UNIVERSITY OF NAIROBI

Masters Research Project

Determinants of immunization uptake in under five children in Amhara region, Ethiopia

By

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X53/35244/2019

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A Research Project Submitted in Partial Fulfillment of the Requirements for the Award of Degree of Master of Science in Health Economics and Policy in the School of Economics, University of Nairobi

December 2021

Declaration

I, Bethelhem Sileshi Tadesse, declare that this study project titled 'Determinants of immunization uptake in under five children in Amhara region, Ethiopia', is my original thesis work and it has not been submitted/presented in any other institution(s).

Signed:…… Date: 02/12/2021

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This research project has been developed under my guidance and was presented with my approval as the university supervisor.

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Signed: *mkmuriithi* Date: 21/02/2022

Dedication

I dedicate this project to my beloved family and my son Ethan Amanuel.

Acknowledgment

First of all, praise and infinite thanks to the Almighty God, for providing me with everything from conception and successful finalization of this research project.

My deepest gratitude goes to my research project supervisor, Dr Moses Muriithi, whom I learned of everything, including encouraging, directing and sharing from his deep knowledge of creating the next generation. His constructive and valuable comments greatly contributed towards the completion of the project. Also, my sincere thank goes to the University of Nairobi for providing pleasant environment to my academic carrier.

I am exceptionally thankful for my husband Dr Amanuel Abajobir and my son Ethan Amanuel for their love, support and understanding to complete this research project.

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Abbreviations/Acronyms

ANC	Antenatal care
ASE	Attitudes-Social-influence-self-Efficacy
DALY	Disability-adjusted life years
DoV	Decade of vaccines
EDHS	Ethiopian Demographic and Health Survey
EPI	Expanded Programme on Immunization
GVAP	Global Vaccine Action Plan
MDG	Millennium development goal
PCV	Pneumococcal conjugate vaccine
RED	Reaching Every District
RV	Rotavirus
WHO	World Health Organization
WDA	Women's Development Army

Abstract

Introduction: Vaccination is efficient and effective communal strategy because it is a long-term effort by humans to combat diseases that damage our health. Vaccination coverage is still a key determinant of child health outcomes in almost every country. Incomplete or non-vaccination of children is associated to further system-wide hurdles. Subsequently, full vaccination in children and its determinants must be the focus of stakeholders, including research and development – and this is the major goal of the current study.

Objective: To analyze determinants of full vaccination uptake in under five children in Amhara region, Ethiopia.

Methods: The study adopted a binary probit regression model that presupposes a linear association between the outcome variable and explanatory characteristics, as well as an inverted standard normal probability distribution. The EDHS 2016 was used to gather data for the study. Household characteristics, education and employment, marriage, religion, child health and survival were all collected as part of the 2016 survey, which provided essential information for this study. The EDHS supplied data on coverage of three doses of pneumococcal vaccine, which was incorporated into Ethiopia's routine immunization program, as well as percentage delivery in health facilities and proportions of no vaccination cases for various regions. Medical records (vaccination cards), HF visits or report from caregivers/mothers were used to determine the degree of vaccination coverage. The information available on medical records was directly entered; otherwise, the caregiver,

primarily the biological mother, or father were approached to attempt to recollect if the kid had received a specific vaccination. Only full cases were examined in this study. The analysis considered VIF to test multicollinearity and get suitable resilient explanatory factors to fit for the analysis model, which fills variance parameter. Explanatory factors with a VIF greater than 10 was considered collinear. Cross-tabulations of the outcome variable and explanatory factors were conducted to see the overview of data that can lead to a model that is unstable. Heteroscedasticity, or observations with a higher variance, was found using plots for residual and the Breusch-Pagan test. Any non-normal residuals were converted to logs. The analysis carried out the Akaike and Bayesian information criterion, as well as the likelihood ratio test to examine model's goodness of fit.

Results: Findings show that out of the 977 children in Amhara region of Ethiopia, 612 (62.6%) and 365 (37.3%) were fully and not fully vaccinated, respectively. Mothers who were aged from 30-34 (0.781), 35-39 (1.028), 40-44 (1.309) and 45-49 (1.657) received full vaccination relative to those children from mothers aged from 15-19 years. The negative coefficient of household size (-0.117) showed that as household size increases, the likelihood of getting full vaccination in children was low. Women with ANC follow up of >7 times (1.070) higher tendency to vaccinate their kids fully relative to those women without ANC visit(s). As birth order increases to >=6 (-0.596), the likelihood of getting their children fully vaccinated is low as compared to a birth order of 1. Those who delivered in a public facility (-0.394) did not vaccinate their children fully relative to those who delivered at home. The coefficients for poorer (0.407), middle (0.664), richer (0.630), and richest (0.871) wealth index were all positive, reflecting that households with a higher wealth index had lower likelihood of vaccinating their children full relative to the poorest households.

Conclusion and recommendations: The study found that maternal age, birth order, wealth index, place of delivery, ANC visits and household size were significant determinants of full vaccine uptake among under five children. However, determinants like education of mothers, matrimonial characteristics, dwelling area (rural/urban) and household head age did not have any significant effect on vaccination coverage.

Increasing demand for full vaccination uptake shall enable regions in Ethiopia to attain more vaccination coverage. According to this study findings, full uptake of vaccination was associated with mother's age, parity, wealth quintile, ANC visits and household size. The government should intensify the sensitization of young mothers and women with low income on the importance of vaccination. This can be done during antenatal and/or post-natal care visits. Community health workers should increase door-to-door campaigns in order to ensure all children born to a woman has received all vaccines that he/she is eligible for. Demand for and uptake of full vaccination might be low in the lower wealth quintiles due to indirect costs related to vaccination, including transport to health facility. The government can increase demand for vaccination in the lowest wealth quintile households by offering incentives that will enable mothers to take their children for vaccination. Women from the poorest households should also be economically empowered which will increase their health seeking behavior and therefore increasing demand for vaccination.

CHAPTER ONE: INTRODUCTION

1.1 Background

Vaccination prevents and controls serious communicable illnesses. Vaccine is effective and efficient intervention, and one of well-established strategies accessible to hard-to-reach remote and vulnerable populations (Gentile et al., 2010). Infectious diseases prevented by vaccines are still significant contributors to illnesses and deaths in many underdeveloped countries around the world. These diseases contribute to 15% deaths in under 5 children, remain the leading factors that contribute to deaths in children, killing about 3m children annually, mostly in Africa and Asia(Close, Pearson, & Cohn, 2016). According to a research by WHO and UNICEF, vaccine preventable deaths accounted for nearly 29 percent of mortality in 1-59 months old children (Kaoje et al., 2017). Pertussis was reported in 24.1 million children, and Africa contributed for 33.3% of the cases (Plans-Rubió, 2021).

Vaccination coverage is still a key determinant of child health outcomes in almost every country. Due to the negative health effects of non-immunized infants, most countries want to improve vaccination coverage by ensuring that all children born in or out of a health care setting get vaccinated. As a result, the WHO established GVAP – global vaccine action plan - in May 2012; it is a blueprint for preventing substantial proportion of lives by enhancing impartial and fair vaccine availability. Countries hoping to attain overall vaccine coverage and distribution rate by a minimum of 90% and by 80% in specific administrative units (e.g., districts in 2020 under this plan. Despite global increases in vaccine coverage over the previous 10 years, provincial discrepancies persist because of reasons, including scarcity of resources, conflicting intersectoral objectives, weak system/administration, and insufficient evaluation and appraisal system (WHO-

UNICEF, 2013). In 2013, it was predicted that vaccines via common delivery modes were not accessible to 21.8 million newborns and children, globally (Galactionova et al., 2017).

Vaccination is unprecedented intervention and wise community health investment because it is a long-term effort by humans to combat communicable infections, which damage people's wellbeing. Regular vaccination is a critical component of a considerable prevention of child/neonatal death due to VPDs. Based on WHO estimation, vaccination prevents between two and three million mortalities worldwide annually. According to research, vaccines improve and simplify infectious diseases control and lessen the burden of DALYS (Sheikh et al., 2018). According to a research from Iran, the DALYs due to measles decreased from 86.1/100,000 in 1990 to 5.6/100,000 in 2010. According to a research by the UN approximation, child survival has improved significantly over the last three decades. It also revealed under 5 child deaths have reduced by 58 percent 1990 onwards, with the number of children under the age of five dying falling from 12.6 million in 1990 to 5.4 million in 2017.

