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A-cross-sectional study examining the association between maternal education and childhood (12-23 months) immunization in Uganda

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Contents

II. Abbreviations

ANC	Antenatal Care
BCG	Bacillus Calmette Guerin
CI	Confidence Interval
DPT3	Diphtheria-Tetanus-Pertussis
HPV	Human Papilloma Virus
ICF	Informed Consent Form
IRB	Institutional Review Board
MDGs	Millennium Development Goals
OR	Odd Ratio
P-value	Probability value
SDGs	Sustainable Development Goals
SIAs	Supplementary Immunization Activities
SSA	Sub-Saharan Africa
UDHS	Uganda Demographic and Health Survey
UNEPI	Uganda National Expanded Programme for Immunization
USA	United States of America
VPD	Vaccine Preventable Diseases
WHO	World Health Organization

III. Abstract

Introduction: Complete childhood Immunization remains the most effective way for prevention of Vaccine Preventable Diseases. The 2016 Uganda Demography Health Survey (UDHS) reported that only 55% of children aged 12-23 months had been fully vaccinated. The relationship between maternal education and childhood immunization among Ugandan children remains unclear with most of the studies done being limited in scope.

Objective: To investigate the association between maternal education and childhood immunization in Uganda.

Methods: This study was based on analysis of data from the UDHS. The study included 2815 children aged 12 – 23 months. Permission and data to conduct the analyses was sought from the DHS Program website. Bivariate and multivariate logistic regression models were used to assess association between the maternal education and full immunization. Adjusted odds ratios (OR) with their 95% confidence intervals (CI) were reported. A p value <0.05 was considered statistically significant.

Results: Association between maternal education and childhood immunization was statistically significant (Primary Education - OR = 0.50 95%CI: 0.32 - 0.77, P value = 0.002 and Secondary Education – OR = 0.62 95%CI: 0.39 – 0.97, P value = 0.038). ANC visits, possession of a Child Health Card also had a strong effect on Childhood Immunization.

Conclusion: Lower maternal education is associated with reduced completion of childhood immunization. To promote childhood immunization Parents with education lower than Secondary School should be targeted and the usefulness of ANC visits should be emphasized.

Keywords: maternal education; childhood immunization; UDHS data

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1. INTRODUCTION

1.1 Introduction

Childhood immunization remains the most cost-effective preventive measure for reducing childhood illness and mortality on vaccine preventable diseases. Globally, under five mortality rate dropped to 39 deaths per 1,000 live births in 2017 from 93 in 1990 – a 58 per cent decline (1). This was in line with the millennium development goals for reduction of child mortality of the under 5s by two thirds between 1995 to 2015 (2). Child mortality declined from 90 to 43 per 1000 live birth and this has been achieved because of increased uptake of immunization services (2). The global and regional immunization profile for the recommended vaccines were all below 90% as per December 2019 data [Pneumococcal conjugate 3rd dose (PCV3) 47%, Diphtheria-tetanus-pertussis (DPT3) 86% and Bacillus Calmette Guerin (BCG) 89%] (3). Routine immunization is thus thought to contribute immensely to the reduction of child mortality in developing countries.

Immunization was implemented as a worldwide public health measure in 1974 by the World Health Organization (WHO) when the Expanded Programme on Immunization (EPI) was launched. The Uganda National Expanded Programme for Immunization (UNEPI) was established by WHO in Uganda in 1983 with a main goal of ensuring that Ugandan children get full access to routine vaccination. According to UNEPI, a child should receive the BCG vaccine, three doses of oral polio vaccine (OPV), DPT vaccine and measles vaccine at 9 months. Receipt of these vaccines at the recommended ages and intervals will provide the children adequate protection from Vaccine Preventable Diseases (VPDs) (4). Despite significant gains with routine immunization coverage over the years, millions of children living in developing countries are not fully immunized, exposing them to disabilities or premature death. Overall, latest coverage data indicates that routine immunization coverage remains sub-optimal, with only 52 percent of children aged 12-23 months being fully vaccinated (5). Whereas almost all children (94%) receive the BCG vaccine, only 72 percent receive DPT 1-3 vaccinations, 63 percent receive polio 1-3, and 76 percent receive the measles vaccine. Four percent of children aged 12-23 months have not received any vaccinations (4). Canavan and colleagues used data from DHSs for East African countries (Uganda, Burundi, Ethiopia, Kenya, Rwanda and Tanzania) in 2014 to determine the vaccination rates for the diseases (polio, measles, BCG and DPT) among children aged 12 to 23 months as recommended by the WHO (6). Whereas results from the analysis suggested that immunization rates varied by country,

completion of childhood immunization as per the vaccination schedule was less than 50% in Ethiopia, Tanzania and Uganda (6).

The World Health Organization (WHO) strategic Group of Experts on Immunization in 2019 called for increased immunization information on non-vaccination and children who are under vaccinated. This was reached on in order to develop strategies geared towards increased childhood immunization. In developing countries like Uganda, many factors play a big role for the country to reach the global level of immunization. The education level of the mother determines her awareness about the importance of immunization. Mothers with basic education were likely to understand the importance of childhood immunizations and hence more likely to have timely and full vaccination of their children. In a study conducted in Uganda, mothers expressed their fear about the side effects of vaccines. All these can be overcome by educating the mothers and caregivers (7).

In Uganda, the Expanded Program for Immunization (EPI) was established as an act of the parliament to run the immunization of children in Uganda and the program is supervised by the Ministry of Health. The program's mandate is to make sure that the Ugandan population is free from VPDs. The vaccines present in Uganda include BCG, OPV/IPV, DPT-HepB-Hib, Measles vaccine, Tetanus Toxoid, HPV (Human Papilloma Virus) vaccine and PCV (4).

Immunization in Uganda is carried out through routine vaccination, outreach and through Supplementary Immunization Activities (SIAs) and national immunization days. Routine vaccination involves offering vaccination services at health facilities and it's incorporated into the normal working detail of the health facilities. Outreach on the other hand involves deploying health workers out to the designated communities. These places normally are far from the health facility and it's through community mobilization that parents and caregivers take their children for vaccination. SIAs are normally done by either house to house or as per the immunization outreach post. Here health workers move to communities with the help of the local leader and mobilizer to identify children who are eligible for immunization (8).

Over time, the immunization status of Uganda has been improving since the start of the current government in 1986. The country had an unstable health system but it has improved with time. According to the demographic surveys that has been done since 2001, vaccination increased from

37% in 2001 to 55% in 2016 for children who completed all the vaccines in the country (5).The percentage of children 12-23 who had received all the basic vaccination ranges from 45% in Busoga region to 73% in Karamojong region according to demographic health survey of 2016 (5). This region is with less educated mothers and remote. Hence, the need to find out whether education plays an important role in childhood vaccination or there are other factors like residence and economic status.

1.2 Immunization and Sustainable Development Goals

The Sustainable Development Goals (SDGs) were integrated in 2015 to follow up the Millennium Development Goals (MDGs) which had ended. The SDGs are comprised of a detailed framework that looks forward to a promising future. In detail, the SDGs will seek to achieve 17 global goals which include no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequality, sustainable cities and communities, climate action, peace, justice and strong institutions and partnerships for the goals (9).

GAVI (The Vaccine Alliance) mentions that in a bid to save lives of children and protect the health of the people, there should be increased use of vaccines equitably especially in developing countries (10). Children and families that are healthy will eventually become prosperous since they will save the money, they would have otherwise spent on health care services. Vaccination has been shown to protect individuals from falling into the poverty line due to expenses on health care (10). According to the Sustainable Development Goals, prevention achieved through immunization will prevent 24 million individual households from dropping into the poverty zone by 2030. The second Sustainable Development Goal focuses on promotion of good nutrition practices which could aid reduction of child morbidity and mortality. Children who are malnourished could most likely die as a result of diseases like pneumonia, measles and diarrhea, some of which would have been prevented if children were immunized thereby making their bodies able to absorb nutrients which are essential (10). In a bid to promote good health, well-being and saving lives, it is essential that children are fully immunized basing on the facts that vaccines save lives ranging from 2 to 3 million annually and several other millions are protected from contracting disease and being disable (10). Seeking vaccination services has also been

reported to bridge the gap between individuals in households and the health care system whereby individuals become better health care seekers and are in close contact with the health care providers. This will in turn drive the access to primary health care services aimed at achieving good health and well-being (10).

