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Impact of Routine Immunization Coverage in Controlling Measles and Progressing Toward the Introduction of Rubella Containing Vaccine: A Comparison Study Between Rwanda and Uganda

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Introduction:

Despite the existence of safe and effective vaccines, measles and rubella present a major public health problem in many developing countries, disproportionally affecting low-income populations.[1-3] Indeed, measles and rubella remain two of the leading causes of death and congenital defects in children worldwide.[4-6] In 2008, an estimated 10 million new cases and 164,000 deaths were reported from measles alone.[3] During the same time period, the United Nations International Children's Emergency Fund (UNICEF) reported an estimated 110,000 cases of Congenital Rubella Syndrome (CRS) in developing countries, with the continent of Africa shouldering 38% of the disease burden.[7]

Measles is a highly infectious viral disease caused by the measles virus. The infection is transmitted person-to-person by contact with contaminated droplets in the air. [6,8,9] The symptoms of the diseases are characterized by conjunctivitis, coryza, malaise, and a generalized maculopapular rash.[6,8,9] The diseases has a case fatality rate of 10%, which is largely due to an increased susceptibility of measles-infected persons contracting secondary bacterial infections.[1,3,9,] Similar to the transmission and symptoms of measles, rubella is by comparison less severe. Caused by the rubella virus, the rubella diseases usually presents as a mild, febrile rash illness in children and adults.[4] Importantly, when a woman is infected with rubella early in her pregnancy, particularly during the first 16 weeks, the virus can result in miscarriage, fetal death, or an infant born with CRS.[4]

In 1999, a reported 61% of global deaths from measles occurred in Sub-Saharan Africa.[10] This high percentage prompted many countries in the region to launch accelerated measles control programs to meet the 2005 global target of halving the number of measles-related deaths.[10] As a result, impressive gains in achieving 75% of the global reduction in measles deaths occurred in Africa.[10] The great strides made in reducing measles-related deaths were achieved by institutionalizing routine immunization programs through the World Health Organization's Expanded Program on Immunization (EPI), which is a disease prevention activity aimed at reducing morbidity and mortality from childhood diseases preventable by immunization.[10-12] WHO member countries administer EPI services as part of their routine immunization schedule against childhood killer diseases such as Tuberculosis, Polio, Whooping cough, measles and Tetanus. Vaccines against these target diseases are known as the eight EPI vaccines which includes: one dose of Bacillus Calmette-Guerin (BCG), three doses of DPT (against diphtheria, pertussis, and tetanus), three doses of oral polio vaccine, and one dose of measles vaccine.[11,13,14] WHO recommends that these eight vaccines be given routinely to all children from birth through 12 months.[13,14]

A safe and effective rubella-containing vaccine (RCVs) has been available since the 1960s.[4,15] In developed nations, RCVs were promptly introduced in national immunization schedules, however, until the 1990s, the vaccine was not available in developing nations due to (1) the cost of the new vaccine and (2) insufficient documentation of the burden caused by rubella virus in these parts of the world.[4] Rubella and RCS were vastly underreported in developing countries because of the difficulties associated with surveillance.[4]

A cost-benefit analysis of introducing RCV in national immunization schedules has shown such an intervention to be cost-effective, contrary to past concerns.[4,16] According to S.E. Reef et al, studies conducted in Barbados and Guyana revealed that the lifetime cost of treating a single CRS case was estimated to be $50,000 in Barbados and $64,000 in Guyana.[4] On the other hand, the rubella vaccine is highly affordable; the same report by S.E. Reef et al shows that the incremental costs of incorporating RCV in measles-rubella (MR) and measles-mumps-rubella (MMR) vaccines using a 10-dose vial are $0.31 and $0.70–$1.37 per dose, respectively.[4]

In the past, documenting the extent of rubella and CRS were particularly challenging because of the difficulties of diagnosis and reporting in settings with limited medical resources.[4,16] However, through progress made in medical technology, there has been great improvement in disease surveillance systems.[4] This has prompted an increase in the case reporting of rubella to WHO by member states. For example, from 2000-2009, the reported rubella cases in the African region increased from 865 to 17,388, and number of reporting countries increased from 7 to 38.[4] In recent decades, the progress made in better identifying cases prompted many member states to introduce RCV in national immunization schedules. Therefore, as of 2009, 130 of 193 member states had introduced RCV, including two countries from the WHO African region.[4,16]

The low introduction rate of RCVs in Africa is due to the lack of establishing rubella elimination, control, or prevention goals in the region.[15,16] From 2000-2009, this hampered African countries from addressing the 20-fold increase in rubella cases.[4,15]