WHO founded the EPI since 1970s. This proposal occurred after a successful smallpox eradication campaign. By the time he or she became one year old, EPI hoped to vaccinate each kid against most infectious but VPDS. Currently, EPI's main mission is to provide vaccination to every eligible child and childbearing women (Ethiopia, 2010). The program was expected to bring improvements on child illnesses and deaths, as well as improving the number of surviving children achieving MDG4. As per WHO directives, Ethiopia introduced and implemented EPI in 1980. Ethiopian immunization strategy was modified in 2007 after national guideline was released in 1988. In many African countries, tremendous progress has been made in improving immunization coverage over the last four decades. Vaccine-preventable illnesses have decreased dramatically since the

commencement of suitable vaccinations for regular provision for babies. Since its inception in 1974, EPI in LMICs has avoided >2m deaths in children from VPDs (Ethiopia, 2010).

Governments in most impoverished nations confront a number of obstacles when it comes to delivering immunization programs. Poor logistics and technical competence, as well as political, social, and cultural barriers, all have a negative impact on access to medical care. Immunization was critical to reaching the MDGs, which included a reduction in fatalities among children under the age of five (Machingaidze, Wiysonge, & Hussey, 2013). Much depends on the government's continuous commitment and the international community's continued efforts to enhance child survival through immunization in order to reach the MDGs.

According to a study conducted in different parts of Ethiopia, education level attained by mothers, residency, and perceiving assistance in healthcare services contribute substantially to full vaccination uptake (Tefera, Wagner, Mekonen, Carlson, & Boulton, 2018). A study conducted in Mozambique, India, and Bangladesh found that access to health services for mothers such as ANC, tetanus toxoid vaccine, and institutional delivery are linked to children's complete immunization status(Etana & Deressa, 2012a). Low immunization coverage is also caused by a lack of access to services, limited caregiver information, missed chances, and a high dropout rate. Low access to services, limited caregiver information, missed opportunities, and high dropout rates have all been identified as important barriers to universal immunization since the beginning of the EPI initiative (Hu, Li, Chen, Chen, & Qi, 2013). Those issues have remained to this day, posing strong obstacles to universal immunization, particularly through regular procedures. The RED (Reaching Every District) method, which has started in 2002 to respond to a WHO recommendation, appears to reduce some of these issues, but its entire impact is difficult to quantify because its implementation has yet to be fully realized.

The need to make immunization a culture and to establish a long-term demand for services in communities must be acknowledged as critical efforts. To succeed and have a long-term influence on child health, the service delivery system must be completely supported by community efforts. In order to achieve universal immunization, the RED approach must be fully implemented, social mobilization actions must be strengthened, and culturally relevant behavioral change communication tactics must be developed (Berhane, 2008). It is impossible to overstate the importance of involving all important stakeholders in the planning, implementation, and evaluation of the immunization program. In order to guarantee high levels of and sustained routine immunization coverage, lessons learnt during immunization campaigns must be integrated into routine care (Berhane, 2008).

Access to and demand for primary healthcare services has significantly improved in Ethiopia after introducing health extension program (HEP) in 2003. Women's Development Army (WDA) was part of HEP, which enhances vaccination efforts of the government and other stakeholders in Ethiopia. Immunization is an important part of the health extension effort. Notwithstanding, Ethiopia has not achieved the 100% vaccination uptake ambition (Lakew, Bekele, & Biadgilign, 2015). The country only achieved 24.3% full vaccination as of 2011. As such, large majority of the children have not been getting the benefits of full vaccination. In comparison to other LMICs, Ethiopia experiences higher rates of neonatal and under 5 mortality (Etana & Deressa, 2012b).

In developing countries, including those in Africa and Asia, factors that hinder access to full vaccination in under 5 children include: lower parental education, lower income, the child's gender being female, traditional religious believes, place of child delivery and being late in receiving a afterbirth check-ups (e.g., after 2 months of birth) by mothers, household wealth, social background, age, and number of birth orders (Jani, De Schacht, Jani, & Bjune, 2008).

Undernutrition, VPDs, and other infectious diseases significantly contribute to under 5 child deaths in Ethiopian (Demissie et al., 2020). Moreover, caregiver's knowledge related to vaccination, delay in child vaccination, and supported provided health facilities (HFs), giving birth in HFs, ANC visits/services, living areas (urban/rural) and healthcare personnel visitation of a family/household, decision-making ability of women, number of under 5 children, women's educational attainment, and distance to HFs were all factors pertinent to full vaccination uptake (Jani et al., 2008).

Providing consistent awareness about vaccination, including its advantages to the public, preparedness of HFs to provide the services and actions to avoid hindrances to vaccination uptake are some of the driving reasons behind the use of immunization services. Increasing childhood disease immunization coverage has become a critical developmental concern. Around 27m under 5 children and 40m expectant mothers are estimated not to have received all of their immunizations, with >2m persons dying each year due to vaccine preventable diseases around the world. Vaccine-preventable diseases are among Africa's leading sources of morbidity and mortality (Peck et al., 2019). Immunization of all children is essential for lowering newborn and child mortality. TB, DPT, tetanus, polio, and measles are among the vaccine-preventable diseases covered by this vaccine (Tesfaye, Temesgen, & Kasa, 2018). In Ethiopia, other children's immunizations are also administered. Ethiopia has introduced PCV 13 and RV1 vaccines in 2011/12 to the country's baby vaccination program, respectively, to prevent primarily pneumonia and meningitis by the pneumococcal vaccine (Tesfaye et al., 2018).

According to sex of children, there is a little discrepancy in vaccine coverage rates. Geographical location has a significant impact on vaccination coverage. According to empirical studies, full immunization coverage is substantially greater in towns/cities than country-sides in Ethiopia, with

65% in towns/cities and 35% in country-side. Addis Ababa (89%) has the highest immunization coverage, while the Afar area has the lowest (15%) (Dessie & Negeri, 2018). As a mother's education level rises, so does vaccination coverage. In Ethiopia, only about 3 out of 10 children whose moms do not have a secondary school are vaccinated fully, relative to >7 out of 10 children from women with a secondary school (Dessie & Negeri, 2018).

The Ethiopian EPI, which began in 1980, has been a top priority in previous health sector development plans (HSDPs) and health sector transformation plan (HSTP) (MOH 2015). To administer vaccination services, Ethiopia has organized WDAs or volunteers, HEWs, and HFs. In 2011, efforts to improve region planning and management were launched, with the goal of reaching every region/woreda. The three main service delivery platforms for immunization services are stationary, outreach, and mobility. Several initiatives also supplied children with antigens for polio, measles, and other diseases. Ethiopian government is dedicated to improving the health of its citizens by aiming to provide health services that are freely available and meet the population's fundamental requirements.

1.2 Problem statement

The collaboration and partnership of WHO with various stakeholders via the GVAP and decade of vaccines (DoV) projects, which were approved by WHA in 2012 enhances the uptake/coverage of vaccination globally (WHO, Fact Sheet N0378 April 2015). In Ethiopia, the government has been at the forefront of expanding, improving, and intensifying immunization services through the Ethiopian Vaccine Initiative (EPI). More health facilities have been equipped with cold chain equipment, health workers have been retrained, outbreaks have been addressed through campaigns, and immunization has been continuously monitored and evaluated (Dessie & Negeri, 2018). Despite these efforts, Ethiopia's vaccine coverage trend is concerning. According to

statistics, vaccination uptake by Ethiopian children has been steadily declining for the last 20 years, with worsening trends in marginalized communities (EDHS, 2014). Low immunization rates will result in more preventable deaths and a higher disease burden (Plan, 2016). This will have a negative influence on national growth, social-economic development and health outcomes.

Based on EDHS (2011) A, 15% of Ethiopian kids have not had any vaccinations, whereas 56% have been vaccinated against measles. According to card and history, the uptake of 3 doses of pentavalent reported o be 44%. When compared to the EDHS 2005 results, this is a significant improvement. Still, overall rate of vaccination is merely at 24%, and the uptake of 3 doses of pentavalent is below 80% in several parts of the nation (Lakew et al., 2015). Several investigations show that Ethiopia's EPI timetable is not being followed as planned. Ethiopia has enhanced reinforced and deployed WDAs throughout the country to facilitate the implementation of HEP. Vaccination, indeed, is one of the main deliberations of HEP. Nonetheless, Ethiopia has not attained its ambitious plan of 100% vaccination uptake children. Only about one quarter of children in Ethiopia received full vaccination in 2011. Consequently, large majority of the children have not been receive the benefits of vaccination. In comparison to countries with similar economic status, Ethiopia has experienced slightly more neonatal and/or under 5 child deaths (Tefera et al., 2018).