Immunization of children has as well been shown to improve the numbers of individuals who are educated given that children who are immunized tend to attend school more often as compared to their non immunized counterparts and they are also able to show better performance making them more productive in the long run. Moreover, schools have also been designated to become centers where some of the vaccines such as the Human Papilloma Virus (HPV) vaccine can be delivered to the schooling children. Children whose parents are educated have also been reported to be more likely to receive immunization services in comparison to their counterparts.

With regard to the 5th SDG (gender equality), immunization of children should be viewed from a gender-equal perspective. All children irrespective of their gender should be immunized at the same rates and accessibility to vaccination services should not vary between the genders. Analyses of different studies by the WHO with regard to gender inequalities and completion of childhood immunization in 2018 reported that boys and girls have the same possibility or likelihood of being fully vaccinated in developing countries (11). Some studies have however showed differences in immunization rates between the boy and the girl child. A cross sectional study by Mugada et al in 2017 among 377 mothers at the outpatient department of Pediatrics at Kakinada Hospital in India found that male children were significantly more likely to have completed their immunization as per the schedule in comparison to the girl children (12). An analysis of trend in the same country at the national level by Prusty and Kumar in 2014 also showed that the average disparity ratio with regard to sex and percentage complete childhood immunization was constant over the years (13). There has been efforts by organizations such as the GAVI to empower countries in a bid to multiply efforts to spot and identify gender specific barriers that hinder mother's accessibility to immunization services for their children (10). Among other efforts, access to immunization services has been facilitated by offering training sessions to healthcare workers who are female and empowering them to ensure completion of childhood immunization (10).

1.3 Maternal education and its role in improving the health of a child

The Equity Reference Group for Immunization (ERG) in December 2018 documented that children who were born by educated mothers significantly stood a higher chance of being fully immunized as compared to children born by mothers with no formal education and this was consistent across countries. The association between maternal education and completion of childhood immunization can as well be explained basing on the socio-economic status of households and their contextual factors. This can as well be explained basing on the fact that the higher the level of education attained by a mother, the higher the likelihood that they have better access to immunization services and other health care services and they live in more affluent communities (14, 15).

Several studies on the effect of maternal education on a child's immunization in other developing countries show a great variation in terms of location; either urban or rural. The level of immunization lower than expected in urban areas. This is due to the rapid rural-urban migration that has led to rapid population growth in urban areas (16).

Findings from the correlates of vaccination completion prevalence from the East African countries, Uganda inclusive using DHS data in 2014 showed that Ugandan women who had completed secondary school or higher were 3 times more likely to have their children complete the vaccination schedule according to the recommended guidelines when compared to children whose mothers had no formal education (6).

Much earlier, Baale et al in 2015 analyzed the Uganda 2006 DHS data to establish factors influencing childhood immunization. In the study, Baale et al reported that children whose mothers had completed a primary level of education or higher were 8% to 14% more likely to have been fully immunized when compared to children whose mothers had no formal education. Similarly, mothers who had a secondary level of education or higher were 6% to 7% more likely to have vaccinated their children with all the three doses of DPT and polio vaccines when compared to children whose mothers had no formal education. With regard to polio vaccines in the study, children whose mothers had no formal education were significantly less likely to be vaccinated against the polio vaccine when compared to children whose mothers had completed a primary level of education or higher (17).

In Kenya for example in 2013, maternal education was significantly associated with completion of childhood immunization among children aged 12 to 23 months of a peri-urban setting (18). Two years later in 2015, the results were not any different in Kenya. In a study which was conducted by Matua, using Demographic Health Data for Kenya, it was found out that among the factors affecting children's immunization especially Oral Polio Vaccine (OPV), maternal education played a big role. Most of the others who had their children vaccinated had completed primary school. Mothers who had completed primary school were 1.5 times more likely to have immunized their children compared to those who had no education (19).

In a study, which was carried out in India by Mira.J et al to investigate the association between maternal literacy and vaccination showed that, maternal health literacy is independently associated with child vaccination. Any initiatives targeting health literacy could improve the vaccination coverage of the children (20). Educated women are more enlightened and can easily understand the health communication messages. It is even cheaper and more economical to transfer messages to educated mother than uneducated one in terms of the channels of communication used.

In another study, which was conducted in Vietnam, this country being still developing, they live in community groups and whatever affects a member of the family affect the whole community. It was found out in this study that family members are a source of information mostly for the marginalized groups and they influence decision-making at all levels. Therefore, a family having an educated mother had more influence on decision-making and mostly maternal health education programs. This distributed maternal education increased health literacy and hence strengthened the health promotion messages and reduces the risks of negative health outcomes (21). In order to improve the Expanded Programme for Immunization (EPI), vaccines have to be delivered in time and vaccination is done as per the country immunization schedule. One of the problems what have led to failure of this program is that mothers bring children late or do not follow the timeline set by the health workers to bring their children. This was one of the problems faced in Senegal where mothers were bringing children not according to age ranges. This was associated with low level of education and low social economic class and living in villages (22).

Karen A. et al did a study in Zimbabwe on maternal education and its association with child mortality. It was found out that education can leads to reduction in child mortality and other health outcomes of which immunization is part. Education can make people to be more efficient producers of health, make people more adherent to treatments or follow health messages. This creates awareness and hence increased uptake of health products. Secondly they found out that education might lead to higher income which could directly affect health by increasing the purchasing power (23). This can affect the health delivery in another of ways; educated mothers are more likely to take their children for immunization because they are aware of the values of vaccination lastly have the transport since they are economically empowered in the communities

Ozer et al did a study on the causal-effect relationship on maternal education and childhood immunization in Turkey. Despite the marriage, culture in Turkey where women are married at a young age compared to her husband. It was found out that once a woman is educated, she tends to play a big role in the affairs of the family compared to those who are not educated. The study showed, education of the mothers increased the probability of completion of full course of Diphtheria, Pertussis, and Tetanus and Hep.B vaccinations (24). For the case of Pakistan improved immunization was associated with completion of secondary by the mothers. Communities where parents were not sending their children to school especially the girl child, mothers were found to less educated hence lower immunization coverage. Asif et al found out that all factors both at individual and community level were substantial to the improvement of vaccination (25). In places that had woman community health workers had a high coverage. The community health workers played a big role in community mobilization and sensitization of the importance of vaccination.

Results from another study done by Gidado and others in 2014 in the Zamfara state of Nigeria also revealed that mothers children whose mothers had completed a secondary level of education or higher were 3.6 times more likely to have been completely immunized when compared to children whose mothers had only completed a level of education lower than secondary school. Education has previously been regarded as the source of knowledge. Of great importance to our study was that the study conducted in Nigeria also established that mothers with a level of education lower than secondary school had less knowledge on immunization when compared to mothers with a higher education level (26).

In contrast, some studies have as well found no significant association between maternal education and completion of childhood immunization. A study done in Ambo Woreda, Central Ethiopia among children aged 12 to 23 months found that literate mothers were 2.8 times more likely to have their children completely vaccinated as per the vaccination schedule in comparison to children whose mothers were illiterate at bivariate. In the multivariate model, whereas literate mothers were 1.3 times more likely to have their children fully vaccinated in comparison to illiterate mothers, this association was not statistically significant (27).

1.4 Determinants of childhood vaccination

Health care services utilization by the community is a complex issue that involves a number of factors such as social economic factors, geographic barriers, parents', caregivers' characteristics and many others. All these play an important role in strengthening immunization (28). According to Sarker R.et al 2019 in a study that was carried out in Senegal to find out the determinants of immunization, it was found that 70.96% of the children were fully immunized and this varied across regions, ethnic groups and demographic characteristics. The study also revealed that's ethnicity, place of delivery maternal age, mass media and wealth index were associated with full immunization (29).

A study done in three African countries (Ethiopia, Cameroon and Ghana) by Lafond and colleagues to find out the drivers to routine immunization reported that it takes a combination of drivers to achieve an immunization coverage as high as 85% or more. The drivers identified in the study included four direct drivers and two enabling drivers. The direct drivers included; 1) cadre of community-centered health workers (paid cadre of community-centered health workers who delivered vaccination through health facilities, outreach services and home visits), 2) health system and community partnership (health system works with district and local government and community groups to plan and execute immunization services, raise awareness and define strategies to reach all children), 3) regular review of programme and health worker performance (conduct regular reviews of data and promote open discussion among peers of performance achievements and shortcomings) and 4) tailoring immunization services to community needs (deliberate efforts to assess community needs and conditions and adapt services accordingly) (30). In addition, the enabling drivers reported included; 1) political and social commitment to routine immunization (making policies and investments in routine services and the prominence given from

national to local levels to increase coverage) and 2) actions of development partners (national and local-level support provided by development agencies through funding, technical advice, capacity building, and commodities and equipment) (30). Lafond and colleagues mention that all the drivers work together and no single method succeeded alone (30). Immunization manager at different levels play a big role for the success of the immunization program. As long as they are able to turn the limited resources into results. Health workers have a role to play by mobilizing the communities such that awareness is increased and caregivers able to bring children for vaccination. These drivers were found to be applied in other community-based activities like TB treatment (30).