Through EPI, most African countries already administer measles-containing vaccine (MCV) as part of their national routine immunization program.[11] Thus, switching from a single measles antigen to a combined MR or MMR vaccine is not only cost effective, but presents an opportunity to address the rising rates of rubella and CRS.[15] Recently, the feasibility of switching from MCV to MR has been made possible through funding from the Global Alliance for Vaccines and Immunization. For funding consideration, GAVI-eligible countries – the majority of which are found in sub-Saharan Africa – must meet one of two requirements: (1) maintain high immunization coverage of the eight EPI vaccines, and (2) achieve and sustain a >80% coverage of MCV. [17]

In an attempt to meet the requirement set by GAVI, 16 African countries have sustained MCV coverage of >80% (i.e., Algeria, Botswana, Burundi, Cape Verde, Eritrea, Gambia, Ghana, Lesotho, Malawi, Rwanda, Sao Tome, Sudan, Swaziland, Togo, Tanzania, and Zambia),[4] of which only Rwanda has introduced RCV into its immunization schedule as of 2013.[18]

Rwanda and Uganda

Geographically, both Rwanda and Uganda are neighboring countries located in East-Central Africa. Demographically, both countries consist of relatively young individuals, where 42.3% and 48.9% of the population are ages 0-14, respectively.[19] The total median age in Rwanda is 18.7 years and 15.5 years in Uganda.[19] Birth rates in Rwanda and Uganda are fairly close: 2013 census estimates were 35.49 births/1,000 populations for Rwanda and 44.5 births/1,000 populations for Uganda.[19] As of 2013, the total infant mortality rate was 61.03 deaths/1,000 live births for Rwanda, and 62.47 deaths/1,000 live births for Uganda.[19] According to the 2011 census for both Rwanda and Uganda, health expenditures were 10.8% and 9.5% of GDP, respectively, and education expenditures were 4.8% and 3.3% of GDP, respectively.[19] Both countries are also comparable on the basis of economy and government type: they both are republics and according to the 2012 census, GDP per capita for both Rwanda and Uganda were 1,500 and 1,400 US dollars, respectively.[19] A map of both countries is found in Figure 1, and characteristics of both countries are summarized in Figure 2.

Objective:

Due to the paucity of research evaluating the slow introduction of RCV in Sub-Saharan Africa, this study employs the requirements set by GAVI to examine causes for low uptake of MCV in Africa and the subsequent introduction of the vaccine by only one country given the established burden of the disease in the region. The assessment will be conducted by evaluating EPI services and program performance of Rwanda and Uganda in providing all eight EPI vaccines and maintaining high coverage rates. Comparing Rwanda to Uganda, a country that has successfully introduced the combined measles-rubella vaccine to a country that has not, allows for a better understanding of areas needing improvement when introducing this positive public health practice in African countries. Due to the lack of direct measures for country-level health governance, the study uses population characteristics as key indicators to explore how Rwanda has been able to meet GAVI requirements and introduce the vaccine in comparison to why Uganda has not been able to do so.

By conducting a comparison case control-study of Rwanda and Uganda, this research seeks to (1) determine which population characteristic has the most influence on vaccination uptake (e.g. child age, parents education and residence); (2) test routine immunization coverage rates to evaluate the effectiveness of EPI services of both countries in delivering all eight vaccines; and (3) assess the overall MCV coverage rate for both countries to analyze whether or not they meet the 80% coverage rate requirement.

Methods

Data Source & Study Sample:

Data for both Rwanda and Uganda used in this study were obtained from the 2010 Rwanda Demographic and Health Survey (RDHS) and the 2011 Uganda Demographic and Health Survey (UDHS*)*. This data source was deemed appropriate for comparison of immunization data because it is nationally-representative and accurately reflects the population. The data were collected using a stratified two-stage cluster sampling procedure. The initial sampling stage involved selecting 492 clusters for Rwanda and 404 clusters for Uganda; the second sampling stage involved systematically selecting households from the already selected clusters.[13,14] This resulted in a probability sample of 12,792 households for Rwanda and 10,086 for Uganda from which data were collected by face-to-face interviews from 13,671 (Rwanda) and 9,247 (Uganda) women aged 15 to 49 years. Interviewed mothers from both countries contributed information on child immunization histories for a total of 16,880 children born within five years prior to the survey: 9002 (Rwanda) and 7878 (Uganda).[13,14]

The survey collected in-depth demographic, socioeconomic information, as well as information on birth histories and immunization details of children.[13,14] Information on vaccination coverage was obtained via two methods – from child health cards and from mothers' verbal reports if the health card was not available.[13,14] This publicly available dataset for the Measure DHS project was produced by ORC Macro through the US Agency for International Development (USAID) funding.[13,14]

<u>*Measures:*</u>

In order to obtain information on vaccination coverage of children aged 0 to 59 months, the present study merged three different dataset survey files on the basis of matching variables: household, individual, and children. The children's survey dataset was the primary file from which the unit of analysis was established, while both household and individual surveys were appended to the children's survey.

