any stand on the effectiveness of public expenditure over private expenditure in these countries. It was concluded that although public health expenditures appeared more effective than private expenditure, much health spending was still required, to ensure the availability of health care services so that the poor could easily access them.

In the findings of Dhrifi (2018), upon studying healthcare expenditures, and its impact on economic growth and infant mortality with evidence from developed and developing countries, the author concluded that there was a positive effect of health expenditure on reducing child mortality only for upper- middle-income and high-income countries, with no significant impact on low-income and lower -middle-income countries. Also, public health expenditure had greater impact on mortality rates than private investment at lower development levels, while at high development levels, private health spending had positive impact on child mortality.

Deduction from these studies implies that developing countries require increased and improved public health investments so as to enhance accessibility and availability of skilled medical care and services.

**2.4.3 Empirical Studies on Developing Countries in Africa**

Azuh, Osabohien, Orbih, and Godwin (2020) studied the effects of public health expenditure on mortality of under-five children in Nigeria. The autoregressive distributed lag technique was engaged in assessment. The outcome of the investigation showed a positive significant relationship between public health expenditure and child mortality. The mismanagement of health fund in Nigeria may be a reason for this as well as low level of maternal education. The researchers concluded that proper allocation and management of health fund will result in improvement in the health outcome. One country was the area of focus and its findings may not be generalised to other West African countries.

Kiross, Chojenta, Barker, and Loxton, (2020) examined the impact of private, public and external health care expenditure on infant mortality in sub-Saharan Africa. Random effects model was used to assess the panel data involving 46 sub-Saharan African countries from 2000 to 2015. The result showed an inverse significant relationship between public and external health care expenditure and infant and neonatal mortality, and an insignificant relationship between private health spending and infant and neonatal mortality. The authors emphasised the importance of health care spending in reducing mortality of infants and neonatal in sub-Saharan Africa through improved health facilities. As such, more budgetary allocations should be encouraged. Also partnerships should be established between public and private health players to further reduce mortality. The focus of this research was not specifically on West Africa, and as such may not be generally applicable to countries within the region.

Van Malderen, Amouzou, Barros, Masquelier, Van Oyen, and Speybroeck (2019) examined the impact of factors such as place of residence, wealth, education, and child gender on child mortality in 32 countries in sub-Saharan Africa. Data was gathered from the Demographic and Health Survey for 366,960 children. It was discovered that major inequalities existed in sub-Saharan Africa among these factors. Low mortality was observed in urban areas of countries like Niger, Senegal and rural areas of Congo and Kenya, explained by policies and health systems. The study also revealed that maternal education had a positive effect on reducing child mortality within the regions.

Nketiah-Amponsah (2019) investigated health expenditure impacts on health outcomes in sub-Saharan Africa. The research examined impacts of macroeconomic and social factors on life expectancy and mortality of children and mothers. The research was conducted on 46 countries in sub-Saharan Africa from 2000 to 2015 using descriptive and analytical methods. The result showed that a 1 per cent increase in health expenditures was significant in reducing child and maternal mortality by 0.5 per cent and 0.35 per cent respectively, as well as improving life expectancy by 0.06 per cent. The author concluded by asserting that improvement in health outcomes in sub-Saharan Africa can be brought about by consistent increases in health expenditure. However, this study did not employ any econometric estimation technique.

Olatunde, Adebayo and Fagbemi (2019) examined the long run relationship between government health spending and child mortality in 15 countries in West Africa from 1991 to 2015. Panel fully modified ordinary least square (FMOLS) was used to ascertain that public health expenditure has a significant effect in reducing under five mortality in West Africa. It was concluded that immunisation, maternal literacy, and the quality of institutions were important determinants for child mortality reduction so they should be prioritised. Also, governments of these countries should increase their budgetary allocations to health sectors for notable improvements. The model used in this study omitted HIV prevalence, which reflects maternal morbidity, a key variable that captures depreciation in health.

Akinlo and Sulola (2019) examined the impact of spending in public health on mortality of under-five and infants in 10 selected sub-Saharan African countries. They analysed their research using pooled OLS, fixed effects and dynamic panel generalized method of moments. The result showed that there exists a positive effect of public health expenditure on infant and child mortality, a negative significant effect of GDP per capita, immunisation, and health assistance, on child mortality. It was concluded that the possibility of corruption in sub-Saharan Africa has hindered the effective utilisation of public health care expenditures being translated into improved child health status. Also, higher income levels would reduce child mortality and this could be achieved by transforming the agricultural sector. Similarly, government should inspire measures to improve health aid that will thus reduce under-five mortality in sub-Saharan Africa. The results obtained may not be generalised to all sub-Saharan countries as a result of difference in the political systems across the region.

Adedokun, Uthman, Adekanmbi and Wiysonge (2017) investigated incompletely immunised children in Nigeria. The cross-sectional data involving 5,754 children aged 12-23 months from 37 states was analysed using multilevel multivariable logistic regression. Over 75 per cent of the children were not fully immunised, over 80 per cent of children from young mothers aged 15-24 years and unlearned mothers were not completely immunised. The more difficult it was to access health facilities and social amenities, the higher the likelihood of incomplete immunisation. The researchers concluded that individual factors, community- and state- level factors are determinants of immunisation completion. This study was focused only on one country within West Africa

Yaya, Ekholuenetale, Tudeme, Vaibhav, Bishwajit, and Kadio (2017) carried out a study on determining the prevalence and factors of childhood mortality in Nigeria. Dataset from 8658 couples obtained from DHS Nigeria, 2013 was analysed using zero-inflated negative binomial (ZINB) regression analysis. The report showed that more men (37.3%) lost children than women (30.8%); age, region, education, religion, wealth, residence, were important factors linked with child mortality. The increase in ages of fathers and mothers were found to increase the occurrence of mortality in children; mortality was more prominent in rural areas; the higher the education level the lower the chances of mortality. The researchers conclude that programmes that could enhance and empower parents via education and profitable ventures should be encouraged by the government.

Ezeh, Agho, Dibley, Hall, and Page (2015) evaluated the factors that pose as mortality risks to post-neonatal, infant, child and under-5 children in Nigeria. The pooled cross-sectional data was drawn from Nigeria Demographic and Health Surveys for three years. The result revealed that mothers with no formal schooling, living in poor homes and in rural areas increased the possibilities of mortality among children in Nigeria. Also, age, child gender, teenage mothers, and previous delivery mode had significant association with mortality. Interventions such as community-based ones should be enhanced to assist parents with low socioeconomic status and living in rural settings.

McGovern and Canning (2015) investigated the relationship between vaccination and child mortality from 1985 to 2011 using survey data. Modified Poisson regression was used to analyse the data gotten on almost one million children from 62 countries. Their finding showed that immunisation, especially vaccines for measles and maternal tetanus, was significant in reducing under-five mortality. They also estimated that increasing vaccination coverage in a bid to reduce under-five mortality would be a cost-effective approach. This research was not based specifically on countries in the West African region, and the findings may not be generally applicable.