Uganda being a country with many cultural norms, there is a lot to consider in having mothers take their children for immunization. In a study that was carried out by Babirye J.et al in Uganda to find out why some mothers do not immunize their children, mothers confessed to have been teased for not dressing properly by health workers. Other pointed out the distance to the facility being far and could not afford transport to the facility. Mothers blamed male parents for their non supportive behavior making the children miss immunization (31). There is therefore need to involve the male parent in the activities of childhood immunization given that immunization is a community programme and fathers are key stake- holders of community programmes.

Results from a study that was conducted by Abadi. G in Ethiopia showed that full immunization was higher at district level compared to the national level but lower than the WHO targets (32). The factors which were found to be associated with full immunization coverage in this studied include mother's low education status, long distance to immunization sites, knowledge about immunization, living in large families and not attending ANC. Encouraging mothers to deliver at health facilities was found to be useful in improving mothers knowledge about immunization (32). This is common to most of the developing countries where the education level of Mothers is low and health facilities are hard to reach. Mothers tend to deliver from homes hence lack advice from Health Workers on the importance of immunization after delivery. Communication of health messages has been found to be key for behavioral change of the mothers. These messages are key to improvement in childhood immunization. However, Oku.et el in Nigeria also found out that the political environment plays a big role in improvement in immunization. They however, noted that these messages also have barriers that are likely to hinder it from reaching the Mothers. These

barriers can be weak political system, poor attitude of Health Workers and vaccination teams and other factors at community level like attitude of community stakeholders (33).

Nsubuga et al. conducted a study in Uganda to compare static and outreach immunization strategies and associated factors in Uganda. It was found out that most parents who were in a radius of 5Km take their children to health facilities for immunization (68.1%) compared to outreach (10.6%). This was also affected by the supplies of vaccines at health facilities, motivation to take children for immunization and having other things to do (34).

Maternal parity, exposure and education were found out to be the key factors in improving childhood immunization in a study that was conducted in Swaziland by Tsawe et al. In this study, mothers were interviewed and it was found out that apart from the mentioned factors above other social economic factors played a big role too. Most of the mothers who had their children fully immunized had high antenatal care attendance (97.3%) and delivery (74%). Due to high service utilization among these mothers, the childhood immunization rate was found to be very high at 80% (35). This has been the case in most developing countries like Uganda. Once mothers use antenatal and postnatal services they are able to learn on how to manage their children well and hence high immunization coverage (31).

Although most of the factors are based on individual level and other factors affecting the country. In a study done by Schuh et al. in Afghanistan, it was found that the system readiness and health workers capacity played a big role on childhood immunization. System readiness with vaccines and all the logistics needed allows mothers to use the services. The capacity of the health workers being able to do well their job plus the demand for the service played was one of the key to childhood vaccination (31). According to the study, the demand side significantly affected the childhood immunization in Afghanistan. This is witnessed by a number of refusals in most parts hence high prevalence of vaccine preventable diseases.

Childhood immunization to some extent also depends on different population groups. This can be demographically, race, level of income and others. In developing countries as seen from above education plays a big role in improving childhood vaccination (19). This seems to be opposite in some developed countries as seen in a study which was carried out in Israel by Bella and et al on parents' education to vaccinate their children. Higher compliance rates were reported among participants with non-education level (p value < 0.001), and average level of income (p value =

0.001) as seen from the study (36). Parents were more concerned on the pain inflicted on the child by the injection. Those who were scientifically educated were much concerned on the effects of vaccination by the vaccine. A study was conducted in Northern Nigeria, to rank the factors affecting childhood immunization. The place being one the polio endemic countries with low immunization coverage. Azawa et al conducted this survey and ranked the factors using the Best-worst scaling to rank this factors (BSW). These factors were based on attributes to demand childhood immunization. The most attribute factor was that childhood immunization makes one a good parent (37). Trust and social norms statements were ranked higher in importance compared to those of perceived risks and benefits of immunization. It was concluded from the study that good parenting and listening the messages on immunization may motivate to increased up take (37).

The wealth indices of households have been found to have a significant impact on vaccination among children aged 12 to 23 months. Results from a study conducted by Abdulraheem et al in 2011 in rural Nigeria indicate that failure to complete vaccination as per the schedule is higher among children whose parents are from a lower socio-economic status in comparison to children from parents of a higher socio-economic status (38). Similarly, results from an analysis of 2011 Ethiopia DHS data by Lakew et al in 2015 revealed that children born to wealthy parents were more likely to complete their vaccination schedules when compared to children who had been born to poor families. Further still, the study reported that children born to mothers of higher socio-economic status at their work places were more likely to complete their vaccination schedules when to compared to children whose mothers were of lower socio-economic status because the later had tough working schedules and found a challenge requesting for day offs to have their children vaccinated (39).

1.5 Research Justification

Studying childhood immunization is of global public health importance. Childhood immunization has an impact on the country's economy and on the safety profile of an individual (40). Completion of childhood immunization can reduce the likelihood of contracting vaccine preventable diseases thereby reducing serious illnesses, complications caused by the diseases and mortality. Findings from the correlates of DHS data from the East African countries (Uganda, Ethiopia and Tanzania) in 2014 revealed that the vaccination rates for the diseases (polio, measles, BCG and DPT) among

children aged 12 to 23 months as recommended by the WHO was less than 50% (6). Most recently, results from the UDHS report show that routine immunization coverage remains sub-optimal, with only 52 percent of children aged 12-23 months being fully vaccinated (5). Previous studies in Uganda have found a statistical association between maternal education and completion of childhood immunization among children aged 12 to 23 months but these used institutional data and not nationwide data making their results ungeneralizable. The correlates of vaccination completion prevalence from the East African countries, Uganda inclusive showed that mothers who had some form of education were more likely to fully immunize their children when compared to children whose mothers did not have any form of formal education (6). Bbaale et al in 2013 as well using the Uganda 2006 DHS data reported that children whose mothers had completed a primary level of education or higher more likely to have been fully immunized when compared to children whose mothers had no formal education (17). Since Bbaale's analysis using the 2006 UDHS data, there has not been any other study specifically looking at the association between maternal education and completion of childhood immunization. It is therefore uncertain if maternal education still influences completion of childhood immunization even in the present.

Uganda is one of the countries where the number of individuals who have attained formal education is low. According to the UDHS report, the majority of Ugandans have either no formal education or only some form of primary education. Furthermore, 19% of women had no formal education while 54% of the women had not completed primary education. Only 6% of the women participants had completed a secondary level of education or a level higher than secondary school (5). It is against this background that the study focuses on the relationship between maternal education attainment and the completion of childhood immunization. Education enables mothers to acquire knowledge that has a great impact as far as promotion of health is concerned. Establishing the association between maternal education and childhood immunization will avail essential information. The findings of this research may be used to inform further research projects and to encourage education among girls in a bid to improve completion of childhood immunization in Uganda and other countries with similar settings as Uganda.

2. Research Aim and Hypothesis

The study aimed to investigate if there exists an association between maternal education and immunization completion among children aged 12–23 months in Uganda. The study highlights the differences in immunization completion percentages among children aged 12 – 23 months born to

mothers who have completed no level of education at all. Those have only completed the primary level of education, those whose highest level of education is secondary school and those who have completed a level of education higher than the secondary school level. The study also brings to light selected healthcare determinants and socio-economic factors which could support or influence completion of childhood immunization in Uganda.

Research Hypothesis: There exists an association between maternal education and childhood immunization in Uganda.

3. METHODS

3.1 Study Design

This was a cross-sectional study that was conducted using secondary data from the Uganda Demographic Health Survey (UDHS) of 2016.