The necessity of universal immunization cannot be overstated. The necessity for methods to achieve complete immunization coverage is obvious from the low full immunization coverage studies undertaken thus far. Incomplete or non-vaccination of children is associated to further system-wide hurdles. Subsequently, vaccination in under 5 children and its determinants must seek the attention of stakeholders, including research and development communities – the major goal to be achieved by the current research. Some studies and publications have found factors that

influence vaccine uptake, but most of them haven't looked at factors that affect under 5 children. Consequently, using EDHS 2016 data, the current research is being conducted to examine, analyze and determine the determinants of vaccination uptake in under 5 children in the Amhara region, Ethiopia. Because EDHS (2016) data is the newly established public dataset and currently no studies in the specified area have been undertaken utilizing it, the current research is carried out to detect contemporary limitations and enhance previous findings. As a result, health care practitioners, educators, policymakers, and investigators in the future can use it as a reference. Moreover, the study supports SDG 3. It is particularly important to meet SGD goal related to child health (SGD 3.2) and reducing premature mortality in children.

1.3 Research questions

1. What was the proportion of under 5 children with full vaccination uptake in Amhara region, Ethiopia?
2. What were socio-demographic-economic and immunization access determinants on vaccination uptake in under five children in Amhara region, Ethiopia?

1.4 Study objectives

General Objective

The broad objectives of this study was to analyze the determinants of immunization uptake in under five children in Amhara region, Ethiopia.

Specific objectives

The specific objectives of this study was in three folds, that is,

1. To determine the proportion of under 5 children with full vaccination uptake in Amhara region, Ethiopia
2. To determine the effect of socio-demographic-economic and immunization access determinants on vaccination uptake in under five children in Amhara region, Ethiopia
3. To derive policy options from objective two mentioned above

1.5 Significance of the study

Vaccination is an essential part of the various combination of strategies employed in developing nations like Ethiopia to battle rising instances of avoidable diseases and improve health outcomes. In this regard, policymakers should be interested in the proposed study for the aforementioned purposes. To begin with, the results of this research should inform relevant national policies aimed at increasing immunization rates. As a result of the better health outcomes, welfare and economic growth will improve. Second, the study will complement the current literature and provide data regarding the factors that influence vaccination uptake in Ethiopia. Finally, the study will serve as a foundation for future conversations and studies in the field of vaccination, allowing for the implementation of more effective measures to promote access and uptake.

Scope of the study

This research was restricted to analyzing the vaccination uptake of under 5 children in the Amhara region of Ethiopia.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section/chapter narrates related literature under 3 headings: theoretical literature, empirical literature, and literature overview. Theoretical literature includes various economic hypotheses that explain how socioeconomic, demographic, and health factors influence vaccination coverage. Conversely, empirical literature refers to those researches that looked into determinants that influence vaccine uptake. There is also a brief overview that covers the gaps in the literature.

2.2 Theoretical Literature

This section presents the theoretical background of the study.

2.2.1 Health care utilization model

Several theories state that socio-demographic, economic determinants contribute a prominent part in determining individual demand for healthcare services. Phillips, Morrison, Andersen, and Aday (1998) created a healthcare utilization model. Age, geography (rural or urban), provider incentives, stratum in a society, and attitudes and beliefs toward health were critical all variables identified factors that affect utilizing healthcare services. Several studies looking into how people use healthcare have used this model. According to the hypothesis, a person's decision to access and use healthcare is affected by their location, towns/cities or countryside. People in metropolitan residents have an affinity to use healthiness services more frequently than those in countryside areas.

A person's socioeconomic standing also influences the uptake of available healthcare services. People who are higher in the social stratum, for example, in attaining higher education and/or

employment are more tend to use healthcare facilities relative to those who have less social stratum. A person's healthiness beliefs influence the coverage and uptake of healthcare services, including vaccination. People who believe health services are valuable are more likely to use them.

Other supportive traits include the availability of resources in the family and in the community. Because they have more purchasing power, those with a higher socioeconomic position tend to receive health amenities relative to the ones with a lower socioeconomic status. Later, he expanded his evaluation to encompass the healthcare system (Andersen & Newman, 1973). The modified model recognizes that utilization is determined by the type of health care and its purpose and the fact that health behavior is a direct determinant of health outcomes. Based on demographic characteristics and health service availability, use and regular uptake of various or individual healthcare services will have various factors in revised model (Andersen & Newman, 2005).

2.2.2 Choice-making model

According to this model, Young (1981) suggested ethnographic research of Mexican healthcare consumption. It comprised four elements that are critical in an individual's choice to use healthcare services. Perceptions of gravity are the first component, that Young defines personal perception of the extent (severity) of a disease and how their social network views it. This model argues that Individuals are more likely to seek medical help if the sickness is severe; otherwise, they are less likely to do so. The second factor, he noted, is that if an individual knows of an effective home remedy, he/she has more tendency of turning to a health facility (health personnel) for various reasons, including convenience and the desire to save

money (Wolinsky & Arnold, 1988). Third, faith in the remedy – refers to the confident a person is that seeking health care for their current condition is effective, and hence whether or not they would use it. The fourth component is treatment access, which includes assessing the cost and availability of health care. He went on to say that getting the needed services would have a significant effect on how much people use it. The cost in terms of economic value for getting medical treatment involves the mechanism of payment for seeking care and lost productivity time and transportation costs, which take into account the time required to access medical care given their geographic location (Garro, 1982).

2.2.3 Grossman model

Grossman (1999) suggested that the basic need for health drives demand medical care and other health inputs. Age, education, health condition, and income are critical variables in this model's generation of health capital (Grossman, 2017). Since illness days are the main reason for ‘disutility’, consumers want healthcare services as a commodity for consumption as it directly satisfies their utility. Health is in high demand and asset or product since it governs the sum of time spent on commodity and non-commodity events. A person inherits a healthiness standard, which decreases with age & can be enhanced through savings. Grossman (1999) goes on to say the demand of capital health, in terms of quantity, increases in lockstep with the rate of income; as an individual’s income increases, more valuable the upsurge in terms of time spent in healthier period is to him since greater time reflects higher income, prompting individuals to capitalize higher in their wellbeing. Higher academic attainment also improves productivity of healthcare provision, lowering the number of inputs necessary for a specific amount of health capital People who are educated value their health more than those who are illiterate, but they demand less health care.

2.3 Empirical Literature

Datar, Mukherji, and Sood (2007) did a study in rural India with 43,416 children aged 2-35 months using data from NFH Surveys. Models – multinomial logistic regression – were used to estimate the tendency of taking polio vaccine. Institutions related to health were employed as stepwise variables allocated to candidate child as categorical variables as per better health facility accessible in residential area of the child. Availability of several divisions of health personnel in communities in the hamlet and associated facilities were also considered variables. The findings revealed that while health facilities had a minor impact on immunization coverage, larger and more equipped ones positively impacted on immunization uptake. However, there was no link between presence of health personnel in the community in the village and higher immunization coverage. Similarly, those from poorer homes tend to vaccinate kids hence having a negative impact on immunization coverage. Again, the study also shows, those from wealthier families tend to vaccinate kids.

Varma and Kusuma (2008) conducted a qualitative and quantitative study to examine the uptake of different vaccines in children from different background from India in a varied socioeconomic context. Although most mothers were aware of vaccination, the results revealed that their willingness to receive immunization uptake was driven primarily by location and other social classes. Data from qualitative segment of the study revealed that the community was dissatisfied with the current immunization services, particularly in rural areas. According to the survey, vaccination coverage was reasonable in urban communities but poor in poor countryside districts, reflecting a linear association between living in an urban setup and immunization uptake.

According to Odusanya, Alufohai, Meurice, and Ahonkhai (2008), vaccine coverage is also

determined by educational level. The findings are based on primary data evaluated using multiple regression models to uncover predictors of vaccination uptake level in under 2 years children in Nigeria. The researcher discovered that immunization coverage was greater in locations where most mothers had a general understanding of vaccine-preventable disease symptoms in his study. Furthermore, in places where immunization services were provided, the range was high.

The location of one's house is also a factor in vaccination coverage. The location of residence of the child can either positively or negatively affect immunization uptake. A population-based survey conducted under the PRRINN-MNCH Programme in Northern Nigeria by Findley et al.(2011), found that children in urban regions regularly received vaccination as compared to those children in rural areas.

Mohammed and Atomsa (2013) conducted a logistic regression exploration to investigate the characteristics, which affect vaccination uptake in under 2 years children in eastern Ethiopia. Quantitative & qualitative data were collected using a community-based cross-sectional design. Findings revealed that mothers' ignorance of the need for immunization negatively impacted on immunization uptake; caregivers/women didn’t bring back their kids for the second and third vaccines due to perceived side effects; incorrect perceptions of immunization contraindications; and a lack of information on immunization location and timing.