**Table 2.1:** Table showing some relevant empirical literature and some gaps in the literature

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | AUTH-OR | TITLE | PER-IOD | VARIABLES | METHOD | COUN-TRIES | RESULTS | GAP |
| 1 | Akinlo and Sulola (2019) | Health care expenditure and infant mortality in sub-Saharan Africa | 2000-2008 | Per capita health expenditure, total health expenditure, health aid, immunisation, urban rate, HIV prevalence, GDP per capita | Pooled OLS and fixed effects estimation, dynamic panel generalised method of moments | 10 selected sub-Saharan countries | Government health spending has a positive effect on child mortality, whereas GDP per capita, HIV, immunisation, total health expenditure and health aids have a negative effect | The result may not be generalised to all sub-Saharan countries as a result of difference in political systems across the region |
| 2 | Olatunde, Adebayo and Fagbemi (2019) | Health expenditure and child health outcome in West Africa | 1991-2015 | Institutional quality, female literacy rate, immunization, per capita health expenditure, Gross Domestic Product per capita, doctor availability | Panel fully modified least square (FMOLS) | 15 West African Countries | Increasing government health expenditure will significantly reduce under-five mortality; female education, available doctors, institutional quality and immunization are important to reduce child mortality | HIV prevalence which reflects maternal morbidity was omitted from the model |
| 3 | Nketiah-Amponsah (2019) | The impact of health expenditures on health outcomes in sub-Saharan Africa | 2000-2015 | Health expenditures per capita, , GDP per capita, carbon emission, physician population, HIV prevalence | Descriptive and empirical methods | 46 sub-Saharan African countries | An increase in health expenditure significantly reduced child mortality, maternal mortality and improved life expectancy | No econometric estimation technique was employed |
| 4 | Raeesi *et al* (2018) | Effects of private and public health expenditure on health outcomes among countries with different health care systems: 2000 and 2014 | 2000-2014 | Public health expenditure, private health expenditure, real per capita income, per capita number of physicians | Random effect model, multivariate regression model | 25 countries with different health care systems | Both public and private health expenditure has significant impact on life expectancy, infant mortality and child mortality in countries with national health care system and mixed health financing system respectively was important in | The research was based on developed countries and such findings may not be applicable to developing nations |
| 5 | Linden and Ray (2017) | Life expectancy effects of public and private health expenditures in OECD countries 1970 - 2012: Panel time series approach | 1970 - 2012 | Public health expenditure, life expectancy, private health expenditure | Panel unit root test, impulse response analysis and panel VAR models | 34 OECD countries | Positive significant effect of public health expenditures and private health expenditures on life expectancy | The focus was on developed countries and the findings may not apply to developing countries |
| 6 | Azuh *et al* (2020) | Public health expenditure and under-five mortality in Nigeria: an overview for policy intervention | 1985-2017 | Crude birth rate, children living with HIV, CO2 emission, electricity, public health expenditure, life expectancy | Autoregressive distribution lag method | Nigeria | Public health spending significantly increased child mortality | One country was the area of focus and its findings may not be generalised to other West African countries |
| 7 | Ali, Gilani and Abdin (2020) | Public health care and government health expenditures in Pakistan | 1982-2016 | Infant mortality rate, health expenditure, immunization, number of hospitals, number of registered doctors | ARDL model | Pakistan | Healthcare spending reduces infant mortality in the long run | It was based on Pakistan, and findings may not apply to West Africa |
| 8 | Bulus and Bakirtas (2021) | The relationship between public health expenditure and child mortality in next-11 countries | 2000-2019 | GDP per capita, fertility rate, domestic general government health expenditure | Pooled Ordinary Least square, Generalized Method of Moment technique | Next-11 countries | Health expenditure positively reduced child mortality | Not based specifically on West African countries |
| 9 | Kiross *et al*  (2020) | The effects of health expenditure on infant  mortality in sub-Saharan Africa: evidence  from panel data analysis | 2000-2015 | Public health expenditure, external health expenditure, private health expenditure, total health expenditure, HIV prevalence, maternal mortality ration, fertility rate, access to improved water and sanitation, measles vaccination coverage, school enrolment, immunisation rate | Random effects model | 46 countries in sub-Saharan Africa | External and public healthcare expenditure significantly reduced mortality of infants and neonatals while there was no significant association between private health spending and mortality | It was not based specifically on countries in West Africa |

**2.5 Research Gap**

Literature is recently emerging on the effectiveness of GVAP on immunisation coverage, especially in West Africa.

This research will also capture the possible difference of each vaccine-preventable disease (DPT, HepB3 and measles) on child mortality in West Africa.

# CHAPTER THREE

# RESEARCH METHODOLOGY

**3.1 Introduction**

This section involves the theoretical framework upon which this study is built. Next, the model specification to be adopted, the technique of analysis, information on sources of data as well as the estimation techniques to be implemented are presented. It also includes the economic expectation for each variable.

**3.2 Theoretical Framework**

**3.2.1 Health Demand Theory**

Grossman’s health demand theory was adopted so as to examine the effects of immunisation coverage on child mortality. The Grossman model shows the relationship between individuals and their investments in health, skills acquisition and education. The health production function of the Grossman’s theory takes the form



Where  is the current stock of health,

 is the original health stock,

 is the depreciation of health with age, and

 is investment in health

The initial stock of health increases by making investments, and decreases by depreciation. The determinants of health investments among others are earnings (socioeconomic status), governmental budgetary allocations to health care (access to health care), environment (sanitation, hygiene), diet and exercise. Health decreases with age, accidents, sicknesses and diseases, carelessness and the likes.

**3.3 Technique of Analysis**

***Preliminary test***

Panel unit root test will be conducted to test whether the variables are stationary or not, to avoid spurious regressions. These panel unit root tests will be implemented: Levin, Lin, and Chu (LLC) (2002) test and Im, Pesaran and Shin (IPS) (2003) Augmented Dickey Fuller (ADF)-Fisher test and Philip Perron (PP)-Fisher chi-square. The LLC assumes occurrences of common unit root processes among cross-sectional units while IPS assumes individual unit root processes across cross-sectional units. The Akaikes Information Criterion (AIC) was used in choosing the lag length.

***Techniques for estimations***

Thereafter, Fixed Effects (FE) which allows for correlation between the random variables and the independent variables in an unobserved effects model will be considered; it is assumed to be appropriate in estimating *ceteris paribus effects.* This is an efficient estimator when there is no serial correlation between the idiosyncratic errors and the explanatory variables. It is suitable for unbalanced panels. Random Effects **(**RE) will be used if key explanatory variables are constant over time in order to estimate its effects on the dependent variable. It is also preferred when the assumption of uncorrelation between unobserved effect and all explanatory variables is upheld.

Hausman specification testwill be used to assess the consistency of an estimator in comparison with an alternative estimator, which may be less efficient. This test relied on the assumption that fixed effects and random effects estimators are consistent. It was used to test for significant statistical differences in the coefficients of explanatory variables which vary with time. If the random effect estimates is used, this implies that the estimates of RE and FE are relatively close, so whichever could be used or that the sampling variation for FE estimates is so large that significant statistical differences cannot be established. However, there was rejection using the Hausman test, and then the FE estimate was adopted (Hausman, 1978; Wooldridge, 2012; Gujarati & Porter, 2009).

**3.4 Model Specification**

Trend analysis will be used to analyse objective one, a table showing the level of immunisation coverage on each VPDs for each country will address objective two while the Fixed or Random effects, and Hausman test will be used to analyse objective three. Hence, for both objectives one and two, descriptive statistics will be used. For objective three, regression analyses will be employed. To motivate the model used for objective three, a simple model for child mortality is first stated below:



Where *Yit* represents child mortality, *αi* (i=1….n) is the unknown intercept for each entity (n-entity-specific intercepts). *β* is the vector of coefficients for each independent variable, *Xit*represents a vector of control variables , *wit* is the error term, and i = 1, …, n and t = 1, …, t are the spatial (cross-section) and temporal (year) dimensions of the panel respectively.

Drawing from Grossman’s model, health stock is dependent on initial health stock, nutrition, investment in medical care, maternal literacy, maternal health, socioeconomic status, and community health. Specifically, the health production function is:

Child mortality = f (immunisation, life expectancy at birth, nutrition, maternal health, improved water source, maternal literacy, improved sanitary facilities, gross domestic product per capita).

From equation 3.1, which will subsequently be referred to as the baseline model, the dependent variable, current stock of health (*Hstockt*) is represented by child health, which captures the child mortality; original health stock (*Hstockt-1*) is represented by life expectancy at birth; depreciation of health (*deprH*) is represented by maternal health (which is proxy for maternal morbidity), and nutrition which captures prevalence of undernourishment; and investment in health (*HI*) is represented by immunisation, improved water source, maternal literacy, improved sanitary facilities and gross domestic product per capita.



Where  : child health,

: dummy variable (GVAP) initiative,

: immunization coverage individually for measles, HepB3 and DPT,

: interaction term between dummy variable (GVAP) and immunisation,

: life expectancy at birth,

: prevalence of undernourishment in children below the age of 5,

: maternal literacy,

: improved water sources,

: gross domestic product per capita,

: maternal health,

: improved sanitary facilities,

: country-specific effect,

: time-specific effect,

: random disturbance term.