3.2 Study Setting

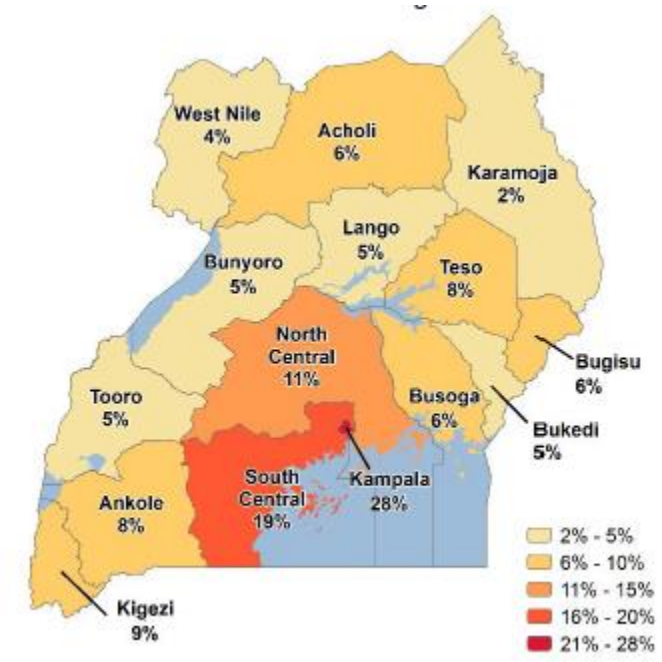
Uganda is one of the East African countries and it held a population of 45 million people as of 2019. Uganda is divided into local administrative units namely; districts, counties, constituencies, sub-counties, parishes and villages to facilitate service delivery near to the people. In total, there are 122 districts in Uganda, Kampala being the capital city (41). Uganda has a fertility rate of 5.4 children per woman and an infant mortality rate of 43 deaths per 1,000 live birth (5). Uganda is an over populated country with limited resources hence life expectancy is still low at 63.7 years and primary school enrollment at 8.8 million people in 2017. The staffing levels in public health facilities was 72% as of 2017 and government spends approximately 8.9% of its budget on health (41). The health system is run by ministries of health and local government funded by central government. From top to bottom, health service delivery is divided into different levels from National referral hospital to a health Centre II. Each level of administration in local government as its own health facility and the level depends on the catchment area it serves.

In Uganda, education services are either government aided or provided by the private sector. The private sector came into play in 1993 in Uganda in a bid to combine efforts with the government towards provision of education services. The government however financially aids some private schools hence the name “government aided schools”. Government schools make up 73% of the primary level schools and 34% of the secondary level schools in Uganda (42).

Uganda's education system is comprised of an early childhood Programme that caters for children aged 3-5 years (preprimary education), followed by seven (7) years of primary education, followed by four (4) years of Ordinary Level secondary education, two (2) years of Advanced Level secondary education and the final tier is three (3) to five (5) years of Tertiary education. Each level is nationally examined with certificates awarded. Pre-Primary School Education Pre-primary education offers Early Childhood Care and Education (ECCE). The official school going age for pre-primary is 3-5 years. The enrolment at Pre-primary level decreased by 10 percent from 18 percent in 2016 to 8 percent in 2017 (41). Over the years, 2013 to 2017, the number of females enrolled in pre-primary has been more than that of males. The Pupil Classroom Ratio (PCR) and Pupil Teacher Ratio (PTR) stood at 27 and 22, respectively. According to the Uganda Bureau of statistics the life expectancy is at 64years (41).The most common level of schooling is primary education with nearly 9 million pupils enrolled at school (5). Meanwhile, secondary education declined by 5% in 2017 compared to the previous year (5).

The economy of Uganda has advanced by 2.7% from as seen from the third quarter of 2019. Gross domestic product by 2018 was at 27.48 billion US dollars. The Gross Domestic Product of Uganda represent 0.04% of the world economy (41). The health system is being financed by a number of stakeholders namely; government, private firms, households, development partners and others. Government facilities are mainly financed through government grants and health development partners like embassies, International Nongovernmental organization and church founded organizations. These facilities are graded as either public (government owned), Public Non for profit facilities (PNFP) or Public For profit (PFP) (43). According to the UDHS of 2016, the number of individuals who had finished more than the median years in school were 50% of the whole population. Furthermore, most of the Ugandans have either only some primary education or no documented formal education at all (5). With respect to gender, the percentage of women who have had formal education was higher than that of men in 2016. The proportion of individuals who had never had any formal education were 19% and 13% for women and men respectively. Analysis of trends also shows that the percentage of females who had had no form of education were 36% in 1995 and 19% in 2016 (5). In Uganda, women who are urban dwellers are reported to be more educated as compared to the rural dwelling women (5). By region, the proportion of women without formal education is highest in the Karamoja region (66%) and lowest in Kampala region (2%) as shown in Figure 1.

Figure 1. Proportion of women of reproductive age who have completed secondary education or higher by region



3.3 Study population

The study population were children aged 12 – 23 months who participated in the 2016 Uganda Demographic and Health Survey between June and December 2016, and who met the eligibility criteria for this study.

3.4 Eligibility criteria

3.4.1 Inclusion criteria

- Children aged 12 – 23 months
- Mothers of children between 12-23 months who participated in 2016 Uganda Demographic and Health Survey

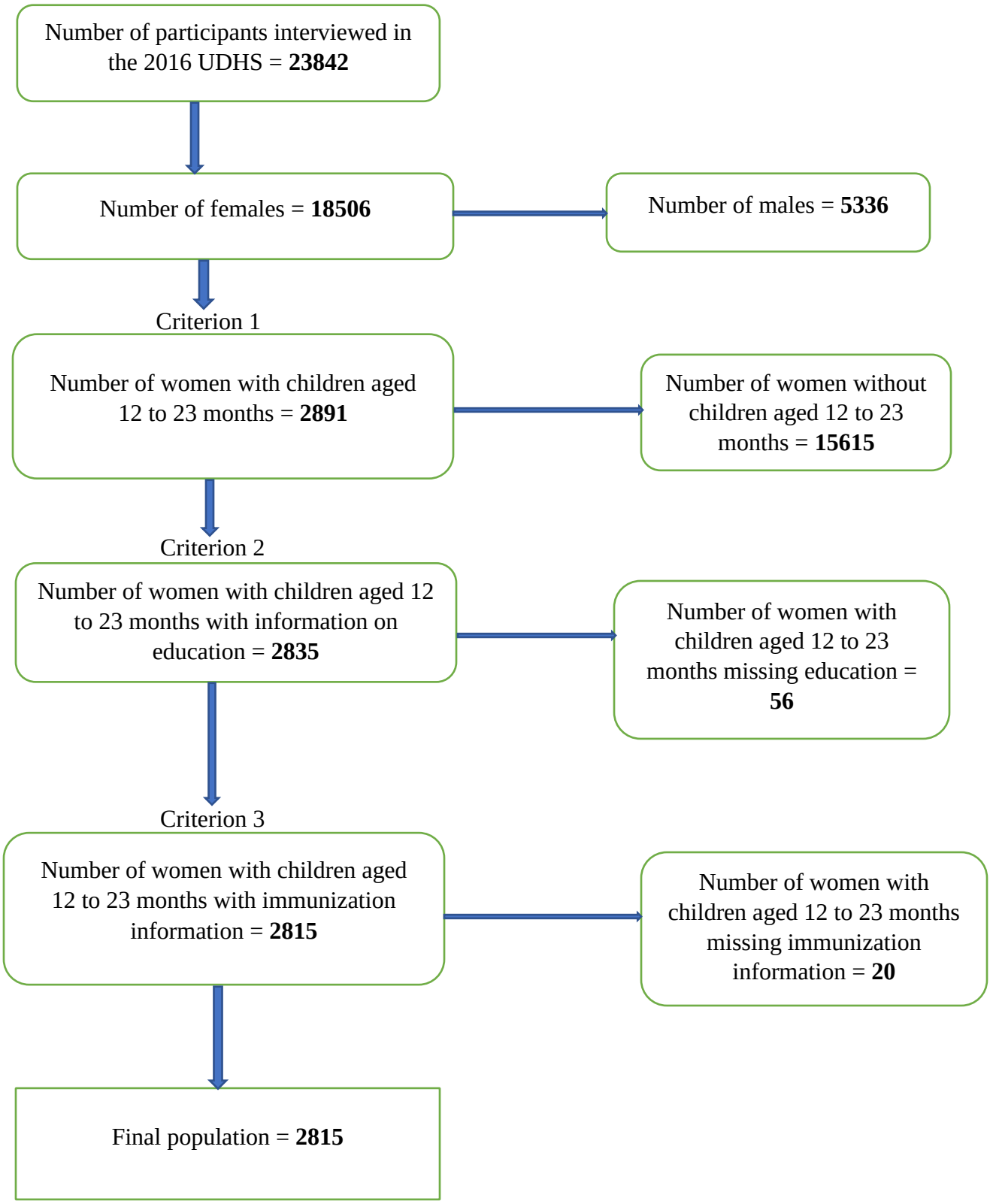
3.4.2 Exclusion criteria

- Missing information on key maternal socio-demographic characteristics such as maternal education.
- Without immunization information

3.5 Sample size requirements

The analysis was based on the 2016 Uganda Demographic and Health Survey which is a nationally representative sample of all households in Uganda. The survey was conducted in 19,588 households and data was collected from all the 15 regions, 162 urban centers and 535 rural areas. A total of 2891 women who participated in the UDHS had children aged 12 to 23 months. Of these, 56 (1.9%) had missing information regarding their education whereas 20 (0.7%) did not have immunization information for the children. The final sample size analyzed was 2815 (97.4%) participants as demonstrated in Figure 2 below.