According to Ibnouf, Van den Borne, and Maarse (2007), vaccine outcomes are determined by distance to a health center. In Khartoum State, Sudan, he conducted a cross-sectional study. Using a multivariate regression analysis, he discovered the likelihood of receiving vaccination was 3.4 times higher for children from caregivers who in < 30 minutes to vaccination facility

as compared to those who walked > 30 minutes. As a result, the amount of time it took to travel to the nearest vaccination center significantly impacted immunization of children. The more the time taken, the greater the negative impact on immunization coverage

The findings of a study conducted in rural Bangladesh (Rahman and Obaida-Nasrin (2010)) using both bivariate & multivariate analysis indicated that maternal education positively influenced the acceptability of full immunization, that is similar with other studies. moreover, the educational status of caregivers reflects many other characteristics such as socioeconomic level, allowing the caregiver to demand competent health services for respective kid/s as per the need (Ibnouf et al., 2007). According to a qualitative study conducted by Jegede and Owumi (2013) in Southwest Nigeria using a content analytical approach, despite high immunization service patronage, some mothers still defaulted due to vaccine supply delays, vaccination schedules clashing by mothers' socio-economic performances, particularly farming or purchasing days, and undesirable behavior of health personnel/members. The perception of a immunization's side effect didn't have a significant detrimental impact on immunization uptake,

A research in Delhi, India, found that the head of home holding a secure and compensated work was connected to more tendency of vaccination in children (Kusuma, Kumari, Pandav, & Gupta, 2010). These data suggest disadvantaged lifestyle are linked to both vaccination and higher disease occurrence.

A qualitative study found that although women as the primary caregivers for their kids in many Ugandan households, fathers frequently make decisions regarding involvement in government programs, and their concerns have been recognized as one of the hurdles to their children's participation in immunization programs (Nuwaha, Mulindwa, Kabwongyera, & Barenzi, 2000). Women's participation in facilitating childhood vaccinations appears to be influenced by two

primary factors: academic attainment and social support. Though both parents' schooling was found to be beneficial manners in health, mother schooling was identified main factor in parental immunization program adherence. In a similar context, a research in SSA utilized a logistic regression analysis explored the relationship of literacy in women and person’s not using women healthcare (McTavish, Moore, Harper, & Lynch, 2010). The findings found that women's literacy was connected with increased healthcare access and utilization.

Etana and Deressa (2012a) investigated factors of immunization uptake using a cross-sectional community-based survey in Central Ethiopia. The findings from the logistic regression revealed that, while the mother's place of dwelling & socio-demographic-economic factors did not show substantial relationship with children receiving vaccination – delivery in health facility, ANC visit and caregiver’s awareness about immunization were. Immunization coverage was significantly influenced by the age at which vaccination began. Children who began immunization at early ages positively influenced vaccination coverage as they had higher chances of getting full immunization. However, the study did not account for the possibility that the mother's report may underestimate or overrate vaccination uptake or that caregivers can overlook child's complete dosage. Furthermore, findings did not reflect the efficacy of the vaccine doses given to the youngster.

Nakayiza (2018) examined the effect of the size of household, timing of rainfall, place of distance form HF, and the age of caregivers on timely immunization in Kawempe, Uganda. In 2002 and 2004, cluster samples and simple random surveys were undertaken, respectively. On the other hand, the study did not consider the possibility that the moms' reports may be inaccurate or incomplete. The analysis of an Inverse Kaplan-Meier survival model of vaccine-card and mothers' recollection data was used to estimate coverage, subsequently confirmed by

checking organizational archives from countrywide and regional immunization depots. To investigate the influence of gender, size of household, distance from HF, caregiver's age, and seasonality like raining season to vaccination intake, the model was fitted to recurrent immunization data. Results indicated a non-linear association between clinic distance and immunization coverage. Vaccination uptake decreased by each every km traveled from dwelling to immunization facility.

The study by Maina, Karanja, and Kombich (2013) found independent determinants of complete vaccination in under 2 years children in Kenya's Nakuru. Sample selection approach was cluster sampling. According to the findings, the percentage drop-out for 1st and 3rd pentavalent immunization uptake was 8.9%. This drop in vaccination uptake was due to the negative relationship between immunization predicting factors like the child's birthplace, family size, advice on the subsequent appointment for routine checkups, and how caregivers perceived the type of immunization provided. However, the research didn't consider immunization-related characteristics such as convenience regarding remoteness to categorize dropouts and lower defaulters.

Schooling attained by the caregivers is also a factor in vaccination outcomes. Travassos et al. (2016) collected primary data to assess complete and timely immunization uptake and related variables in under 2 years children. A basic random strategy was used to select the samples. According to robust analysis, children of caregivers with lower academic level or families families where the spouse was away received less full vaccination hence negatively impacted on immunization coverage. Given that the trial was done in a rural context, the researchers discovered evidence of a distance decay effect, in which vaccination reduced as the distance from the vaccination facility increased.

2.4 Overview Literature

In summary, the following factors were found to positively influence on immunization uptake Mother's education (secondary and above), maternal literacy, childbirth place, antenatal visits and household head age (Doctor et al., 2011; Etana & Deressa, 2012a; Tsawe et al., 2015). Similarly, other studies found that the child's immunization inception age, HF delivery, ANC visits and mothers' awareness about immunization had positive impact on immunization uptake among the children(Ibnouf et al., 2007; Jegede & Owumi, 2013; Nakayiza, 2018). However, factors like child's birthplace, family size, advice on the subsequent appointment for routine checkups, and their perception of the type of immunization provided negatively impacted on the immunization uptake (Maina et al., 2013) According to the literature mentioned in the preceding paragraphs, several pieces of research have been done to assess the determinants of vaccination uptake. The majority of studies used data from the entire country, with very few studies considering regional determinants. However, the structure of a region could have socio-economic factors that differ from other regions. Hence, generalizing the result could result to non-optimal policy option. This study intends to solve such inconsistency that might affect implementation of targeted policy by using data from Amhara region which has reported low uptake od vaccination compared to the national average. The proposed research aims to fill this gap in knowledge by using EDHS 2016 data from the Amhara region to gain new insights into the determinants of immunization uptake in Ethiopia's Amhara region and compare the results over time to determine what is causing the decline in immunization uptake.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter describes methodology, framework, description of measurement variables & data source used for the study.

3.2 Conceptual Framework

Immunization coverage is determined by considerable characteristics, including demographic-socio-economic & health institution or structure features. Government capacity to deliver immunization services is determined by socioeconomic factors such minimum school attended, impoverishment, and remoteness of the HFs, indicating the presence of health institutions. These factors have also been extensively documented as drivers of higher vaccination coverage in the literature. A healthy health system includes an increase in the ration of nurses to clients, prenatal services, delivery in a HF, and the possession of a vaccination record/document. These factors, according to extant literature, influence complete vaccination in a specific district or region.