**3.5 Definition of Variables**

**Child mortality rate**, this is the dependent variable that captures child health, is defined as the percentage of newborns that die before reaching five (5) years expressed in units of death per 1,000 live births yearly. Mortality rate of children under the age of five reflects the attention and health care given at the cradle age.

**Life expectancy at birth** is used to represent the initial health stock of children given that it captures existing patterns of mortality which may include disability, morbidity, mortality among others.

**Prevalence of undernourishment** captures nutrition, which is the percentage of children under the age of five with insufficient nutrient necessary for a healthy life.

**Maternal health** represents the percentage of women between the ages 15-49 living with HIV, which represents maternal morbidity, as used by Kiross *et al* (2020) as a proxy for maternal morbidity for lack of data. The condition of a mother’s health is important to this study because it is reflected in the child’s health directly (or otherwise) as with the case of HIV which is transmittable.

**Maternal literacy** is captured by the rate of primary school enrollment of female. It is believed that female literacy enhances a mother’s knowledge about children health outcomes, as they become more conscious of nutrition and health needs which is necessary for child survival. As a result of data limitation, net enrollment ratio, primary, female (%) was used as a proxy, to capture maternal literacy

**Immunisation** is captured by the percentage of children between the ages 12 and 23 months who have been vaccinated against measles, hepatitis B3 and DPT. Immunisation represents investments in medical care necessary for children’s health outcomes.

**Gross Domestic Product per capita** is included so as to control for parental income levels, which is a necessary determinant for children accessing health care or not and how much can be invested.

**Improved water source and improved sanitary facilities** represent theproportion of people having access to improved source or facility. This depicts the environmental condition in which people reside, seeing that children and people live in a location which affects their health status.

**3.6 *A Priori* Expectations**

In the models, the expected relationship between each explanatory variable and the dependent variable is presented in the table below:

**Table 3.1: *A priori* Expectations**

|  |  |  |
| --- | --- | --- |
| **Variable Description** | ***A priori* expectation** | **Unit of Measurement** |
| Log of CH - Child health |  | Per 1000 live births |
| DGVAP (Dummy variable) | Negative | 0 for pre-GVAP (2009-2010)  1 for post-GVAP (2011-2019) |
| DGVAP\*IM (Interaction term) | Negative |  |
| Log of LEB - Life expectancy at birth | Negative | Years |
| Log of PU - Prevalence of undernourishment | Positive | Percentage of population |
| Log of IMd - Immunization coverage for DPT | Negative | percentage of children ages 12-23 months |
| Log of IMh - Immunization coverage for HepB3 | Negative | percentage of one year old children |
| Log of IMm - Immunization coverage for measles | Negative | percentage of children ages 12-23 months |
| Log of ML - Maternal literacy | Negative | Percentage of female ages 15 and above |
| Log of MH - Maternal morbidity | Positive | Percentage of population |
| Log of IWS - Improved water sources | Negative | Percentage of population |
| Log of GDP - GDP per capita | Negative | GDP per capita (constant 2015 US $) |
| Log of ISF - Improved sanitary facilities | Negative | Percentage of population |

**Source:** Author

**Note**: The DGVAP and DGVAP\*IM are not logged because DGVAP is a dummy variable

**3.7 Data Sources and Scope of the Study**

Secondary data covering the 15 West African countries for the period of 2000 to 2019 (twenty years) was considered. The data for under-five mortality rate, GDP per capita, life expectancy at birth, improved water sources, maternal health, improved sanitary facilities, maternal literacy, and immunization (DPT, HepB3 and measles) was sourced from the World Bank’s World Development Indicators (World Bank, 2021). DPT, HepB3 and measles are not the only vaccine-preventable diseases, however as a result of data availability, only these three was considered.

**CHAPTER FOUR**

**RESULTS AND DISCUSSION OF FINDINGS**

**4.1 Introduction**

This chapter comprises the analysis carried out on the model, the discussion and the findings obtained. Trend analysis is employed to examine the trend in the level of immunisation coverage and child mortality in West Africa. The levels of immunisation coverage on each vaccine preventable disease for each country in West Africa will be described with the help of a table and the third objective of investigating the impact of immunisation coverage (for three models - measles, hepatitisB3 (HepB3), and Diphtheria, Pertussis and Tetanus (DPT)) on child mortality before and after the GVAP initiative in West Africa will be addressed using the fixed and random effects model. A choice between the fixed and random effects is made using the Hausman test.

**4.2 Presentation of Results**

The descriptive statistics of the variables is first presented in Table 4.1 below:

**Table 4.1: Descriptive statistics of variables for the models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Observation | Mean | Standard Deviation | Minimum | Maximum | Skewness |
| lncm | 300 | 4.586 | 0.505 | 2.701 | 5.416 | -1.387 |
| lnimmd | 300 | 4.279 | 0.280 | 3.219 | 4.595 | -1.343 |
| lnimmh | 223 | 4.343 | 0.276 | 2.708 | 4.595 | -2.698 |
| lnimmm | 300 | 4.250 | 0.253 | 3.401 | 4.595 | -0.935 |
| lnleb | 300 | 4.044 | 0.105 | 3.675 | 4.290 | -0.165 |
| lnpu | 228 | 2.644 | 0.583 | 1.548 | 3.926 | 0.222 |
| lnml | 168 | 4.144 | 0.312 | 3.073 | 4.579 | -0.907 |
| lnmh | 300 | 4.065 | 0.091 | 3.811 | 4.209 | -0.851 |
| lngdpc | 300 | 6.771 | 0.542 | 5.897 | 8.155 | 0.800 |
| lniws | 300 | 4.128 | 0.190 | 3.607 | 4.480 | -0.403 |
| lnisf | 300 | 3.036 | 0.637 | 1.648 | 4.350 | 0.155 |

**Source**: Author’s calculations using STATA software.

The descriptive analysis suggests that there are no outliers that may affect the empirical analysis negatively as indicated by the minimum and maximum values. For skewness of selected variables, the negative value of the dependent variable (lncm) shows that more West African countries have more than the average value of child mortality (lncm). The same interpretation also applies to skewness for immunisation (lnimmd, lnimmh and lnimmm). Gross domestic product per capita (lngdpc) has a positive value showing that more West African countries have less than the average GDP per capita.

Next is the result of the correlation analysis for West African countries for each vaccine preventable disease.

**Table 4.2: Correlation statistic for Immunisation Coverage of DPT**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lncm | lnimmd | lnleb | Lnml | Lnmh | lngdpc | lniws | lnisf | Dlnpu |
| Lncm | 1.000 |  |  |  |  |  |  |  |  |
| Lnimmd | -0.563 | 1.000 |  |  |  |  |  |  |  |
| Lnleb | -0.939 | 0.688 | 1.000 |  |  |  |  |  |  |
| Lnml | -0.713 | 0.437 | 0.640 | 1.000 |  |  |  |  |  |
| Lnmh | 0.356 | -0.072 | -0.358 | -0.069 | 1.000 |  |  |  |  |
| Lngdpc | -0.704 | 0.022 | 0.562 | 0.532 | -0.366 | 1.000 |  |  |  |
| Lniws | -0.774 | 0.491 | 0.750 | 0.424 | -0.078 | 0.526 | 1.000 |  |  |
| Lnisf | -0.592 | 0.190 | 0.538 | 0.369 | -0.535 | 0.519 | 0.609 | 1.000 |  |
| Dlnpu | -0.207 | 0.072 | 0.176 | 0.149 | -0.054 | 0.114 | 0.157 | 0.194 | 1.000 |

**Source**: Author’s using STATA software.

**Table 4.3: Correlation statistic for Immunisation Coverage of HepB3**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lncm | lnimmh | Lnleb | lnml | lnmh | lngdpc | Lniws | lnisf | Dlnpu |
| Lncm | 1.000 |  |  |  |  |  |  |  |  |
| Lnimmh | -0.366 | 1.000 |  |  |  |  |  |  |  |
| Lnleb | -0.939 | 0.487 | 1.000 |  |  |  |  |  |  |
| Lnml | -0.723 | 0.229 | 0.646 | 1.000 |  |  |  |  |  |
| Lnmh | 0.417 | 0.019 | -0.420 | -0.167 | 1.000 |  |  |  |  |
| Lngdpc | -0.703 | -0.045 | 0.550 | 0.531 | -0.402 | 1.000 |  |  |  |
| Lniws | -0.763 | 0.390 | 0.717 | 0.428 | -0.096 | 0.498 | 1.000 |  |  |
| Lnisf | -0.567 | 0.132 | 0.498 | 0.313 | -0.587 | 0.448 | 0.571 | 1.000 |  |
| Dlnpu | -0.183 | 0.052 | 0.146 | 0.124 | -0.075 | 0.103 | 0.131 | 0.187 | 1.000 |