Figure 2. The flow to final study sample population of Women with children aged 12 to 23 months in Uganda



3.6.1 Data collection

Permission to conduct the respective analyses was sought from the DHS Program website and data was obtained from the website. The website requires that a brief description of the project title and the research questions are filled in through the website to be able to access the data and authorization for usage. Approval to utilize the data for this study was obtained from the data originator, ICF Macro International U.S.A approximately 48 hours following the request to extract the data files from the website. (5). The DHS Program separates the data for the household members, women, children under five, men and couples. The program however includes variables for household characteristics in the women, men and children's files. Where necessary in this analysis, we merged data sets in order to obtain variables that met our analysis. When merging files, for the women and household data sets, we used variables HV001 with V001 and HV002 with V002. Women variables were also combined with their children's variables by appending. It was however impossible to append children's variables to the men's given that children come from the women's birth history. The women variables were thus appended to men variables in order to create couples.

3.6.2 Ethical Consideration

The survey report states that during data collection, informed consent was sought from all prospected participants to observe the ethical principles of research which entail respect for autonomy, beneficence, no maleficence and justice. Respondents who were not willing to participate (demonstrated by not consenting) were not included in the survey. The Uganda Demographic Health Survey program ensures privacy and protection of human subjects .All the procedures and questionnaires are acquired through ethical approval of the Science and Technology Research review board (5). More to that, informed consent statement is normally read to the respondents before the interviews are carried out. This gives chance to the participants to decide whether to participate or pull out. For the case of a child or an adolescent, parents give consent before the interviews are carried out. Participants have right to accept or decline participation irrespective of gender or age. Before data is collected, Data collectors are chosen from reputable health workers who have experience. They are trained for some days to fulfill the necessary requirements needed for the study. During this training Field supervisors and Field Editors, attend all the training sessions to ensure guidelines of the organization are followed. The data collected is checked by supervisors on a daily basis to correct missing data

and misstates made. Data Editors also make sure data collected is right and entered in the system as required. Participants are normally selected as per gender such that females feel more comfortable with their fellow female. This creates privacy of the participant and he or she is free to give their views freely. Throughout interview participants views are respected and protected.

3.7 Methods and variables

3.7.1 Dependent variables

The outcome variable of this study was immunization status of a child. The child was regarded as immunized when they received all the basic vaccinations that a child must receive according to the MOH guidelines. The recommended doses of vaccines as earlier listed include 1 dose of the BCG vaccine, 3 polio doses, 3 DPT doses and 1 measles dose). Children who had missed any dose were regarded as not immunized in this study. Information on the immunization status of a child in the survey was abstracted from the health card of the child or the mother's direct report. The outcome variable in this analysis was coded as 1"immunized" and 0"not immunized".

3.7.2 Independent variables

The independent variable in this analysis was maternal highest level of education. Maternal education in the UDHS data was categorized and coded as 0 'no education', 1 'primary', 2 'secondary' and 3 'higher'.

3.7.3 Confounders

Prior research has demonstrated that socio-economic factors greatly affect the intent of mothers to have their children vaccinated. The main confounders considered for this study were the residential area, mother's age and wealth quintiles. Other covariates that were chosen were possession of a health card, number of ANC visits and having visited the health facility in the last 12 months prior to the survey. Previous research has shown women who had more than 3 visits were more likely to have their children complete immunization (27, 39).

Data collection during the survey was done using interviewer administered questionnaires which had been pre-tested prior to the study (5). The interviewers were also trained on data collection

before being deployed to the field (5). In addition to the training, the UDHS report mentions that the interviewers attended a field practice for two days before the actual data collection (5).

3.8 Statistical analyses

Data analysis was performed using STATA version 16 (STATA corp., college station, Texas USA). Descriptive statistics were done by summarizing continuous and discrete variables into means and standard deviations because all the continuous variables were normally distributed. Categorical variables were summarized into frequencies and percentages. Descriptive statistics were done using both weighted and unweighted data as shown in the tables of results. Differences between levels of categorical variables were explored using a chi-squared test. Association between completion of childhood immunization (outcome) and maternal education (exposure) was explored using binary logistic regression basing on the null hypothesis that maternal education does not have an influence on completion of childhood immunization. The measures of association in this analysis were odds ratios and they were reported with their corresponding 95% confidence intervals. The analysis for associations was done using the survey weighted data in order to minimize bias.

The analysis was done in 3 major stages. The first stage was to summarize the characteristics of the participants of the study (those who met the eligibility criteria). The characteristics were categorized into maternal socio-demographics, maternal education, child characteristics and maternal birth characteristics. The second stage was to test the association between maternal education and full childhood immunization, and then the association between full childhood immunization and other chosen covariates separately. The third stage was to explore the impact of maternal age, residential area, wealth quintiles, possession of a health card, number of ANC visits and visiting the health facility on full childhood immunization and maternal education. Multiple logistic regression was utilized at this stage. A p value <0.05 was regarded as statistically significant in this analysis.

4. RESULTS

4.1 Descriptive characteristics of the participants

Most of the selected respondents were either married or they were living with their partners (83.5%). Similarly, the ratio of urban dwellers to rural dwellers in this study was 1:4. The median age of the respondents in this study was 27 years with 50% of the respondents being between 22

and 32 years of age. Majority of the respondents were Christians (85.6%). There was a normal distribution of respondents across the regions. Details of these are presented in table 1 below.

Table 1. Basic socio-demographic characteristics of the mothers of children aged 21 – 23 months who participated in the 2016 Uganda Demographic and Health Survey

	Unweighted sample		Weighted sample	
Characteristic	**Frequency (n=2815)**	**Percentage (%)**	**Frequency (n=2815)**	**Percentage (%)**
Age categories				
15 - 19	270	9.6	277	9.8
20 - 24	846	30.1	852	30.3
25 - 29	660	23.4	671	23.8
30 - 34	546	19.4	532	18.9
35 - 39	336	11.9	326	11.6
40 - 44	124	4.4	124	4.4
45 - 49	33	1.2	33	1.2
Region				
Kampala	152	5.4	135	4.8
South Buganda	224	8.0	339	12.0
North Buganda	225	8.0	308	11.0
Busoga	240	8.5	266	9.4
Bukedi	198	7.0	192	6.8
Bugisu	145	5.2	132	4.7
Teso	219	7.8	185	6.6
Karamoja	164	5.8	81	2.9
Lango	183	6.5	160	5.7
Acholi	157	5.6	129	4.6
West Nile	220	7.8	214	7.6
Bunyoro	182	6.5	146	5.2
Tooro	222	7.9	238	8.4
Ankole	170	6.0	204	7.2
Kigezi	114	4.1	86	3.1
Marital status				
Never in union	175	6.2	190	6.8
Married	1174	41.7	1141	40.5
Living with partner	1176	41.8	1180	41.9
Widowed	27	0.9	27	0.9
Divorced	13	0.5	10	0.4
Separated	250	8.9	266	9.5

Residence type				
Urban	554	19.7	661	23.5
Rural	2261	80.3	2154	76.5
Religion				
No religion	4	0.1	29	1.0
Anglican	873	31.0	881	31.3
Catholic	1133	40.3	1073	38.2
Muslim	373	13.2	415	14.7
SDA	39	1.4	38	1.4
Pentecostal	2	0.1	377	13.4

Maternal Education characteristics of the respondents

In this study, it was found that almost two-thirds of the respondents (62.3%) had a primary level of education whereas the least of them had a level of education higher than secondary school. Similarly, majority of the partners to the respondents in this study also had a primary level of education. Two-fifths of the respondents in this study (39.7%) could not read at all at the time of the survey. More than half of participants (55.1%) in this study reported to listen to a radio at least once a week. Majority of the respondents had never used internet by the time of the survey (93.7%). Details of the maternal education characteristics are shown in table 2.