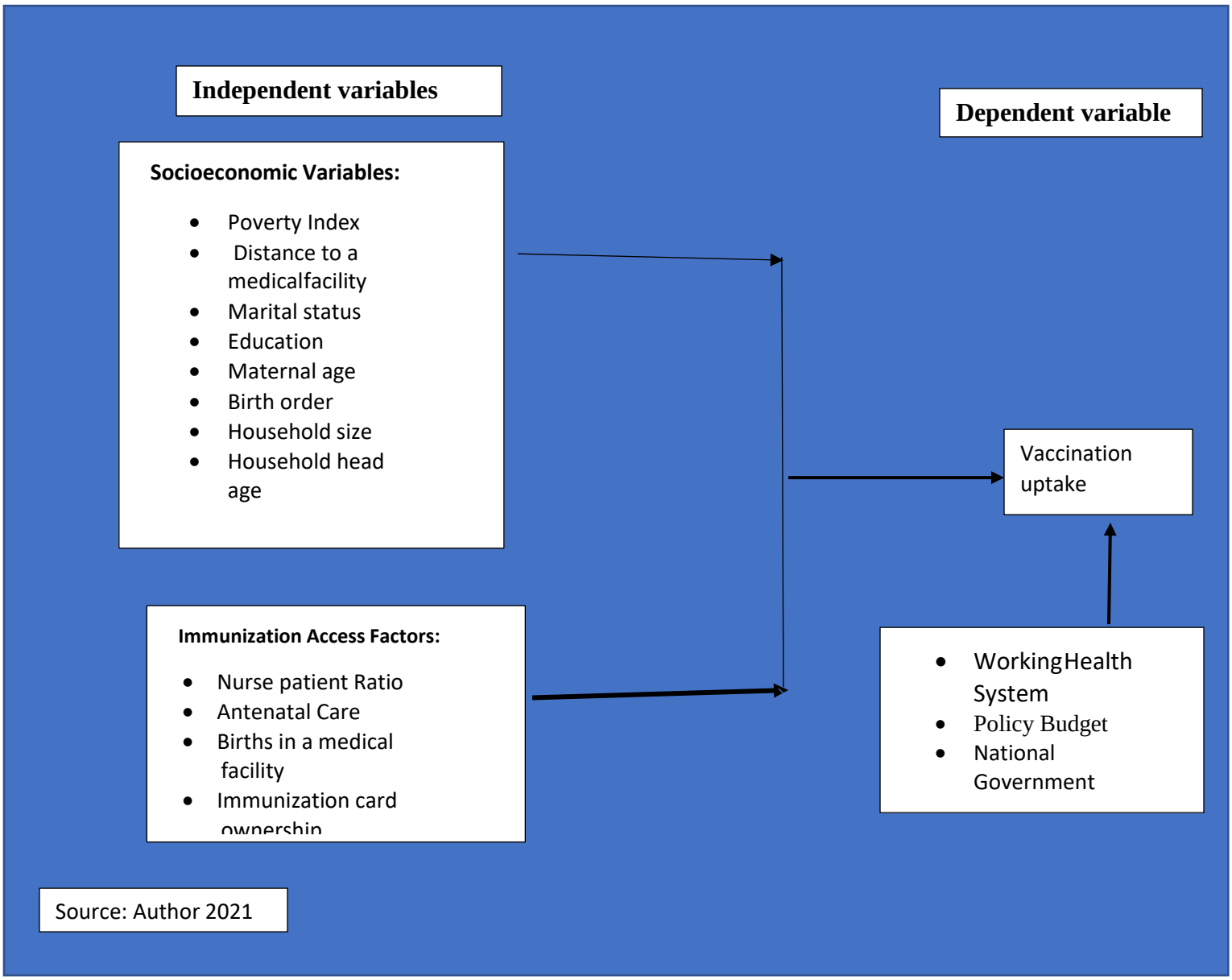
Moreover, the administration has a responsibility to carry out in ensuring that everyone is fully immunized. In Ethiopia, for example, the central government is responsible for giving policy direction and money to county governments to deliver necessary healthcare. In exchange, country government must maintain a competent health system that ensures access to primary healthcare and oversees the maintenance of immunization clinics. In their jurisdictions, regional governments have the authority to make decisions on how to improve their respective health systems utilizing the resources available to them.

These options could include expanding the building of HFs to lessen remoteness that

households must travel to obtain health care or boosting the doctor-to-nurse-to-patient ratio. Furthermore, through various development programs, which the administration play a larger portion of the service in promoting and reducing the magnitude of health illiteracy and impoverishment.

Households, particularly those with under 5 children, should be accountable to warrantee that their kids receive complete immunization as per WHO requirements. Circumstances that may affect the availability and access of vaccines, on the other hand, have varied effects on households' capacity to obtain vaccination.

Figure 1: Conceptual Framework



Model specification

The study adopted a binary probit regression model that presupposes a direct association between result and independent variables, as well as an inverted standard normal probability distribution (Wooldridge, 2010):

$$y_i^* = \alpha + \beta x_i + \varepsilon \quad (1)$$

Where:

y_i^* = the unobserved dependent variable [full vaccination uptake]

x_i = vector of independent variables

β = vector of parameters to be estimated

ε = error term

The observed outcome variable (y) is linked to the unobserved outcome variable (y_i^*) variable as follows:

The observed dependent or outcome variable (y) is linked to the unobserved outcome variable (y_i^*) as follows:

$$y_i = \begin{cases} 1 \; if \; y_i^* > \tau \\ 0 \; if \; y_i^* \leq \tau \end{cases} \quad (2)$$

Where τ is the threshold, while full vaccination coverage is y = 1 and incomplete coverage is y = 0. The cumulative distribution function of the probit model can the be expressed as:

$$prob(y_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x_i\beta} e \frac{-(x_i - x_i\beta)^2}{2} dx = \Phi x_i\beta \quad (3)$$

Equation 4 shows the probability of full vaccination coverage:

$$\Pr(y_i = 1) = \Phi(x_i\beta') \quad (4)$$

Where, $\Phi(x_i\beta')$ is the cumulative distribution function that is used to calculate the maximum likelihood function (L) as follows:

$$\mathrm{L} = \prod_{y=0} \Phi(-x_i\beta') \prod_{y=1} [1 - \Phi(-x_i\beta')] \quad (5)$$

The marginal effects at the mean of the probit model ($\frac{\partial y}{\partial x}$) was calculated as follows:

$$y = \Phi(\beta_0 + \beta_1 x_1 + \beta_1 x_1 + \beta_1 x_1 + \cdots + \beta_n x_n) \text{ so} \quad (6)$$

$$\frac{\partial y}{\partial x} = \beta_i \phi(\beta_0 + \beta_1 x_1 + \beta_1 x_1 + \beta_1 x_1 + \cdots + \beta_n x_n) \quad (7)$$

This probit model was interpreted according to coefficients or marginal effects. Positive coefficients showed that an increase in the outcome variable increased the predicted probability while negative coefficients showed a decrease in predicted probability for an increase in the explanatory variable.

Estimable model

The determinants of vaccine uptake in Amhara region, Ethiopia was calculated applying a binary probit regression model. Vaccination uptake is a binary outcome variable (1 = complete coverage, 0 = incomplete coverage)

The model will be as follow:

$$y_i^* = \alpha + \beta x_i + \varepsilon$$

$$Y(vaccination\ uptake) = \beta + \beta_1(Mother's\ age) + \beta_1(Education) + \beta_1(marital\ status) + \beta_1(location) + \beta_1(place\ of\ delivery) + \beta_1(antenatal\ care) + \beta_1(Household\ head\ age) + \beta_1(Household\ size) + \beta_1(Birth\ order) + \beta_1(Household\ wealth) + \varepsilon$$

Table 1: Definitions, measurements and sign of the variables

Variable Name	Description	Measurement	Sign
Dependent variable			
Vaccination uptake	Whether a child is vaccinated or not	Dummy variables, 1 if child is fully vaccinated, 0 if otherwise	
Explanatory variables			
Age of mother	In years	Continuous variable	
Education of mothers	Levels of education attained by the mother	1 if no formal, 0 otherwise	Negative
		1 if primary, 0 otherwise	Negative
		1 if secondary, 0 otherwise	Positive
		1 if tertiary, 0 otherwise	Positive
		1 if literate, 0 otherwise	Positive
Mother's marital status	whether married or not	Dummy variable,	
		1 if mother is married, 0 otherwise	Positive
Place of delivery	Place where mother gave birth	Dummy variable, 1 if mother delivered in a health facility and 0 otherwise	Positive
Antenatal care	whether an expectant mother get antenatal care or not	Dummy variables, 1 if yes and 0 otherwise	Positive
Location	Area of residence in terms of urban and rural	Dummy variable, 1 if urban area and 0 otherwise	Positive
Birth order	Individual 's rank by age among siblings	Reflects the number of children born by the same mother	Postive / Negative

Wealth index, quintiles	measure of living standard based on aggregate of household assets using principal component analysis	1 if rich, 0 otherwise	Positive
		1 if middle, 0 otherwise	Positive
		1 if poor, 0 otherwise	Negative
Age of household head	Age of household head	In years	Positive
Household size	Number of individuals in a household	Indicated by the number of individuals living in the household	Negative

Data source

The EDHS 2016 was used to gather data for the study. Every five years, the EDHS conducts a national sample survey that targets families that offer extensive information on health-related issues across the country. Household characteristics, education and employment, marriage, religion, child health and survival were all collected as part of the 2016 survey, which provided essential information for this study. The EDHS supplied data on coverage of three doses of pneumococcal vaccine, which was incorporated into Ethiopia's routine immunization program, as well as percentage delivery in health facilities and proportions of no vaccination cases for various regions. Vaccine cards and mother's verbal reports will be used to determine the degree of vaccination coverage. The information was directly entered if medical document was present; otherwise, caregiver or father was inquired to attempt to recollect if the kid had received a specific vaccination (Annex).