**Source**: Author’s using STATA software.

**Table 4.4: Correlation statistic for Immunisation Coverage of Measles**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lncm | Lnimmm | lnleb | lnml | lnmh | lngdpc | lniws | lnisf | Dlnpu |
| Lncm | 1.000 |  |  |  |  |  |  |  |  |
| Lnimmm | -0.585 | 1.000 |  |  |  |  |  |  |  |
| Lnleb | -0.939 | 0.672 | 1.000 |  |  |  |  |  |  |
| Lnml | -0.713 | 0.398 | 0.640 | 1.000 |  |  |  |  |  |
| Lnmh | 0.356 | -0.065 | -0.358 | -0.069 | 1.000 |  |  |  |  |
| Lngdpc | -0.704 | 0.092 | 0.562 | 0.532 | -0.366 | 1.000 |  |  |  |
| Lniws | -0.774 | 0.515 | 0.750 | 0.424 | -0.078 | 0.526 | 1.000 |  |  |
| Lnisf | -0.592 | 0.208 | 0.538 | 0.369 | -0.535 | 0.519 | 0.609 | 1.000 |  |
| Dlnpu | -0.207 | 0.081 | 0.176 | 0.149 | -0.054 | 0.114 | 0.157 | 0.194 | 1.000 |

**Source**: Author’s using STATA software.

From the above correlational analysis, the independent variables do not have high correlations with themselves as they have values less than 0.8.

Next is the result of the trend analysis for West African countries for each vaccine preventable disease and its corresponding child mortality values. The values are West African averages.

**4.2.1 Trend in DPT Immunisation Coverage and Child Mortality in West African Countries**

Figure 4.1 shows the trend in the average DPT immunisation coverage and its corresponding child mortality rate values in West Africa. From the result, as expected, there tends to be an inverse relationship between immunisation and under-five mortality. As DPT vaccination increased between 2000 and 2007, child mortality fell by a larger proportion.

**Figure 4.1: Trend in DPT immunisation coverage and under-five mortality rate in West Africa**

**Source:** World Bank, World Development Indicators (2021)

However, immunisation became stable between 2008 and 2019, but the mortality rate continued to decline. This could probably be as a result of political instability and conflict in some countries within the region.

**4.2.2 Trend in Measles Immunisation Coverage and Child Mortality in West African Countries**

Here, the trend in measles immunisation coverage and mortality rate in West Africa is presented as shown by Figure 4.2. Given the importance of immunisation coverage as noted by UNICEF (2021) and McGovern and Canning (2015), between the space of two decades, mortality rate has declined by almost half of what it originally was.

From the trend result, the coverage of measles vaccination has been rising steadily but witnessed a decline between 2009 and 2015. The mortality rate however has been declining over the decades, probably brought about by insurgencies, disease outbreak and war in the region.

**Figure 4.2: Trend in measles immunisation coverage and under-five mortality rate in West Africa**

**Source:** World Bank, World Development Indicators (2021)

**4.2.3 Trend in HepB3 Immunisation Coverage and Child Mortality in West African Countries**

Data for Hepatitis B3 coverage for some countries in West Africa between 2000 and 2008 was unavailable; this accounted for the low average as shown in Figure 4.3, however, between 2009 and 2019, HepB3 immunisation coverage was relatively constant, possibly caused by terrorism threats and social inequalities.

**Figure 4.3: Trend in HepB3 immunisation coverage and under-five mortality rate in West Africa**

**Source:** World Bank, World Development Indicators (2021)

There are similarities in the trend in DPT and HepB3 immunisation coverage being that these vaccines are taken at about the same time period (6 weeks, 10 weeks and 14 weeks), whereas the measles vaccine is taken at 9 months and 18 months.

Afterward, tables will represent the statistics of levels of immunisation coverage on each vaccine preventable disease (VPD) for each country in West Africa, thus addressing the second objective.

**Table 4.5: Recent statistics on the levels of DPT immunisation coverage in West Africa**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Countries | Year 2015 | Year 2016 | Year 2017 | Year 2018 | Year 2019 | Average |
| Benin | 74 | 76 | 76 | 76 | 76 | 75.6 |
| Burkina Faso | 91 | 91 | 91 | 91 | 91 | 91 |
| Cabo Verde | 93 | 96 | 96 | 98 | 96 | 95.8 |
| Cameroon | 78 | 75 | 74 | 67 | 67 | 72.2 |
| The Gambia | 97 | 95 | 92 | 93 | 88 | 93 |
| Ghana | 88 | 93 | 99 | 97 | 97 | 94.8 |
| Guinea | 47 | 47 | 47 | 47 | 47 | 47 |
| Guinea-Bissau | 88 | 88 | 88 | 88 | 84 | 87.2 |
| Liberia | 80 | 84 | 84 | 84 | 74 | 81.2 |
| Mali | 71 | 76 | 77 | 77 | 77 | 75.6 |
| Niger | 84 | 80 | 85 | 79 | 81 | 81.8 |
| Nigeria | 42 | 53 | 55 | 56 | 57 | 52.6 |
| Senegal | 89 | 93 | 93 | 82 | 93 | 90 |
| Sierra Leone | 86 | 84 | 90 | 93 | 95 | 89.6 |
| Togo | 82 | 82 | 83 | 81 | 84 | 82.4 |

**Source:** Author

Over the years from the statistics, it is observed that DPT coverage has been constant in countries like Benin, Burkina Faso, Guinea, Mali; declining in Cameroon, Guinea-Bissau, Liberia; fluctuating in Cabo Verde, Senegal and increasing in Sierra Leone, and Nigeria.

Countries with the highest averages of immunisation coverage for DPT are The Gambia (93%), Ghana (94.8%) and Cabo Verde (95.8%), probably because they are relatively small countries, while countries with the least averages are Nigeria (52.6%) and Guinea (47%) probably due to conflict and political instability.

Guinea is the only country below 50% in DPT immunisation coverage in West Africa probably due to the Ebola outbreak.

**Table 4.6: Recent statistics of the levels of measles immunisation coverage in West Africa**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Countries | Year 2015 | Year 2016 | Year 2017 | Year 2018 | Year 2019 | Average |
| Benin | 67 | 68 | 70 | 71 | 71 | 69.4 |
| Burkina Faso | 88 | 88 | 88 | 88 | 88 | 88 |
| Cabo Verde | 92 | 93 | 96 | 99 | 98 | 95.6 |
| Cameroon | 97 | 97 | 90 | 91 | 85 | 92 |
| The Gambia | 89 | 89 | 95 | 92 | 92 | 91.4 |
| Ghana | 47 | 47 | 47 | 47 | 47 | 47 |
| Guinea | 85 | 86 | 86 | 86 | 86 | 85.8 |
| Guinea-Bissau | 74 | 80 | 87 | 91 | 85 | 83.4 |
| Liberia | 66 | 70 | 70 | 70 | 70 | 69.2 |
| Mali | 85 | 76 | 82 | 77 | 79 | 79.8 |
| Niger | 42 | 51 | 54 | 54 | 54 | 51 |
| Nigeria | 80 | 93 | 90 | 83 | 90 | 87.2 |
| Senegal | 78 | 85 | 80 | 87 | 93 | 84.6 |
| Sierra Leone | 75 | 73 | 77 | 71 | 75 | 74.2 |
| Togo | 67 | 68 | 70 | 71 | 71 | 69.4 |

**Source:** Author

Measles immunisation coverage has been gaining grounds in Senegal and Benin; inconsistent in Cabo Verde, Cameroon, Guinea-Bissau, Nigeria and constant in Burkina Faso, Ghana, Liberia, Guinea.