Outcome variable

The outcome variable was the likelihood of a child between 0 to 59 months old having received all eight recommend vaccines (yes/no). Full immunization was coded as 1 if the child received all 8 vaccines, and 0 if the child received 0-7 of the vaccines. For a child to be classified as being completely vaccinated with each vaccine, they had to receive all vaccine doses. For BCG and Measles, vaccine completion, 1, was denoted as child receiving BCG and Measles and 0 for otherwise. For a child to be coded as having received DPT, they had to have completed all three doses, anything less than the required three doses was denoted as "not receiving DPT." Likewise, for the Polio vaccine, the completion of all three doses was denoted as "receiving the vaccine" and anything less than the required three doses was denoted as "not receiving Polio vaccine."

Predictor variables

Intrapersonal-level factors. Two individual child-level variables of interest were examined: (1) sex of child, assessed as male and female; and (2) age of child in months, grouped as: <12 months, 12-23 months, 24-35 months, 36-47 months, and 48-59 months.

Interpersonal-level factors. Four parental and household-level variables of interest were examined. The first variable "Parents' education" was created by appending mother and father education variables; "parents' education" level was determined by the highest level of education attained by either mother or father: no education (reference category), primary education, secondary education and higher. The second variable "parents' age" was created by appending the mother and father's age, and grouped as: <20 years, 20-34 years, and 35-49 years. The "parents' age" group was determined by the highest age of either mother or father. The third variable "insurance coverage" was grouped as "insured" and "uninsured." Lastly, the fourth variable, "household economic status" was created using the DHS wealth index as a proxy with quintiles ranging from poorest (reference category) to richest.[13,14]

Community-level factor. Geographic residence was the only community-level variable of interest and was categorized as: "urban" or "rural."

Statistical Analysis:

The study analyses were conducted using IBM SPSS Statistics software (version 21.0). Descriptive statistics reported in Table 1 show the distribution of key characteristics among respondents. Chi-square (X^2) analyses (Table 2) were used to describe the association between individual predictor variables and full immunization status. A stepwise logistic regression model (Table 3) was applied to identify the subset of predictor variables with the strongest relationship to a child's full immunization status. For both bivariate and regression analyses, probability values less than 0.01 were considered significant. Lastly, a 2x2 table (Table 4) was used to assess the uptake of MCV in both Rwanda and Uganda.

Ethics:

The Institutional Review Board at the University of Kentucky waived review of this study because it was a secondary data analysis of an existing survey data that had all identifying information removed.

Results

Of the 16,880 children aged 0-59 months analyzed, 9002 children were Rwandese and 7878 children were Ugandan (Table 1). In Rwanda, 76% of children between 0 and 59 months were fully immunized, compared to 43% in Uganda. The distribution of males and females was fairly even between both countries. However, Rwanda had slightly more males (50.9%) then girls (49.1%). Overall, there were more parents aged 20 – 34 years, 57.7% in Rwanda and 54.1% in Uganda, compared to the < 20 and 35 – 49 age groups. Those aged <20-years was 0.6% for Rwanda and 1.1% for Uganda. The second largest age group, those aged 35 – 39 years, were 41.6% in Rwanda and 45% in Uganda.

In Rwanda, far more parents had completed primary education (73.1%) than had no education (13.4%) and secondary or higher (13.5%). In Uganda, more parents had completed primary (52.3%) and secondary education or higher (37.2%) in comparison to having had no education (10.5%). More children in both Rwanda (23.1%) and Uganda (26%) belonged to the poorest quintile of households rather than the richest quintile of households. More children resided in rural than urban areas, with 86.4% of children in Rwanda in rural areas and 78.6% in Uganda. In Rwanda, 73.3% of the surveyed population had insurance coverage as compared to 58.5% in Uganda.

This study sought to carry out comparison analysis between Rwanda and Uganda. Due to a low respondent rate in Uganda for "insurance coverage," this predictive variable was excluded from the bivariate and multivariate analyses of both countries.

Overall, five variables were significantly associated with a child's uptake of all vaccines in unadjusted bivariate analyses (p-value < .01): child's age, residence, household income, parents' age, and parents' education (Table 2). The association between parents' education with child's vaccine uptake was only significant for Uganda and not Rwanda (p-value = .100). In both countries, the sex of the child was not statistically associated with vaccination uptake (p-value = .026 for Rwanda; p-value = .774 for Uganda). However, more boys in Rwanda were fully immunized (52%) than girls (49%). On the contrary, in Uganda 51% of girls were fully immunized as compared to boys at 50%.

The following variables were statistically associated with vaccination uptake in multivariable analysis: residence, household income, child's sex, parents' age, and education.