Table 2. Maternal education characteristics of the selected participants

	Unweighted sample		**Weighted sample**	
Characteristic	**Frequency (n=2815)**	**Percentage (%)**	**Frequency (n=2815)**	**Percentage (%)**
Education level				
No education	333	11.8	259	9.2
Primary	1754	62.3	1708	60.7
Secondary	551	19.6	646	22.9
Higher	177	6.3	202	7.2
Literacy				
Cannot read at all	1118	39.7	1002	35.6
Able to read only parts of sentence	388	13.8	381	13.5
Able to read whole sentence	1299	46.2	1419	50.4
No card with required language	9	0.3	13	0.5

Blind/visually impaired	1	0.0		
Reading newspaper				
Not at all	2355	83.7	2264	80.4
Less than once a week	276	9.8	323	11.5
At least once a week	184	6.5	228	8.1
Listening to radio				
Not at all	821	29.2	787	28.0
Less than once a week	441	15.7	437	15.5
At least once a week	1553	55.1	1591	56.5
Watching TV				
Not at all	2128	75.6	2036	72.3
Less than once a week	265	9.4	290	10.3
At least once a week	422	15.0	489	17.4
Use of internet				
Never	2638	93.7	2613	92.8
Yes, last 12 months	155	5.5	178	6.4
Yes, before last 12 months	22	0.8	24	0.8
Partner education level (n=2145)				
Primary	1260	58.7	1209	56.4
O level	494	23.0	513	23.9
A level	92	4.3	95	4.4
Tertiary	142	6.6	160	7.5
University	98	4.6	107	5.0
Don't know	59	2.8	61	2.8

Table 3. Household and child characteristics of the children aged 12 – 23 months who participated in the 2016 Uganda Demographic and Health Survey

	Unweighted sample		Weighted sample	
Characteristic	**Frequency (n=2815)**	**Percentage (%)**	**Frequency (n=2815)**	**Percentage (%)**
Child age (months) mean ± SD	17.34 ± 3.4		17.33 ± 3.4	
Child age categories (months)				
12 to 15	951	33.8	938	33.3
16 to 20	1215	43.2	1246	44.3
21 to 23	649	23.0	631	22.4
Sex of child				
Male	1458	51.8	1476	52.4
Female	1357	48.2	1339	47.6
Who child lives with (n=2714)				

Respondent	2614	96.3	2608	96.1
Elsewhere	100	3.7	107	3.9
House hold number				
1 to 3	493	17.5	517	18.4
4 to 6	1363	48.4	1359	48.3
7 to 9	687	24.4	672	23.9
10 to 15	250	8.9	246	8.7
>15	22	0.8	21	0.7
Sex of household head				
Male	2087	74.1	2081	73.9
Female	728	25.9	734	26.1
Wealth index				
Lowest	739	26.3	611	21.7
Second	635	22.5	603	21.4
Middle	507	18.0	523	18.6
Fourth	462	16.4	486	17.3
Highest	472	16.8	592	21.0

The median age of the children included in this analysis was 17 months and 50% of them were aged between 14 and 20 months. More than half of the children were male (51.8%). Majority of the children in this study lived with the respondent of the survey. A quarter of the households included in this analysis were headed by females (25.9%). Most of the households were in the lowest and second quintiles of wealth index as shown in table 3 above.

Birth related descriptive characteristics of mothers

Nearly a quarter of the respondents (23.5%) reported to have a birth interval of between 1 year and 2 years. Among every 100 women included in this study, 15 (15.2%) women reported to have borne 7 children and more. Only a few (3.7%) of the respondents reported to have borne a child when they were older than 26 years of age but more than half of the participants included in this analysis reported to have given birth to a child when they were 18 years or below. Every 6 in every 10 women in this study had attended at least 4 ANC visits during their latest pregnancy. Details of the maternal characteristics related to birth are described in table 4 below.

Table 4. Birth related characteristics of mothers of children aged 12 – 23 months who participated in the 2016 Uganda Demographic Health Survey

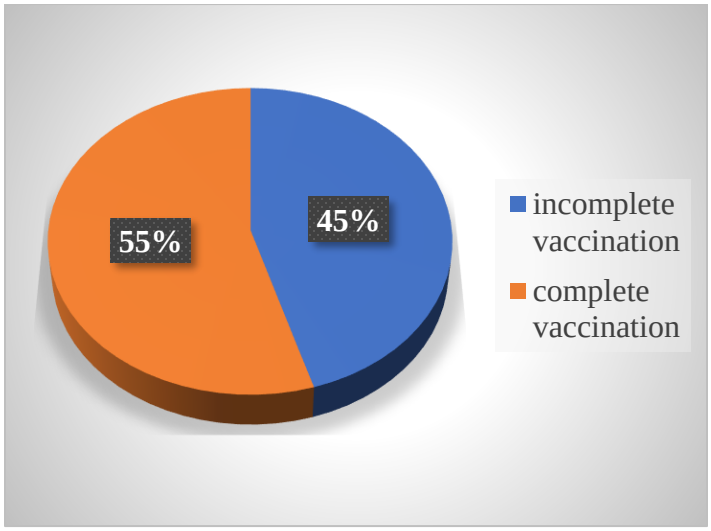
Characteristic	Unweighted sample		Weighted sample	
	Frequency (n=2815)	Percentage (%)	Frequency (n=2815)	Percentage (%)
Birth interval (months) (n=2180)				
8 to 12	50	2.3	44	2.0
13 to 24	513	23.5	501	23.0
25 to 36	773	35.5	762	34.9
37 to 48	429	19.7	441	20.3
>48	415	19.0	432	19.8
Number of children				
1 to 2	1120	39.8	1158	41.1
3 to 4	793	28.2	799	28.4
5 to 6	474	16.8	447	15.9
7 to 8	260	9.2	233	8.3
>8	168	6.0	178	6.3
Age at first birth				
12 to 15	334	11.9	329	11.7
16 to 18	1134	40.3	1120	39.8
19 to 25	1242	44.1	1249	44.4
>26	105	3.7	117	4.1
Health facility visit in past 12 months				
Yes	2202	78.2	2174	77.2
No	613	21.8	641	22.8
Last pregnancy planned				
Yes	1558	55.4	1551	55.1
No	1016	36.1	1025	36.4
No more	241	8.5	239	8.5
1st ANC check time (months)				
0 to 3	835	30.2	809	29.3
4 to 6	1719	62.3	1730	62.7
>6	206	7.5	221	8.0
Number of ANC visits				
<3	1052	37.4	1064	37.8
3 to 4	1523	54.1	1490	52.9
>4	240	8.5	261	9.3
Place of delivery				
Respondent's home	520	18.5	482	17.1
Other home	136	4.8	142	5.0
Government hospital	540	19.2	590	21.0
Government health center	1157	41.1	1098	39.0
Other public sector	6	0.2	5	0.2

Private hospital/ clinic	403	14.3	451	16.0
Other private sector	7	0.3	7	0.3
Other	46	1.6	40	1.4
Normal delivery				
Yes	2638	93.9	2613	93.0
No	171	6.1	196	7.0
Child's health checked before discharge				
Yes	1525	72.2	1514	71.6
No	566	26.8	576	27.3
Don't know	22	1.0	24	1.1
Insurance coverage				
Yes	33	1.2	37	1.3
No	2782	98.8	2778	98.7
Ever vaccinated (n=798)				
Yes	764	95.7	763	95.6
No	34	4.3	35	4.4

4.2 Vaccination status among children aged 12 – 23 months who participated in the 2016 Uganda Demographic Health Survey

The overall completion of vaccination in accordance with the Ugandan EPI schedule among children in this study was 54.7% (95%CI 52.88 – 56.59). Vaccine specific defaulters for the BCG vaccine, 1st dose of DPT, first dose of Polio, 2nd dose of DPT, 2nd dose of Polio, 3rd dose of DPT, 3rd dose of Polio and the measles vaccine were 3.5%, 5.2%, 8.3%, 10.1%, 13.7%, 19.6%, 29.7% and 19.7% respectively. Majority of the children had their dates of vaccination recorded on the card. Further still, some of the vaccination status on particular vaccines was self-reported by the mother of the child. The completion of vaccination is demonstrated in figure 3 below.