The top four countries having the highest average immunisation coverage for measles are Burkina Faso (88%), The Gambia (91.4%), Cameroon (92%), and Cabo Verde (95.6%) while Niger (51%) and Ghana (47%) are countries with the least averages.

Ghana is the only country below the 50% average, this could probably be to the low uptake of the second dose of measles vaccine at the eighteenth month (Wemakor, Helebe, Abdul-Mumin, Amedoe, Zoku and Dufie; 2018).

**Table 4.7: Recent statistics of the levels of HepB3 immunisation coverage in West Africa**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Countries | Year 2015 | Year 2016 | Year 2017 | Year 2018 | Year 2019 | Average |
| Benin | 74 | 76 | 76 | 76 | 76 | 75.6 |
| Burkina Faso | 91 | 91 | 91 | 91 | 91 | 91 |
| Cabo Verde | 94 | 96 | 97 | 99 | 97 | 96.6 |
| Cameroon | 78 | 75 | 74 | 67 | 67 | 72.2 |
| Gambia, The | 97 | 95 | 92 | 93 | 88 | 93 |
| Ghana | 88 | 93 | 99 | 97 | 97 | 94.8 |
| Guinea | 47 | 47 | 45 | 47 | 47 | 46.6 |
| Guinea-Bissau | 88 | 88 | 88 | 88 | 84 | 87.2 |
| Liberia | 80 | 84 | 84 | 84 | 74 | 81.2 |
| Mali | 71 | 76 | 77 | 77 | 77 | 75.6 |
| Niger | 84 | 80 | 85 | 79 | 81 | 81.8 |
| Nigeria | 42 | 53 | 55 | 56 | 57 | 52.6 |
| Senegal | 89 | 93 | 93 | 82 | 93 | 90 |
| Sierra Leone | 86 | 84 | 90 | 93 | 95 | 89.6 |
| Togo | 82 | 82 | 83 | 81 | 84 | 82.4 |

**Source:** Author

From the above in Table 4.7, it can be observed that Guinea is the only country with less than 50 per cent HepB3 immunisation coverage. In Benin, Burkina Faso and Mali, the coverage has been stationary. Coverage increases can be observed in Nigeria, Sierra Leone with more of the countries experiencing fluctuations or decline.

The countries having the highest average on coverage for HepB3 are Senegal (90%), Burkina Faso (91%), The Gambia (93%), Ghana (94.8%) and Cabo Verde (96.6%) while the countries with the least coverage are Nigeria (52.6%) and Guinea (46.6%), probably brought about by insurgency and political crisis.

There are similarities between the averages of DPT and HepB3 amongst the countries because these two vaccines are taken at about the same time.

Clues have been garnered from the descriptive statistics thus far. In what follows, the impact of immunisation coverage on child mortality is examined. However, the stationary property of the variables will first be conducted to avoid running spurious regressions. The Panel Unit Root Tests, using the AIC lag selection were conducted to check the stationarity of the variables. Table 4.8 shows the result of the tests for Levin-Lin-Chu, Im Perasin and Shin, and Fisher.

**Table 4.8: Panel Unit Root Tests**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | LLC | IPS | FISHER ADF | FISHER  PP | STATION-ARY |
| lncm | -20.99\*(0.00) | -6.42\*(0.00) | 214.57\*(0.00) | 16.43(0.98) | I(0) |
| lnimmd | -6.37\*(0.01) | -0.35(0.36) | 59.99\*(0.00) | 98.59\*(0.00) | I(0) |
| lnimmh | - | -2.23\*(0.01) | 92.39\*(0.00) | 381.34\*(0.00) | I(0) |
| lnimmm | -9.14\*(0.00) | -0.61(0.27) | 52.27\*(0.01) | 56.61\*\*(0.02) | I(0) |
| lnleb | -30.58\*(0.00) | -37.19\*(0.00) | 681.43\*(0.00) | 22.10(0.85) | I(0) |
| lnpu | -6.85\*\*\*(0.07) | 0.97(0.83) | 15.84(0.89) | 45.82\*(0.00) | I(1) |
| lnml | -10.23\*\*\*(0.06) | 0.95(0.90) | 30.78(0.79) | 12.30(0.74) | I(0) |
| lnmh | -8.11\*\*(0.04) | 1.87(0.97) | 41.27\*\*\*(0.08) | 9.53(1.00) | I(0) |
| lngdpc | -6.92\*\*(0.05) | 0.96(0.83) | 22.87(0.82) | 25.67(0.69) | I(0) |
| lniws | -35.03\*(0.00) | -67.99\*(0.00) | 301.88\*(0.00) | 277.22\*(0.00) | I(0) |
| lnisf | -23.42\*(0.00) | -30.00\*(0.00) | 367.31\*(0.00) | 426.45\*(0.00) | I(0) |

**Note:** The null (Ho) for LLC, IPS, and Fisher is that there is unit root

\*.\*\*and \*\*\* denotes stationary series at 1%, 5% and 10% level respectively

p values are in parentheses

The results show that all the series are stationary at least at 10 per cent with the exception of the log of pu (lnpu) which is non-stationary but integrated of order one. From this test, a spurious regression resulting from presence of non-stationary variables would be averted since the variables are all stationary but for lnpu which is integrated of order one and which would enter the regression in its first difference form.

**Table 4.9: Hausman Test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Coefficients** | | | |
|  | **Fixed effects** | **Random**  **effects** | **difference** | **Standard error** |
| **dgvap** | 2.803 | 3.540 | -0.737 | 0.251 |
| **dgvap\_lnimmd** | -0.648 | -0.807 | 0.160 | 0.054 |
| **Lnimmd** | 0.153 | 0.241 | -0.088 | 0.049 |
| **Lnleb** | -2.591 | -3.550 | 0 .959 | 0.500 |
| **Dlnpu** | 0.154 | 0.146 | 0.007 | - |
| **Lnml** | 0.000 | 0.055 | -0.055 | 0.067 |
| **Lnmh** | -1.245 | -0.555 | -0.690 | 0.229 |
| **Lngdpc** | -0.136 | -0.161 | 0.024 | 0.082 |
| **Lniws** | -0.390 | -0.403 | 0.013 | 0.096 |
| **Lnisf** | -0.031 | -0.001 | -0.030 | 0.091 |
| **CHI2** | **35.39** |
| **PROB>CHI2** | **0.0001** |

**Source: STATA**

The Hausman test reveals that the fixed effects model should be used based on the decision criteria below:

Ho: random effects model is appropriate

H1: fixed effect model is appropriate

The 0.0001 value of probability shows that the fixed effects estimation technique is more consistent and efficient at a 1% level of significance.

**Table 4.10**: **Empirical result for DPT immunisation coverage on child mortality (Model 1)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **Robust standard errors** | **Coefficient** | **Robust standard errors** |
|  | **Fixed effects** | | **Random effects** | |
| dgvap | -0.248(0.640) | 0.515 | -0.248(0.651) | 0.548 |
| dgvap\_lnimmd | -0.092(0.401) | 0.105 | -0.092(0.412) | 0.112 |
| Lnimmd | -0.038(0.713) | 0.101 | -0.038(0.723) | 0.107 |
| Lnleb | 1.328(0.067) | 0.652 | 1.328 (0.056) | 0.694 |
| Dlnpu | 0.101(0.306) | 0.094 | 0.101 (0.313) | 0.100 |
| Lnml | -0.252(0.023) | 0.096 | -0.252 (0.013) | 0.102 |
| Lnmh | -1.472(0.001) | 0.348 | -1.472 (0.000) | 0.370 |
| Lngdpc | 0.104(0.403) | 0.119 | 0.104 (0.414) | 0.127 |
| Lniws | -0.253(0.133) | 0.157 | -0.023(0.128) | 0.167 |
| Lnisf | -0.023(0.800) | 0.090 | -0.023 (0.807) | 0.095 |
| Constant | 6.852(0.024) | 2.615 | 7.258 (0.010) | 2.835 |
| **R-squared (overall)** | 0.034 |  | 0.997 |  |
| **F-statistics(Wald chi-squared)** | 1634.81 |  | (1624.97) |  |
| **F-stat (p-value)** | 0.000 |  | 0.000 |  |
| **Corr(u\_i)** | -0.580 |  | 0 |  |
| **Time dummy** | Yes |  | Yes |  |
| **Country dummy** | Omitted |  | Yes |  |
| **No. of countries** | 15 |  | 15 |  |
| **No. of observation** | 122 |  | 122 |  |

**Note:** p values are presented in brackets

Robust standard errors are consistent in the presence of any form of heteroskedasticity within the panels

The F-statistics shows that the model is significant

From the table above, the dgvap, dgvap\_lnimmd, lnimmd, Dlnpu, lnml, lniws and lnisf have the correct sign and follow the economic expectation. However, the lnleb, lnmh, and lngdpc present wrong signs and do not follow *a priori* expectations.