Estimation Issues

Only full cases were examined in this study. VIF was utilized to test for multicollinearity and identify most stable variables to fit into the model, that measured parameter variance. Variables with a VIF greater than 10 was considered collinear. Cross-tabulations between the outcome and explanatory variables were carried out to look for the size of each cell that can lead to a model that is unstable(Wooldridge, 2010). Heteroscedasticity, or observations with a higher variance than others, were found by constructing residual plots and the Breusch-Pagan test. The normality of residuals will be determined using skewness/kurtosis tests and density plots (histogram, probability plot, and Q-Q plot). Any non-normal residuals were converted to logs. The Akaike and Bayesian information criterion, as well as the likelihood ratio test, were carried out to examine the goodness of fit of the model.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

In this section, the study findings on determinants of vaccination uptake in under five children are presented and interpreted using two approaches. First, the descriptive statistics, which answer objective (1), is presented. Second, the inferential statistics that provide answer for objective (2) on the effect of socio-demographic-economic and vaccination access determinants on vaccination uptake among under 5 children. Descriptive statistics, diagnostic pre-estimation tests, inferential statistics and marginal effects were computed using STATA. Interpretation of the results and discussion in relation to other studies are also presented.

4.2 Descriptive statistics

An aggregate number of 977 under 5 children were used for the analysis of this study. Only 62.6% were found to be fully vaccinated. Of these, maternal age which ranged 25-29 years constituted 28% of the children included in this study and 74.9% children were from mothers who did not have any schooling. About $1/4^{th}$ of the included children (23.6%) came from families with middle household capital index and 9.7% from the richest house wealth status. Majority of the mothers were married (94.4%) and lives in rural area (90.8%). About one third of mothers had >7 ANC visit with a parity >6. 73.5% of the mothers delivered at home. The mean age of the household were found to be 40 yrs, the youngest was 18 yrs old and the oldest was 90 yrs while average household size was found to be 5.6%.

Table 2: Descriptive statistics

Variables	Category	Obs	Mean	Std. Dev.	Min	Max
Vaccination status		977	0.626407	0.484005	0	1
Maternal age						
	15-19	977	0.025589	0.157985	0	1
	20-24	977	0.158649	0.365536	0	1
	25-29	977	0.287615	0.452883	0	1
	30-34	977	0.201638	0.401429	0	1
	35-39	977	0.186285	0.389536	0	1
	40-44	977	0.094166	0.292209	0	1
	45-49	977	0.046059	0.209721	0	1
Maternal education						
	No schooling	977	0.749232	0.433677	0	1
	Primary school	977	0.189355	0.391991	0	1
	Secondary school	977	0.039918	0.195867	0	1
	Higher school	977	0.021494	0.1451	0	1
Marital status						
	Never-in-union	977	0.004094	0.063887	0	1
	Married	977	0.944729	0.228626	0	1
	Living-with-partner	977	0.001024	0.031993	0	1
	Widowed	977	0.004094	0.063887	0	1
	Divorced	977	0.038895	0.193443	0	1
	No-longer/living together/separated	977	0.007165	0.084385	0	1
Household size		977	5.623337	1.984414	1	13
ANC						
	1 to 3	977	0.28045	0.449449	0	1
	4 to 7	977	0.222109	0.415877	0	1
	>7	977	0.233368	0.423191	0	1
	None	977	0.264074	0.441065	0	1
Birth order number						
	1	977	0.180143	0.384504	0	1
	2 to 3	977	0.334698	0.472127	0	1
	4 to 5	977	0.22825	0.419919	0	1
	>=6	977	0.256909	0.437153	0	1
Place of delivery						
	Government HF	976	0.243853	0.429625	0	1
	Private HF	976	0.020492	0.141748	0	1
	Home-delivery	976	0.735656	0.44121	0	1

Wealth index						
	Poorest	977	0.224156	0.417239	0	1
	poorer	977	0.237462	0.425745	0	1
	middle	977	0.236438	0.425112	0	1
	richer	977	0.204708	0.403695	0	1
	richest	977	0.097236	0.296431	0	1
Age of household head		977	39.99591	11.11195	18	90
Residence						
	Urban	977	0.091095	0.287892	0	1
	Rural	977	0.908905	0.287892	0	1

4.3 Vaccine coverage

The results show that out of the 977 children in Amhara region of Ethiopia, 612 (62.6%) and 365 (37.4%) were fully & not-fully vaccinated, correspondingly, (Fig. 2). That is, this analysis considered those children who missed any of the basic vaccines, including 1 BCG (vaccine) dose, 3 doses of DPT-HepB0Hib, all polio vaccine doses (0-3) and 1 dose of measles vaccine, as 'not fully-vaccinated'. Data on these vaccines was collected information gathered from different sources, including medical records (vaccination cards), HF visits or report from caregivers/mothers.

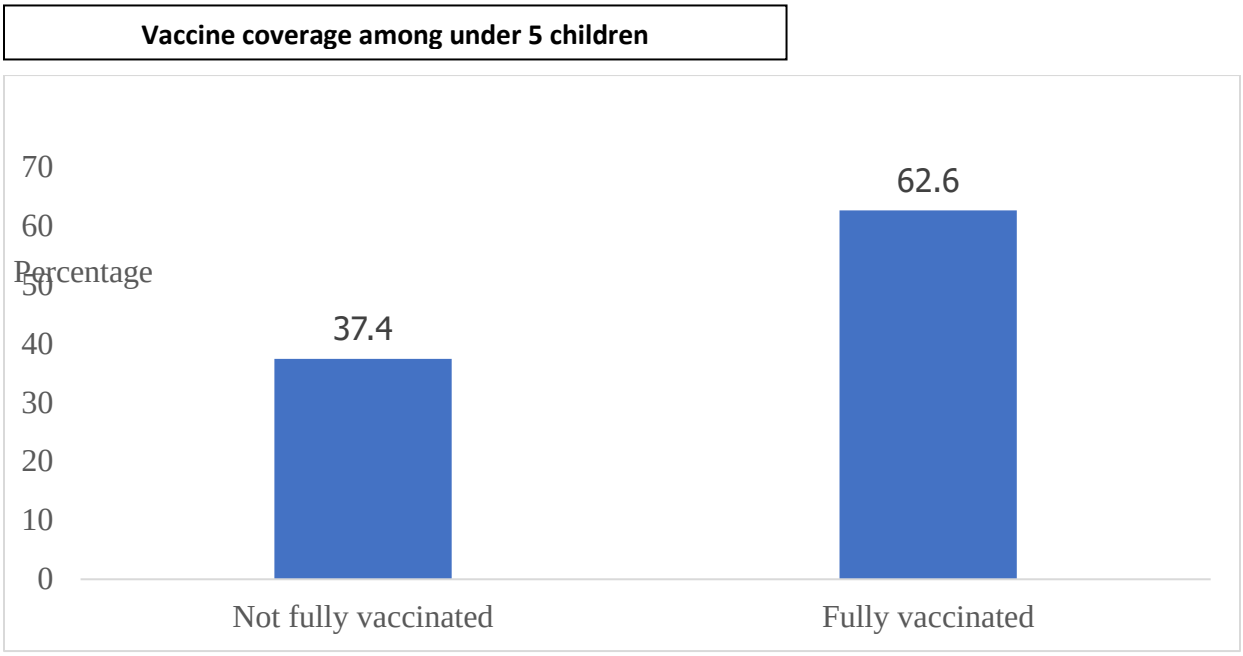


Figure 2: Vaccination uptake among under 5 children in Amhara region, Ethiopia

4.4 Diagnostic pre-estimation tests

This analysis aimed at achieving reliable and valid estimates of socioeconomic and other determinants in regards to the intake of vaccination in under 5 children. The following tests were executed to find out the fitness of the data. Correlation analysis, variance inflation factors and Breusch Pagan test were conducted for heteroscedasticity.

4.4.1. Correlation analysis

The study did an analysis of the correlation coefficient to determine the dyads of factors that were correlated. The coefficient of correlation shows the strength and the sign of the association (regardless of a positive or negative association). If the coefficient is 0, this implies the absence of correlation whereas (+1) reflects an absolute +ve relationship, whereas -ve reflects an absolute -ve relationship. High correlation results in reduced accuracy of estimated coefficient and therefore reducing statistical power of the regression model. The findings showed a positive correlation (0.7933) between birth order and maternal age. Overall, there was no a perfect correlation between the other variables (Table 3).