Figure 3. **Completion of vaccination among children aged 12 - 23 months**



4.3 Bivariate binary logistic regression for maternal education and childhood immunization

Binary logistic regression was run to assess the association between the outcome (complete childhood immunization) and each of the covariates independently. The first assessment of association was between childhood immunization and maternal education given that maternal education was our main predictor. Running each covariate with the outcome omits the possibility of interaction and effect modification by other covariates.

The findings from the analysis show that there exists a strong association between maternal education and completion of childhood immunization. The results suggest that a child whose mother completed primary school are 37% less likely to complete immunization when compared to those whose parents had completed a level of education higher than secondary school (OR = 0.63 95%CI: 0.43 - 0.91).

Table 5. Bivariate binary logistic regression for childhood immunization completion

Characteristic	Complete Vaccination	Incomplete Vaccination	Unadjusted Odds Ratio (95% CI)	P value
Independent Variable				
Education level				
No education	140	119	0.69 (0.45 - 1.08)	0.11
Primary	881	827	0.63 (0.43 - 0.91)	0.015*
Secondary	362	283	0.75 (0.50 - 1.14)	0.18
Higher	127	75	Reference	
Covariate Variables				
Age categories				
15 - 19	132	145	Reference	
20 - 24	463	389	1.30 (0.95 - 1.79)	0.10
25 - 29	377	294	1.40 (1.02 - 1.94)	0.040*
30 - 34	307	226	1.50 (1.06 - 2.09)	0.022*
35 - 39	164	162	1.11 (0.77 – 1.61)	0.57
40 - 44	54	69	0.85 (0.52 - 1.40)	0.53
45 - 49	13	20	0.72 (0.33 - 1.57)	0.41
Residence type				
Urban	354	307	Reference	
Rural	1157	997	1.01 (0.81 - 1.25)	0.96
Religion				
Anglican	484	397	1.14 (0.54 – 2.38)	0.74

Catholic	595	479	1.16 (0.55 – 2.42)	0.70
Muslim	191	224	0.80 (0.37 - 1.71)	0.56
Pentecostal	203	174	1.08 (0.51 – 2.32)	0.49
SDA	23	15	1.40 (0.49 – 4.01)	0.47
None	15	14	Reference	
ANC visits				
<3	533	531	Reference	
3 to 4	831	660	1.25 (1.04 - 1.51)	0.015*
>4	147	113	1.29 (0.93 - 1.80)	0.13
Health card				
No	66	448	Reference	
Yes, seen	1389	513	18.4 (13.44 – 25.12)	<0.001*
Yes, not seen	54	242	1.5 (0.98 - 2.38)	0.06
Wealth index				
Lowest	335	276	Reference	
Second	321	282	0.94 (0.74 - 1.19)	0.78
Middle	282	240	0.97 (0.75 - 1.25)	0.81
Fourth	258	229	0.93 (0.71 - 1.21)	0.58
Highest	315	277	0.94 (0.72 - 1.23)	0.64
Health facility visit in past 12 months				
No	301	340	Reference	
Yes	1210	964	1.42 (1.15 - 1.75)	0.001*

***** *shows statistically significant variables (P value <0.05), Weighted data*

The age categories of the mothers were as well found to be independently associated with completion of childhood immunization. The proportion of completion of childhood vaccination in this study seemed to increase with increase in the age of the mothers. Children whose mothers were aged between 25 and 29 years of age were more likely to be completely immunized when compared to those whose mothers were aged between 15 and 19 years (OR = 1.4 95%CI: 1.02 - 1.94). Mothers who had attended 3 to 4 visits of ANC were more likely to have their children fully immunized (OR = 1.25 95%CI: 1.04 - 1.51) compared to those who had had less than 3 antenatal clinic visits during their last pregnancy. Children whose mothers had a health card were more likely to have been fully immunized (OR = 18.4 95%CI: 13.44 – 25.12) when compared to those whose mothers didn't have a health card. The odds of full immunization among children whose mothers had visited a health facility in the last 12 months at the time of the survey were 1.42 times more as compared to those of a child whose mother had not visited the health facility (OR = 1.42

95%CI: 1.15 - 1.75) when compared to those whose mothers had visited the health facility (Table 5). The respondent's religion, residence and wealth index were not independently associated completion of childhood immunization.

4.4 Multivariate Logistic Regression for maternal education and childhood education with other covariates

To explore correlation of other covariates (age, religion, ANC visits, possession of a health card and visiting the health facility in the last 12 months before the survey) with maternal education (exposure), multivariable logistic regression was used. These covariates were the possible confounders and they were added to the model all at once.

There exists a significant association between maternal education and completion of childhood immunization. Children whose mothers had primary level being their highest level of education were 50% less likely to complete immunization (OR = 0.50 95%CI: 0.32 - 0.77) when compared to children whose mothers had completed a level higher than secondary. Likewise, completion of childhood immunization was 38% less likely (OR = 0.63 95%: 0.39 - 0.97) in children whose mothers completed secondary school compared to children whose mothers had completed a level higher than secondary school.

There was no significant association between maternal age, residence, religion, wealth index and the outcome (completion of childhood immunization). The number of ANC visits, possession of a health card and visiting the health facility in 12 months prior to the survey were however found to have a significant association with the outcome. The odds of completion of childhood immunization were significantly higher in children whose mothers had 3 to 4 ANC visits (OR = 1.25 95%CI: 1.03 – 1.52) compared the odds of those whose mothers had less than 3 visits. Similarly, children whose mothers had visited the health facility in the last 12 months were more likely to complete immunization when compared to those whose mothers had not visited the health facility (OR = 1.35, 95%CI: 1.08 – 1.68). Details are shown in table 6.

Table 6. Multivariate binary logistic regression for childhood immunization completion

Characteristic	Complete Vaccination	Incomplete Vaccination	Adjusted Odds Ratio (95% CI)	P value
Independent Variable				
Education level (n=2815)				
No education	140	119	0.64 (0.38 – 1.09)	0.10
Primary	881	827	0.50 (0.32 - 0.77)	0.002*
Secondary	362	283	0.62 (0.39 - 0.97)	0.038*
Higher	128	75	reference	
Covariate Variables				
Age categories (n=2815)				
15 - 19	132	145	reference	
20 - 24	463	389	0.94 (0.62 - 1.43)	0.77
25 - 29	377	294	0.87 (0.56 - 1.34)	0.52
30 - 34	307	226	0.97 (0.62 - 1.52)	0.91
35 - 39	164	162	0.76 (0.46 - 1.26)	0.29
40 - 44	54	69	0.71 (0.36 - 1.41)	0.32
45 - 49	13	20	1.24 (0.37 - 4.20)	0.73
Residence type (n=2815)				
Urban	354	307	reference	
Rural	1157	997	0.92 (0.66 - 1.29)	0.64
Religion (n=2815)				
Anglican	484	397	1.83 (0.77 – 4.34)	0.17
Catholic	595	479	1.75 (0.74 - 4.14)	0.20
Muslim	191	224	1.17 (0.48 – 2.86)	0.73
Pentecostal	203	174	1.46 (0.60 – 3.54)	0.14
SDA	23	15	2.57 (0.74 - 8.93)	0.40
None	15	15	reference	
ANC visits (n=2815)				
<3	533	531	reference	
3 to 4	831	660	1.20 (1.03 - 1.53)	0.023*
>4	147	113	1.33 (0.86 - 1.74)	0.27
Health card (n=2712)				
No	66	448	reference	
Yes, seen	1389	513	18.4 (13.92 - 24.19)	<0.001*
Yes, not seen	54	242	1.30 (0.88 - 1.93)	0.19

Wealth index (n=2815)				
Lowest	335	276	reference	
Second	321	282	1.04 (0.80 - 1.36)	0.75
Middle	282	240	1.16 (0.86 - 1.54)	0.33
Fourth	258	229	1.14 (0.84 - 1.56)	0.39
Highest	315	277	1.40 (0.95 - 2.06)	0.09
Health facility visit in past 12 months (n=2815)				
No	301	340	reference	
Yes	1210	964	1.35 (1.08 - 1.68)	0.008*

** shows statistically significant variables (P value <0.05), Weighted data*

5. Discussion

This study sought to determine if there existed an association between maternal education and completion of vaccination among children aged 12 to 23 months in Uganda. The study also assessed other factors that could have an influence on completion of childhood immunization simultaneously. The education level of a mother had an influence on completion of childhood immunization in this analysis. Accordingly, the number of ANC visits, possession of a health card and a health facility visit in the 12 months preceding the survey explained the variation in completion of childhood immunization amongst the children.