The GVAP coefficient (Dgvap) carries a negative sign, as expected, but it is not statistically significant. The GVAP variable is GVAP when immunisation is zero, but this is not the variable of interest. The negative sign of the coefficient of interaction term, dgvap\_lnimmd, meets the *a priori* expectation. This is the independent variable of interest. It represents post-GVAP, specifically meaning immunisation coverage when the GVAP initiative had been put in place. For an increase in 1 per cent of immunisation coverage, the average effect is 0.092 per cent decrease in child mortality. This implies that GVAP initiative has helped in improving immunisation coverage and meeting some of its objectives. However, the statistical insignificance of the interaction term shows that the level of GVAP in West Africa does not significantly reduce child mortality. Hence, we fail to reject the null hypothesis, that immunisation coverage has no significant impact on child mortality post-GVAP in West Africa.

DPT immunisation coverage (lnimmd) refers to the period when GVAP is zero, that is, when the GVAP initiative had not begun. The coefficient of DPT immunisation coverage picks up a negative sign which suggests that child mortality decreases with increasing immunisation coverage and follows the *a priori* expectation, which is in line with the empirical evidence of Olatunde *et al* (2019). Pre-GVAP initiative, the average effect of 1 per cent of immunisation coverage will yield a decline in child mortality by 0.038 per cent. The statistical insignificance of this variable shows that in West Africa, immunisation coverage before the GVAP initiative does not have any significant impact on under-five mortality. We therefore accept the null hypothesis that DPT immunisation coverage has no significant impact pre-GVAP in West Africa.

The statistical significance and positive sign of life expectancy (Lnleb) at birth would mean that an increase a 1 per cent increase in life expectancy will increase child mortality by 1.33 per cent, ceteris paribus. This does not follow the *a priori* expectation. It was expected that the more healthy children are at the time of delivery, the lower the probability of them dying before their fifth birthday. An explanation for this may be disease outbreak within the region, which may serve as a threat to the health status of the children.

The coefficient of maternal literacy (Lnml) is correctly signed (negative) as expected and is statistically significant. The more informed mothers are, the more likely they are to visit hospitals for antennal and post-natal sessions, access and improve hygiene. Child mortality will drop by 0.252 per cent with a 1 per cent increase in maternal literacy.

Maternal health (lnmh) has a negative sign and is statistically significant, implying that as maternal morbidity increases, child mortality decreases, this is against the expectation. In a similar study by Yashim (2014), maternal health was inversely related to under-five mortality. The expectation is that as maternal health worsens as a result of HIV prevalence in women, under-five mortality will also increase, being that HIV is somewhat transferable. A possible explanation for this negative coefficient could be the improvements in technology which prevents HIV-infected mothers from transmitting the virus to their unborn children, thus giving birth to HIV-free children.

Prevalence of undernourishment (Dlnpu) has a positive coefficient, which implies that as undernourishment increase, child mortality will also increase. This is in agreement with economic expectation; however this variable is insignificant.

The GDP per capita (Lngdpc) has a positive coefficient; this does not meet the *a priori* expectation. This indicates that as the GDP per capita is increasing by 1 per cent, then child mortality is also increasing by 0.104 per cent. A possible explanation may be that allocations for health care are not effectively and efficiently utilised by some West African countries due to corruption. Another probable reason may be that allocations to health may be low. However, this variable is also not statistically significant.

Improved water source (Lniws) has a negative sign as expected, and is statistically significant, suggesting that child mortality will fall by 0.25 per cent with a 1 per cent increase in improved water source. This implies that improved water source is a contributing determinant to the reduction of child mortality in West Africa, being that deaths caused by water-borne diseases from unclean and unsafe water can be curbed.

The inverse relationship of the coefficient of improved sanitation facilities with under-five mortality goes along with expectation. Thus implying that the healthier an environment gets by having right to use improved sanitation facilities, the lower the possibility of deaths of children below five years due to disease infection or contamination. However, improved sanitation facilities do not significantly reduce child mortality in West Africa.

**Table 4.11: Empirical result for Measles immunisation coverage on child mortality (Model 2)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **Robust standard errors** | **Coefficient** | **Robust standard errors** |
|  | **Fixed effects** | | **Random effects** | |
| dgvap | - | - | -0.404 (0.438) | 0.521 |
| dgvap\_lnimmm | -0.060 (0.571) | 0.103 | -0.060 (0.583) | 0.109 |
| Lnimmm | -.0704(0.427) | 0.0853 | -0.070 (0.438) | 0.091 |
| Lnleb | 1.356 (0.020) | 0.499 | 1.356 (0.011) | 0.531 |
| Dlnpu | 0.090 (0.339) | 0.091 | 0.090 (0.347) | 0.096 |
| Lnml | -0.238 (0.030) | 0.095 | -0.238 (0.019) | 0.101 |
| Lnmh | -1.460 (0.003) | 0.390 | -1.459 (0.000) | 0.415 |
| Lngdpc | 0.113 (0.363) | 0.119 | 0.113 (0.372) | 0.127 |
| Lniws | -0.214 (0.211) | 0.161 | -0.214 (0.211) | 0.083 |
| Lnisf | -0.036 (0.656) | 0.078 | -0.036 (0.666) | 0.083 |
| constant | 6.580 (0.006) | 1.956 | 6.964 (0.001) | 0.026 |
| **R-squared (overall)** | 0.041 |  | 0.997 |  |
| **F-statistics(Wald chi-squared)** | 6269.44 |  | (2035.24) |  |
| **F-stat (p-value)** | 0.000 |  | 0.000 |  |
| **Corr(u\_i)** | -0.592 |  | 0 |  |
| **Time dummy** | Yes |  | Yes |  |
| **Country dummy** | Omitted |  | Yes |  |
| **No. of countries** | 15 |  | 15 |  |
| **No. of observation** | 122 |  | 122 |  |

**Note:** p values are presented in brackets

Robust standard errors are consistent in the presence of any form of heteroskedasticity within the panels

The F-statistics shows that the model is significant

The dgvap is omitted from the fixed-effect regression because of collinearity.

The coefficient of dgvap\_immm, picks up a negative sign, which is as expected, implying that an increase in immunisation coverage for measles by 1 per cent during the initiative will result in a decline of child mortality in West Africa by 0.06 per cent. The statistical insignificance of immunisation for measles during GVAP suggests that it is not contributing significantly to the decline of mortality of children under-five years in West African region. We therefore fail to reject the null hypothesis that immunisation coverage has no significant impact on child mortality during the GVAP in West Africa.

The negative but insignificant coefficient of immunisation coverage for measles is in contrast with Yashim (2014) (a similar study in West Africa) who observed a positive but insignificant relationship of this variable on child mortality and Olatunde *et al* (2019) who observed a significant and an inverse relationship between these variables in West Africa. The coefficient of immunisation coverage indicates that a 1 per increase is associated with a 0.07 per cent fall in child mortality rates, before the GVAP initiative. Hence, we do not reject the null hypothesis that immunisation coverage for measles has no significant impact on child mortality before the GVAP in West Africa.

Maternal literacy (lnml) exhibits a negative sign, which is in agreement with economic expectation. The more enlightened mothers are, the better informed decisions they will make. A 1 per cent increase in maternal literacy will result in about 0.24 per cent fall in child mortality in the West African region. This variable is a significant driver in reducing mortality of children under the age of five, as also observed by Olatunde *et al* (2019) and Van Malderen (2019).