Table 3: Correlation matrix

	Maternal age	Maternal education	Marital status	Household size	ANC visit	Birth order	Place of delivery	Wealth index	Household head age	Residence
Maternal age	1									
Maternal education	-0.2601	1								
Marital status	-0.071	-0.0041	1							
Household size	0.4886	-0.2011	-0.1047	1						
ANC visit	0.1337	-0.1764	0.0456	0.1024	1					
Birth order	0.7933	-0.3559	-0.1135	0.6125	0.1521	1				
Place of delivery	0.1862	-0.3887	0.0082	0.1664	0.3005	0.2836	1			
Wealth index	-0.0199	0.3512	-0.0241	-0.0998	-0.253	-0.1467	-0.3513	1		
Household head age	-0.0347	0.0731	0.3898	-0.1952	0.0125	-0.0914	-0.1026	0.0464	1	
Residence	0.0501	-0.4468	0.0223	0.1806	0.1283	0.1542	0.3844	-0.406	-0.1612	1

4.4.2 Multicollinearity test

Multicollinearity was tested using a Variance Inflation Factor. The findings showed an overall VIF of 1.88. This is lower than the recommended threshold of 10, indicating the absence of multicollinearity. Therefore, no variable was excluded from the regression (Table 4).

Table 4: VIF test

Variable	VIF	1/VIF
Birth order	3.62	0.276039
Maternal education	2.8	0.35659
Maternal education	2.52	0.39637
Household size	1.69	0.592978
Residence	1.49	0.669743
Place of delivery	1.42	0.70536
Wealth index	1.36	0.73658
Age of household head	1.26	0.790939
Marital status	1.21	0.828316
ANC	1.15	0.871793
Mean VIF	**1.88**	

4.4.3 Breusch-Pagan/Cook-Weisberg Test for Heteroscedasticity new

Heteroscedasticity was tested using Breusch-Pagan test. A null hypothesis of constant error variance (homoscedasticity) was assumed. Results showed a X^2 of 11.58 and a p-valueof 0.3962. Since p-value >0.05, the analysis failed to reject null hypothesis & concluded that there was a presence of homoscedasticity (Table 5).

Table 5: Breusch-Pagan/Cook-Weisberg Test for Heteroscedasticity

Fixed effect	X^2	**Prob>** X^2
Panel mode 1	11.58	0.3962

H0: Constant error variance (homoscedasticity)

4.5 Inferential statistics

4.5.1 Binary Probit regression results on determinants of vaccination uptake among children below 5 years in Amhara region Ethiopia

Results in Table 6 present that children from mothers who were aged from 30-34 (0.781), 35-39 (1.028), 40-44 (1.309) and 45-49 (1.657) received full vaccination relative to those children from mothers aged from 15-19 years. The negative coefficient of household size (-0.117) showed that as household size increases, the uptake of complete immunization in under 5 children was low. Under 5 children from those mothers/caregivers who had an ANC follow up of >7 times (1.070) received full vaccination relative to those under 5 children from mothers who did not receive ANC services/visits. As birth order increases to >=6 (-0.596), the likelihood of getting their children fully vaccinated is low as compared to a birth order of 1. Those mothers who delivered in a public facility (-0.394) did not vaccinate their children fully relative to those who delivered at home. The coefficients for poorer (0.407), middle (0.664), richer (0.630), and richest (0.871) wealth index were all positive, reflecting that households with a higher wealth index had lower likelihood of vaccinating their children full relative to the poorest households. Other variables did not have significant coefficients on full vaccination uptake among under 5 children (Table 6).

Table 6: Probit Estimation Results on Determinants of Demand of vaccination uptake among Children below 5 years in Amhara region

Variables	Coefficient	Robust Standard Error	z	P>z	95% Confidence interval	
Maternal age (*ref: 15-19)*						
20-24	0.324936	0.3117786	1.04	0.297	-0.2861389	0.9360108
25-29	0.5904114	0.3351174	1.76	0.078	-0.0664067	1.247229
30-34	0.7817677	0.3510476	2.23	0.026**	0.0937271	1.469808
35-39	1.02844	0.3711081	2.77	0.006**	0.301081	1.755798
40-44	1.309247	0.3914772	3.34	0.001**	0.5419661	2.076528
45-49	1.657963	0.4158474	3.99	<0.001**	0.842917	2.473009
Maternal education *(ref: no schooling*)						
Primary school	0.2906429	0.1876214	1.55	0.121	-0.0770882	0.6583741
Secondary school	0.2463713	0.3192531	0.77	0.44	-0.3793534	0.8720959
Higher school	0.4829744	0.4327714	1.12	0.264	-0.3652421	1.331191
Marital status(ref: widowed)						
Married	-0.4166748	0.6679447	-0.62	0.533	-1.725822	0.8924726
Living-with-partner	0	(empty)				
Widowed	-0.0765513	0.6927389	-0.11	0.912	-1.434295	1.281192
Married	-1.10347	0.8750109	-1.26	0.207	-2.81846	0.6115197
Never in union	-0.5555642	0.8593591	-0.65	0.518	-2.239877	1.128749
Household size	-0.1171756	0.0331443	-3.54	<0.001**	-0.1821373	-0.052214
ANC(ref: none)						
1 to 3	-0.1342343	0.1212048	-1.11	0.268	-0.3717913	0.1033228

4 to 7	-0.2545814	0.1372461	-1.85	0.064	-0.5235789	0.014416
>7	1.070625	0.1474276	7.26	<0.001**	0.7816722	1.359578
Birth order number(ref:1)						
2 to 3	-0.1320208	0.1689181	-0.78	0.434	-0.4630942	0.1990525
4 to 5	-0.3897879	0.2114494	-1.84	0.065	-0.8042212	0.0246453
>=6	-0.5962461	0.2630942	-2.27	0.023**	-1.111901	-0.0805909
Place of delivery(ref: home)						
Private HF	-0.3945569	0.1288483	-3.06	0.002**	-0.6470948	-0.1420189
Home-delivery	-0.1436508	0.3221021	-0.45	0.656	-0.7749593	0.4876576
Wealth index(ref: poorest)						
Poorer	0.4073908	0.133622	3.05	0.002**	0.1454966	0.669285
Middle	0.6647661	0.1400911	4.75	<0.001**	0.3901926	0.9393395
Richer	0.6300994	0.1465577	4.3	<0.001**	0.3428516	0.9173472
Richest	0.8716185	0.2415747	3.61	<0.001**	0.3981408	1.345096
Household head age	-0.2979789	0.1859062	-1.6	0.109	-0.6623484	0.0663907
Residence (ref: urban)						
Rural	0.099898	0.2385157	0.42	0.675	-0.3675842	0.5673802

*P-value <0.05; **P-value<0.01.

Probit regression			Number of obs	=	974	
	Wald X^2(30)		=	138.11		
	Prob> X^2		=	0.000		
Log pseudo-likelihood	=	-1167.09		Pseudo R^2	=	0.1415

The number of observations was 974, with p-value and the log likelihood X^2 ratio of 0.000 and 0.1415, respectively. This shows combined significance of the independent variables in explaining vaccination uptake and 14.15% of the change in vaccination uptake was explained by changes in the independent variables.

4.5.2 Marginal Effects of the determinants of immunization intake in under 5 children

Findings in Table 7 show the marginal effect of the significant variables. The probability of being fully vaccinated depended on the marginal effects that were computed from the covariates. Maternal age, household size, ANC visit, childbirth place, parity and wealth index were factors that revealed statistical association with uptake of full vaccination in under 5 children.

Based on the marginal effect of the model for maternal age, as maternal age increased from 30-34 towards 45-49 years, the vaccination uptake increased by 25% to 48%, respectively, as compared to younger mothers. As household size increased, the rate of full vaccination in under 5 children was 3.7% less. Children from mothers who received > 7 ANC visits had a 29% greater likelihood of getting full immunization relative to those children from women who didn't have ANC visit. In terms of birth order, 1 unit increase in parity led to a corresponding decrease of 18% in the uptake of full vaccination as compared to a birth order of 1. For those who gave birth in a public HF, the probability of vaccinating their child decreased by 12% relative to caregivers/women who delivered at their dwelling. As family (household) income quintile of increase from poorer to richest, the probability of getting their child fully vaccinated increased from 13% to 28% as compared to the poorest quintile. Maternal education level, age of household age and dwelling areas weren't significant determinants for full vaccination coverage in under 5 children (Table 7).