Maternal education in this analysis was significantly associated with completion of childhood immunization. Results from this study suggest that the likelihood of a mother to have their children completely immunized increases with increase in the level of education of the mother. Children whose mothers had only completed the primary level were 50% less likely to have completed immunization as compared to those whose mothers had completed a level higher than secondary school. Similarly, children were 38% less likely to have been fully immunized if their mothers had completed secondary school in comparison to those whose mothers had completed a level higher than secondary school. The odds of completion of immunization among children whose mothers had completed primary school or secondary school were lower compared to those of children whose mothers had completed a level of education higher than secondary school. This could have been so because mothers who are more educated are expected to have more knowledge and understanding of the usefulness of immunization of children and hence the urge to have their

children fully immunized. It is also expected that mothers who are more educated will keep grasp of the immunization schedules and adhere to them. It is with these findings that we recommend that the girl child be supported and encouraged to attain basic education in order to increase the likelihood of mothers having their children completing immunization according to the immunization schedule.

The observed results are similar to those reported in the analysis of Ethiopia DHS data by Kinfe et al. in 2016 which found that the odds of completion of vaccination were 2.5 times fold higher among children whose mothers had completed a secondary level of education or higher in comparison to children whose mothers had no formal education. Similarly, children whose mothers had completed a primary level of education were 1.6 times more likely to have completed vaccination in comparison to children whose mothers had no formal education (44).

The results are also similar to those reported in Kenya where mothers who had completed primary, secondary and tertiary education were between 2 and 9 times more likely to fully immunize their children when compared to children whose mothers didn't have any form of education. The results as such suggest that maternal education is useful in a bid to ensure positive health outcomes among children (19). The findings are also similar to those reported by other studies in Nigeria (45, 46) and Mozambique (47).

The results of this analysis are different from findings by an analysis of a community-based household survey in Eastern Uganda by Sematimba which reported that there was no association between maternal education and completion of childhood immunization (48). The variation could have been so because majority (79.8%) of the participants in Sematimba's study had only completed a primary level of education and hence the sample was nearly homogenous with regard to maternal education (48). Another study done by Etana and Deressa among children aged 12 to 23 months in Ambo Woreda, Central Ethiopia also found no significant association between maternal education and completion of childhood immunization in the multivariate model. The contrast in the results could be so because the study in Ethiopia only grouped maternal education as illiterate and literate in comparison to DHS data where maternal education is grouped into 4 levels (no education, primary, secondary and higher than secondary). The study in Ethiopia also regarded a mother as being literate if they had completed any formal education ranging from primary school through secondary school to tertiary level). This may not be accurate given that

mothers who have completed primary education do not have the same knowledge on childhood vaccination as compared to mothers who have completed a secondary level of education or higher as established by the study conducted by Gidado et al in Nigeria (26).

Findings from this study also suggest that children whose mothers made ANC visits were more likely to complete immunization. Children whose mothers had 3 to 4 ANC visits had 1.2 higher odds of being fully immunized when compared to those whose mothers had less than 3 ANC visits. This could be so because mothers who have more ANC visits most probably have a better health seeking behavior and will most likely visit the health facility more often. During the ANC visits, pregnant women go through health education sessions that also cover the usefulness of childhood immunization and the various specific schedules for the vaccinations. The mothers who attend ANC thus have access to information and could eventually have their children fully immunized. These results are similar to findings by other studies done in Ethiopia (44, 49), Indonesia (50) and East China (51).

Similarly, in this study, children whose mothers had visited the health facility in the past 12 months at the time of the survey had higher odds of being fully immunized as compared to those whose mothers had not visited the health facility. The possible reason could be because these mothers have better knowledge of where to access the vaccination services at the facility since they visit the health facility often. In addition to the knowledge, these mothers also could be thought to have a better health seeking behavior.

Findings from the multivariate regression analysis showed no statistically significant association between completion of childhood immunization and wealth index and residence type. The results observed could be due to the fact that immunization in Uganda is universal as explained by Bbaale and others in 2015 (17). These findings are similar to those reported from the analysis of Senegalese DHS data in 2017 (22). Another study conducted in Uganda by Bbaale in 2015 also found no significant association between the family's wealth index and completion of childhood immunization.

The results are different from those in a study done in Ethiopia by Lakew and colleagues in 2014 which reported that children whose mothers were from a higher wealth index were 40% more likely to have completed immunization in comparison to children whose mothers had a poor wealth index (39). The observed difference could have probably been because in the study done in

Ethiopia, the wealth of the house hold was only categorized into poor, middle and rich where as in the UDHS data 2016, wealth of the house hold was grouped into the lowest, second, middle, fourth and highest quintiles.

In this study, all participants who had documented religions were more likely to have completed childhood immunization in comparison to the participants who had no religion. This association was however not significant. These results are however different from the findings of a study done about religion and childhood immunization coverage across countries in Sub Saharan Africa by Costa and colleagues which found that children of Muslim households were significantly less likely to be vaccinated (52). The findings of the current study also differ from those by Bbaale and colleagues in 2015 in Uganda which found that children born to Muslim mothers were significantly less likely to receive all the doses of DPT when compared to children born to catholic mothers (17). In the same study, children born to Anglican mothers had the lowest percentage of completing immunization with the children born to catholic mothers being the most fully immunized (17). The current study was prone to selection bias arising from the included sample. The selected sample may not have been representative of the population because just a specific portion of the households was interviewed. The study was also liable to information bias because the information collected was obtained through self-reports by the participants to the questions asked to them by the interviewers. It is thought that some participants may not have responded to the questions honestly leading to the capture of incorrect information.

5.1 Validity

During the implementation of the survey, the DHS program adheres to their set principles and standard operating procedures to ensure validity and reliability of the survey results. According to the UDHS 2016 report, the number of participants sampled to take part in the survey represents the true picture of the population of Uganda.

To ensure data quality, several trainings were conducted to equip the stakeholders with the necessary expertise and refresh their skills. The training course for the data collectors lasted one month. During the training, the data collectors received instructions on techniques of interviewing and field procedures, reviewing the questionnaire content in detail and practice interviews with respondents who were not included in the 2016 UDHS sample.

Furthermore, all the individuals involved in data collection had had some experience with household surveys. The questionnaires were as well pretested among approximately 240 households which were not included in the 2016 UDHS sample area. Teams also spent an additional week upcountry testing the translations. Modifications to the questionnaires were made based on lessons learned from the exercise (5). Data accuracy was as well achieved by random selection of participants to minimize selection bias.

Systematic bias resulting from missing data which would have been present if some of the questionnaires had not been completed was not a problem in this study since all the participants had complete information and none of them was excluded from the statistical analysis hence giving high response rates.

5.2 Study Limitations

Our analysis was subject to limitations. Information regarding childhood immunization was obtained from possession of a vaccination card or self-reports on vaccination by the mother of the child which could present information bias. Data collection on other attributes as well was obtained through self-reports on interviewer administered questionnaires which as well could present information bias. It may have also led to the overestimation of the completion of immunization among children because the status was based on both indication on the vaccination card or self-report by the mother. To minimize information bias, the interviewers underwent thorough training on data collection prior to the survey.

It may also not be possible to establish a causal relationship in this study given that information on the outcome (completion of childhood immunization) and exposure (maternal education) was collected in a cross-sectional design and at the same point in time. Furthermore, it was impossible to fully study the variation in proportions of completed childhood immunization amongst the different regions and districts given that the DHS data is usually sampled to become representative of the whole nation or region and not a much smaller area.

This study may also have been liable to recall bias. In cases where the mothers did not have the vaccination cards, some others may have not been able to remember some of the information related to their children’s immunization.

5.3. Conclusion

Results from this study show that lower education among Ugandan mothers is associated with reduced completion of childhood immunization. This suggests that efforts should be made to improve education with an emphasis on the Ugandan girl child to be able to increase education levels among mothers.

Other factors that had an influence on the association between maternal education and completion of childhood immunization were number of ANC visits, possession of a health card and having visited the health facility in the 12 months prior to the survey. Parents who have a level of education lower than secondary school should thus be targeted with revised strategies to promote childhood immunization. Information regarding immunization and the usefulness of ANC visits should also be emphasized among these mothers by strengthening the village health teams and media out-reach in a bid to equip mothers with information regarding the usefulness of childhood vaccination and the different vaccination schedules.

6. Availability of data and materials

The data set used in this study is not available to the public. The design and implementation of this study is however given in detail in the text.

7. Conflict of interest

The researcher declares no conflict of interest.

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