The coefficient of life expectancy at birth (lnleb) in this second model picks up a positive sign, implying that the more healthy children are at birth, the higher the possibility of them not living to celebrate their fifth birthday, this is against the expectation. This could probably be as a result of inaccessibility to quality primary healthcare facilities, brought about by insecurity within the region. The result is in contrast to Yashim (2014) who observed a negative and significant impact of this variable on child mortality. Life expectancy at birth is however statistically significant, indicating that it has significant influence on child mortality in West Africa.

The negative sign of maternal health (lnmh) implies that as maternal deaths increase, under-five mortality rate will fall. This is not in line with the *a priori* expectation. It is anticipated that as maternal morbidity increases then child mortality will also increase. This could mean that technology which hinders infection transmission from mothers to their unborn children have been improved upon. The statistical significance of this variable indicates that it has influence on child mortality in West Africa.

GDP per capita (lngpdc) picks up a positive sign suggesting that increases in GDP per capita by 1 per cent will increase child mortality by 0.11 per cent. This finding is contrary to empirical studies of Olatunde *et al* (2019) and Bulus and Bakirtas (2021) who discovered that child mortality decreases as GDP per capita increases. In this research GDP per capita is statistically insignificant in impacting child mortality in West Africa.

Prevalence of undernourishment (Dlnpu) exerts the expected sign, which is a direct impact on mortality in West Africa. This suggests that a 1 per cent increase in undernourishment prevalence will increase under-five deaths in West Africa by 0.09 per cent. Although this variable meets the *a priori* expectation, it is not significant, which was also observed by Yashim (2014). This means that PU in West Africa has no contributory effect in under-five mortality.

Improved water source (Lniws) and improved sanitation facilities (Lnisf) both follow *a priori* expectation but are not significant in West African countries. This implies that as there are increased accesses to (Lniws) and (Lnisf), infections and disease spread are curtailed which directly or otherwise reduces the under-five deaths.

**Table 4.12: Empirical result for HepB3 immunisation coverage on child mortality (Model 3)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Coefficient** | **Robust standard errors** | **Coefficient** | **Robust standard errors** |
|  | **Fixed effects** | | **Random effects** | |
| dgvap | 0.040 (0.933) | 0.465 | 0.040 (0.936) | 0.499 |
| dgvap\_lnimmh | -0.154 (0.142) | 0.097 | -0.154 (0.140) | 0.104 |
| Lnimmh | 0.012 (0.753) | 0.037 | 0.012 (0.764) | 0.040 |
| Lnleb | 0.918 (0.159) | 0.607 | 0.918 (0.159) | 0.651 |
| Dlnpu | 0.112 (0.201) | 0.083 | 0.112 (0.205) | 0.089 |
| Lnml | -0.186 (0.075) | 0.095 | -0.186 (0.066) | 0.101 |
| Lnmh | -1.121 (0.017) | 0.401 | -1.131 (0.009) | 0.430 |
| Lngdpc | 0.084 (0.562) | 0.140 | 0.084 (0.577) | 0.150 |
| Lniws | -0.335 (0.008) | 0.103 | -0.335 (0.003) | 0.111 |
| Lnisf | 0.002 (0.982) | 0.082 | 0.002 (0.983) | 0.088 |
| Constant | 7.010 (0.179) | 2.051 | 7.434 (0.001) | 2.211 |
| **R-squared (overall)** | 0.024 |  | 0.998 |  |
| **F-statistics(Wald chi-squared)** | 794.77 |  | (3923.50) |  |
| **F-stat (p-value)** | 0.000 |  | 0.000 |  |
| **Corr(u\_i)** | -0.524 |  | 0 |  |
| **Time dummy** | Yes |  | Yes |  |
| **Country dummy** | Omitted |  | Yes |  |
| **No. of countries** | 15 |  | 15 |  |
| **No. of observation** | 111 |  | 111 |  |

**Note:** p values are presented in brackets

Robust standard errors are consistent in the presence of any form of heteroskedasticity within the panels

The F-statistics shows that the model is significant

From the estimates of FE regression, dgvap\_lnimmh, Dlnpu, Lnml, and Lniws all follow *a priori* expectation.

The interaction term (Dgvap\_lnimmh) is statistically significant and follows *a priori* expectation. This implies that immunisation coverage for HepB3 during the GVAP initiative is relevant in reducing under-five child deaths in West African countries. The coefficient on this variable shows that an increase of 1 per cent in immunisation coverage for HepB3, as a result of the initiative will result in a 0.15 per cent decrease in child mortality in these countries. One of the objectives of African Regional Immunisation Strategic Plan for the GVAP is to improve immunisation coverage (HepB3 inclusive). Therefore, we do not reject the null hypothesis that immunisation coverage has no significant impact on child mortality post-GVAP in West Africa

Immunisation coverage for HepB3 (lnimmh) (before GVAP) was inversely related to child mortality in West Africa but was however not statistically significant. This negative relationship result is in line with Akinlo and Sulola (2019) who also observed a negative correlation between immunisation and infant mortality. From the estimates, a 1 per cent increase in immunisation coverage will lead to a 0.012 per cent drop in under-five deaths. Although immunisation coverage for HepB3 meets with the *a priori* expectation, it is not statistically significant before the GVAP initiative in reducing child mortality in West Africa. Hence, we fail to reject the null hypothesis that immunisation coverage has no significant impact on child mortality pre-GVAP in West Africa.

The finding of this study that life expectancy at birth (lnleb) was statistically insignificant and contrary to the economic expectation is in contrast to Yahim(2014) who found a negative relationship between life expectancy and child mortality. From the result above, a 1 per cent increase in life expectancy will result in a 0.918 per cent increase in child mortality in countries in West Africa. A possible explanation could be unhealthy practices which could endanger the health of children such as maternal smoking and alcohol intake. A second probable reason could be failure to meet up with immunisation schedules and inadequate nutrition.

The positive and statistical insignificance of GDP per capita (Lngdpc) from the result implies that as the level of GDP per capita increases child mortality will also increase in West Africa. This is against economic interpretation. A probable reason may be that output per capita in West Africa does not reflect inclusive growth. The coefficient of improved sanitation facilities (Lnisf) also shows a direct and insignificant influence on child mortality in West Africa.

Prevalence of undernourishment (Dlnpu) is correctly signed but insignificant in influencing child mortality in West African countries. The positive correlation implies that as more children are undernourished, the increased chances of them not living to celebrate their fifth birthday are inevitable.

Maternal literacy (Lnml) exhibits the expected sign and is statistically significant in influencing child mortality in West African countries. This indicates that a 1 per cent increase in learning of mothers will reduce under-five mortality by 0.186 per cent.

The negative sign and statistical significance of improved water source (Lniws) suggests that improvements in water source has a contributing influence in reducing deaths of children below five years in West Africa brought about by safe and healthy water supply that does not encourage the spread of water borne diseases.

**4.3 Evaluation of Hypotheses**

The null hypotheses as stated in chapter one are re-stated below:

1. H0: immunisation coverage has no significant impact on child mortality pre-GVAP in West Africa

2. H0: immunisation coverage has no significant impact on child mortality post-GVAP in West Africa

The empirical analyses showing the null hypothesis of no significant impact of immunisation coverage on child mortality pre-GVAP in West Africa- cannot be rejected.

Hence this research concludes that for model 1 (immunisation coverage for DPT (diphtheria-pertusis and tetanus)), model 2 (immunisation coverage for measles) and for model 3 (immunisation coverage for Hepatitis (HepB3), immunisation coverage has no statistical significant impact on child mortality in West African countries before the GVAP initiative.

Similarly, the empirical analyses indicate that for model 1 (immunisation coverage for DPT) and model 2 (immunisation coverage for measles) during the GVAP initiative, immunisation coverage does not significantly impact child mortality in West Africa. The findings therefore support the null hypothesis that immunisation coverage (for DPT and measles) does not have significant impact on child mortality post-GVAP in countries in the Western region of Africa.

However, empirical analysis shows that immunisation coverage of HepB3 (model 3) significantly impacts child mortality post-GVAP in West Africa. Hence, the null hypothesis is rejected.