Table 7: Marginal Effects of determinants of immunization intake in under 5 children in Amhara region, Ethiopia

Variables	dy/dx	Standard error	z	p>z	95% confidence intervals	
Maternal age (*ref: 15-19)*						
20-24	0.1057393	0.0986813	1.07	0.284	-0.0876725	0.2991512
25-29	0.1937155	0.1055883	1.83	0.067	-0.0132337	0.4006647
30-34	0.2554153	0.1092618	2.34	0.019**	0.0412662	0.4695644
35-39	0.3301352	0.1127612	2.93	0.003**	0.1091274	0.551143
40-44	0.4055658	0.1140049	3.56	<0.001**	0.1821203	0.6290113
45-49	0.4815995	0.1124042	4.28	<0.001**	0.2612914	0.7019077
Maternal education *(ref: no schooling*)						
Primary school	0.0911742	0.0566092	1.61	0.107	-0.0197778	0.2021262
Secondary school	0.0778519	0.0973302	0.8	0.424	-0.1129118	0.2686157
Higher school	0.1460462	0.1184538	1.23	0.218	-0.086119	0.3782113
Marital status(ref: widowed)						
Married	-0.1249836	0.1817375	-0.69	0.492	-0.4811825	0.2312153
Living-with-partner	.	(not estimable)				
Widowed	-0.0212504	0.1891812	-0.11	0.911	-0.3920387	0.3495379
Married	-0.354137	0.2594733	-1.36	0.172	-0.8626954	0.1544213
Never in union	-0.170578	0.2570375	-0.66	0.507	-0.6743623	0.3332063
Household size	-0.0377042	0.0104761	-3.6	<0.001**	-0.0582369	-0.0171715
ANC (ref: None)						

1 to 3	-0.0481344	0.0432925	-1.11	0.266	-0.1329861	0.0367172
4 to 7	-0.0919296	0.0492306	-1.87	0.062	-0.1884198	0.0045607
>7	0.293171	0.0366849	7.99	<0.001**	0.2212699	0.365072
Birth order number (ref: 1)						
2 to 3	-0.0391261	0.0489999	-0.8	0.425	-0.1351641	0.056912
4 to 5	-0.1207969	0.062546	-1.93	0.053	-0.2433848	0.0017911
>=6	-0.1892846	0.0795053	-2.38	0.017**	-0.3451121	-0.033457
Place of delivery (ref Home)						
Public Health facility	-0.1298853	0.0426643	-3.04	0.002**	-0.2135058	-0.0462648
Private Health facility	-0.0459873	0.1050356	-0.44	0.662	-0.2518533	0.1598787
Wealth index (ref: poorest)						
Poorer	0.1374832	0.0444303	3.09	0.002**	0.0504014	0.224565
Middle	0.2196431	0.0444882	4.94	<0.001**	0.1324479	0.3068383
Richer	0.2089727	0.0466104	4.48	<0.001**	0.117618	0.3003274
Richest	0.2800171	0.0693051	4.04	<0.001**	0.1441816	0.4158527
Household head age	-0.0958822	0.0595234	-1.61	0.107	-0.212546	0.0207815
Residence (ref: urban)						
Rural	0.0324004	0.0779101	0.42	0.678	-0.1203007	0.1851014

*P-value <0.05; **P-value<0.01.

4.6 Discussion

The current study tried to determine individual- & community-level determinants of full vaccination uptake in under 5 children in Amhara region, Ethiopia. The uptake of full vaccination among under 5 children in Amhara region of Ethiopia was 62.6%. Maternal age, ANC visit, household wealth index, birth order, and place of delivery significantly related with full vaccination uptake. The current findings revealed that age of mothers +vely determined vaccination uptake in under 5 children. Full vaccination uptake was higher in children from mothers >/= 30 years relative to those children from mothers below the age of 29 years. This was supported by findings from other studies in Ethiopia (Abadura, et al., 2015) and India (Kumar, 2011). This might be due to the fact that mothers in older age categories possess better information about the benefit and side effects of vaccination in children, including VPDs; in turn, this enhances the uptake of vaccination services.

Moreover, household wealth index determined full vaccination uptake in under 5 children. The finding revealed that those children from richer households received full vaccination relative to those children from poor household wealth index. This finding coincided with other findings conducted in Ethiopia (Etana & Deressa, 2012) and Bangladesh (Boulton, et al., 2018). This could be justified by the disparities in access to healthcare between poor vs rich households. Consequently, children in the disadvantaged households might be marginalized and had difficulty to in accessing healthcare. In other words, disadvantaged families spend less time/resource child health care as significant portion of their resources might be drained to maintain daily livelihood.

Women with more ANC visits fully vaccinate their children relative to those women without an ANC visit, coinciding with other findings from Ethiopia (Abadura, et al., 2015), India (Phukam, et al., 2009), Senegal (Mbengue, et al., 2017), and Bangladesh (Bondy, et al., 2009). This can be explained by mothers with more ANC visits might get health education and promotion about vaccination and its benefits during their visits.

Another significant factor for full childhood vaccine uptake was place of child delivery. Accordingly, children delivered in public HFs were less likely vaccinated fully than those children delivered at home. This was consistent with findings from Ethiopia (Abadura, et al., 2015), Philippines (Bondy, et al., 2009), and Nigeria (Odusanya, et al., 2008). Differences in the

distribution of health amenities, other basic infrastructure and expertise within the public facilities in the region. They might affect access to basic healthcare services, including vaccination.

Another important determinant factor was the birth order. As such, the uptake of full vaccination was lower to children with a birth order number above 5 compared to a birth order of 1. The finding was consistent with the finding from Togo (Ekouevi, et al., 2018). Moreover, vaccination uptake in children was lower in mothers from a large family size. This is consistent with a finding from Angola that revealed the uptake of vaccination in under 5 children was lower for those mothers with a big family size (Manuel, et al., 2014). The decrease in full vaccination uptake of children as the size of household increases might suggest the less effort given to child health, including vaccine as there may be many competing interests that would overwhelm caregivers. The findings suggested that the differences in the uptake of full vaccination was best justified by the combination of individual- and household-level determinants.

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND POLICY RECOMMNEDATION

5.1 introduction

The current section summarizes the results of this study, conclusion & policy directives according to the findings – and it covers aspects that future studies can focus on.

5.2 Summary of the study

Childhood vaccination has proven to be an efficient way in preventing childhood diseases. In Ethiopia, vaccination coverage has varied over the years. This study sought to find out characteristics related with uptake of full vaccination in under 5 children. In chapter one, we introduced the study by giving a background to the topic, stating the problem, giving a justification and stating the objectives of the study. Chapter two provides evidence from existing literature on the study topic and identify existing literature gaps. It also covered the theory that this study was framed. Chapter three covered the methodology used to conduct the study, and the conceptual framework for the study. Chapter four covered the results and study findings, as well as the interpretation of the results and discussion sections.

Findings from the study show that the full vaccination uptake was 62.6% among children aged below 5 years in Amhara region, Ethiopia. Vaccination uptake was high among children with mothers aged between 45-49 (48%), who had more than seven ANC visit (29%). Majority of the women had between 2 to 3 children.

Probit regression model was used to determine maternal, health system and household economic factors associated with full vaccination uptake. Correlation coefficients were interpreted. Mother's age, and parity were the maternal factors significantly associated with uptake for full vaccination at 5% level of significance. In terms of household economic factors, higher household income (wealth) quintile was a strong determinant of uptake of full vaccination uptake where there is high probability of being fully vaccinated. Place of delivery which is a health system factor was also a factor associated with uptake for full vaccination in under 5 children.

5.3 Conclusion

In conclusion, the study sought to investigate determinants of full vaccination uptake in under 5 children in Amhara region of Ethiopia. The study found that maternal age, birth order, wealth index, place of delivery, ANC visits and household size were significant determinants of full vaccine uptake among the children. However, factors such as maternal education, residence and household age did not have any significant effect on vaccination coverage.

5.4 Policy recommendations

Increasing demand for full vaccination uptake shall enable regions in Ethiopia to attain more vaccination coverage. According to this study findings, full uptake of vaccination was associated with mother's age, parity, and wealth quintile, ANC visits and household size.

The government should intensify the sensitization of young mothers and women with little or no income on the importance of vaccination. This can be done during antenatal and/or post-natal care visits. Community health workers should increase door-to-door campaigns in order to ensure all children born to a woman has received all vaccines that he/she is eligible for.

Demand for and uptake of full vaccination might be low in the lower wealth quintiles due to indirect costs related to vaccination, including transport to health facility. The government can increase demand for vaccination in the lowest wealth quintile households by offering incentives that will enable mothers to take their children for vaccination. Women from the poorest households should also be economically empowered which will increase their health seeking behavior and therefore increasing demand for vaccination.

The stakeholders, including government, should introduce mobile clinics in remote areas targeting those with low income mother. This will encourage mothers to take their children for vaccination and therefore increasing the demand for and uptake of vaccination.

5.5 Study limitation and the way forward

This research was susceptible to recall bias since children without vaccination cards information about their vaccination history was limited to mother's verbal response. Using secondary data limited the number of health system factors that could be assessed in relation to demand for and uptake of vaccination. Future studies should consider collecting primary data in order to assess

other factors related to health system, including presence of health workers, vaccines availability, etc. and their effect on demand for and uptake of full vaccination.

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