**4.4 Implication of Findings**

The effect of immunisation on child mortality in Western Africa has been examined. The insignificant impact of immunisation coverage in the absence of the GVAP suggests that there is need for intense efforts in West Africa to drive child mortality to the least minimum. This is especially important given the year 2030 benchmark of the Sustainable Development Goals. Furthermore, the significant impact of GVAP on HepB3 immunisation coverage in reducing under-five mortality indicates that coverage for other vaccine-preventable diseases should be concentrated on for expansion and impact.

Maternal literacy was found to be significantly and inversely correlated with child mortality. This implies that the more increasingly aware mothers become the lower the chances of experiencing child deaths. Awareness programmes should continue to be encouraged in West African countries.

The significance of improved water source in child mortality reduction indicates that the more access children have to clean water conditions the lower the probability of contracting infections, hence mortality is reduced. Hence, governments should ensure a continued supply of portable water within the West African region.

The outcome of maternal health (capturing morbidity) estimates was significant but inversely correlated with child mortality in West Africa. This suggests that technology that could prevent transmission of diseases from mothers to children may have been adopted.

Child mortality increased as a result of prevalence of undernourishment in West Africa, despite not being significant. Programmes that involve nutritional packages targeting child survival can be adopted so as to decrease child deaths to a significant level within the region.

Access to improved sanitation facilities was observed to insignificantly reduce child mortality. Access to improved hygiene is still a major concern in West Africa. Therefore, more efforts are required to boosts access to improved sanitation within the region that will combat disease spread.

The significance but direct relationship between life expectancy at birth and child deaths in Western Africa infers that although children that may be born healthy may be exposed to any pandemic or negligence on the part of the mother that may threaten the survival of that child.

The insignificant impact of immunisation coverage for DPT and measles in reducing child mortality in West Africa indicates that more efforts from the governments within this region is required to ensure that the GVAP initiative has an enabling environment to fulfill its objectives.

**CHAPTER FIVE**

**SUMMARY, CONCLUSION AND RECOMMENDATIONS**

This chapter contains the summary and conclusion of this research. Next it proffers recommendations based on the research findings. It goes ahead to highlight the contributions to knowledge and concludes with limitations of the study and suggestions for future researches.

**5.1 Summary**

This study investigated the impact of immunisation coverage (involving three vaccine- preventable diseases) on child mortality in West Africa, before and during the Global Vaccine Action Plan (GVAP). The Grossman health production model was adopted because of its ability to capture health stock, investments and depreciation brought about by individual decisions and actions and because of its ease of operationalisation.

The research dealt with three sub-objectives. The first assessed the trend in immunisation coverage and child mortality in West Africa. The trend analysis revealed that as immunisation coverage increased, child mortality rate dropped. The second objective is to examine the levels of immunisation coverage on each vaccine-preventable disease for each country in West Africa; this was accomplished using descriptive statistics, specifically using Tables. The analysis showed that more countries in West Africa are above the average percentage level in immunisation coverage for Diphtheria, Pertussis and Tetanus (DPT), Hepatitis B3 (HepB3) and measles.

The third objective investigated the impact immunisation coverage had on under-five mortality, pre and post-GVAP within West African countries; the fixed effects estimation was implemented in achieving this. The empirical findings revealed that in West Africa, immunisation coverage in the three models did not significantly impact child mortality before the GVAP initiative.

In contrast, for the post-GVAP era, only the immunisation coverage for HepB3 was significant in reducing child mortality. Immunisation coverage for DPT and measles did not significantly contribute to reductions in child mortality in West Africa.

Amongst the regressors, maternal literacy was the only variable that was significant and met economic expectation across the three models, implying that in West Africa, the literacy level was a significant determinant in reducing child mortality. However, Gross Domestic Product per capita had a direct but insignificant impact on child mortality across the models, suggesting that the standard of living in West Africa does not sufficiently reduce child mortality in the region.

Improved water source was significant in DPT and HepB3 model indicating that water source could aid or deter the spread of diseases in West Africa. Conversely, life expectancy at birth (LEB) and maternal health were against expectations in all models but were significant except LEB in HepB3 model.

Prevalence of undernourishment was positive but insignificant in the models suggesting that malnourishment increases child mortality in West Africa but not to a significant degree. Likewise, improved sanitation facilities was insignificant in all models but met expectation in DPT and measles model

**5.2 Conclusion**

The conclusion drawn from the first objective is that as immunisation coverage increases, child mortality in West Africa decreases, ceteris paribus. The second objective reveals that immunisation coverage for each vaccine-preventable disease has been on the increase, on average. From the third objective, it can be concluded that prior to the GVAP initiative in West Africa, immunisation coverage was not significant in reducing child mortality for the three vaccine-preventable diseases captured; also, during the initiative, only Hepatitis B3 immunisation coverage was significant in influencing child mortality reductions.

The significant determinants of child mortality are maternal literacy, maternal health, life expectancy at birth and improved water source. Immunisation coverage, prevalence of undernourishment, GDP per capita and improved sanitation facilities are not significant determinants of child mortality in West Africa.

**5.3 Policy Recommendations**

In tackling child mortality in West Africa, the following recommendations have been suggested as an offshoot of the findings from this study in order to aid reduction of child mortality within the region.

1. Maternal literacy was significant and followed *a priori* expectation in the three models, governments in West African countries can count on this variable to significantly impact child mortality. Programmes that create and promote awareness for mothers could be implemented by governments within this region with the aim of achieving reduction in under-five deaths.
2. The significance and economic expectation of improved water source can be relied on to reduce child mortality in West Africa; hence governments should ensure the availability and accessibility of clean and safe water within their environs.
3. The prevalence of undernourishment was observed to increase under-five mortality, although not significant in West African countries. Government can adopt programmes that target undernourishment within member states, so as to boost the level of contribution to combatting child mortality within the West African region.
4. Inference can be drawn from the insignificant but inverse relationship between improved sanitation facilities and child mortality in this study. Governments in Western Africa can target improvements in sanitation facilities so as to enhance its influence in the reduction of deaths of under-five children.
5. Comparing the results for immunisation coverage, before and after the GVAP initiative, there seems to be not much difference; governments in West Africa could strengthen the impact of GVAP by ensuring an enabling environment for the initiative through its African Regional Immunisation Strategic Plan to carry out its objectives, resulting in the protection of their citizens from VPDs, thereby reducing child mortality within the region.

**5.4 Contributions to Knowledge**

The contributions of this study to the body of knowledge are highlighted briefly:

1. This research has assessed the impact of immunisation coverage on child mortality in West Africa from the Global Vaccine Action Plan perspective. Although there are numerous studies on immunisation and child mortality, there is no identified empirical study devoted to West Africa with respect to the GVAP initiative. This study is unique in the sense that it was devoted to comparing the impacts of immunisation coverage before and after the GVAP initiative, which is analogous to assessing the impact of GVAP with respect to immunisation in West Africa. More efforts are required to pursue reductions in child mortality in West Africa given that prior to the initiative, immunisation coverage was not significant in reducing child mortality. Also, the significance of GVAP on Hepatitis B3 immunisation coverage in reducing under-five deaths, suggests that more attention should be given to other vaccine-preventable diseases so as to strengthen the immunisation coverage impact on child mortality in West Africa.
2. This study has also contributed to existing body of knowledge by shedding more light on immunisation coverage for three vaccine preventable diseases (VPDs) that could reduce the child mortality rate in West African countries. Hepatitis B3 was found to be significant in reducing the child mortality rate in West Africa.

**5.5 Limitations of the study and Suggestions for Further Studies**

This study was not without limitations. First, recent data which captured immunisation coverage during the Covid-19 pandemic was unavailable; hence the study could not go beyond the year 2019 as at the time the empirical analysis was conducted. Upon recent data availability, further empirical studies could be conducted to assess whether there has been significant change in immunisation coverage and how it has impacted child mortality in West Africa. Second, diphtheria pertussis and tetanus (DPT), hepatitis B3 and measles are not the only vaccine preventable disease (VPD) but this study limited its investigations to these three as a result of data unavailability on other diseases. More studies could be carried out on other VPDs when the data is available.

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