Within the Rwanda sample (Table 3), four factors were positively associated with a child's uptake of all vaccines in unadjusted bivariate analyses (p-value < 0.01): child's age, residence, household income, and parents' age. However, with all factors controlled for in the fully adjusted logistic model, parents' aged 20-34 years (AOR=3.26; 99% CI: 1.12 – 9.50), and children living in richer (fourth wealth index quintile) households (AOR=1.47; 99% CI: 1.00 – 2.16) were the only factors found to be significant and positive determinants of a child's vaccination uptake. While child's sex and residence were found to be significant, specifically being a female (AOR= 0.74; 99% CI: 0.58 -

0.94) and residing in rural area (AOR= 0.64; 99% CI: 0.41 – 1.01) negatively determined a child's vaccination uptake.

Within the Uganda sample (Table 3), five factors were positively associated with a child's uptake of all vaccines in unadjusted bivariate analyses (p-value < 0.01): child's age, residence, household income, parents' age, and parents' education. In the fully adjusted logistic model, when holding all variables constant, living in a rural area was a significant and negative determinant of a child's vaccination uptake (OR= 0.68; 99% CI: .46 – 1.00), while having parents with secondary education or higher was a significant and positive determinant of a child's vaccination uptake (OR= 1.787; 99% CI: 1.027 – 3.109).

The multiple logistic regression model of the socio-demographic characteristics accounted for a reasonable amount (Nagelkerke R^2 =0.45 for Rwanda; Nagelkerke R^2 =0.21 for Uganda) of predictability related to vaccination uptake.

Table 4, shows the weighted percentage and frequency of fully vaccinated children by MCV coverage rate for both Rwanda and Uganda. Of the total fully vaccinated children, 82.1% (6956) of children in Rwanda received MCV, compared to 68.4% (5017) in Uganda.

Discussion:

Main Findings:

The present study attempts to show which population characteristic has the most influence on vaccination uptake in a country with high immunization coverage (Rwanda) and one with low immunization coverage (Uganda). Results indicate that all three levels – intrapersonal (child's gender and age), interpersonal (parents' age and education, and household economic status), and community (residence type) – are important in explaining differences in immunization status among children in the study. On average, the study found that 76% of children in Rwanda were fully immunized, compared to 43% in Uganda. These numbers were inconsistent with literature, the final 2010 RDHS reported 90% coverage and the 2011 UDHS reported 52% coverage.[13,14] Discrepancies in results is because past studies coded full immunization as 1 if the child received all 8 vaccines and 0 if the child received 0 vaccines.[13,14] Children who received 1-7 of the vaccines were excluded. However, in this study, we included all children and categorized them as 1, for receiving all 8 vaccines, and 0, for receiving 0-7 of the vaccines.

Prior literature highlights the importance of both paternal and maternal education in predicting a child's full immunization uptake.[3,20,21] Education is said to be an important predictor in changing attitudes and beliefs. Parents that are educated have more control over resources and tend to be more autonomous, and thus practice better healthcare seeking behaviors. [21,22] Findings for the Uganda sample were consistent with previous literature. Specifically, the current study found that education was positively associated with a child's uptake of all eight vaccines, and having parents with secondary education or higher increased this odd by 0.30 in comparison to children whose parents only had primary education. However, in the Rwanda case, findings were inconsistent with previous studies.[20,21] Parental education was not significantly associated with full immunization but the odds of full immunization increased with higher educational attainment.

An urban and rural area discrepancy in immunization coverage was found in both Rwanda and Uganda. In both countries, children residing in rural areas were at significantly higher odds of receiving full immunization than children residing in urban areas. These findings are in agreement with previous studies attributing residential disparities to inaccessibility of health care services.[22] Conditions such as long distance from health centers, poor road networks, poor social infrastructure, and area economic depravity all contributed to making children in those areas inaccessible to vaccination officers.[20,22,23] Consequently, most of these children only get vaccinated during national immunization days.

The overall household economic status for both countries was not significant in determining full immunization status. Which, according to Edward Bbaale, is to be expected because immunization is universal in both Rwanda and Uganda.[22] However, in the case of Rwanda, children from the richer wealth index were found to have significantly higher odds of being fully immunized than those in the lower wealth index. This is attributed to the propensity that parents from higher wealth index have more access to information, in seeking medical care, and in having their children immunized.[20,22] Although not significant in determining uptake of vaccination, children from the richest households had a much greater odds of being fully immunized than that those of lower household economic status (AOR=1.243). However, there was a discrepancy between the richer and richest households. Instead of seeing an increase from one to the other, the reverse was observed. The adjusted odds of being fully immunized decreased by 0.23 from richer to richest households. This decrease is attributed to the difference in sample size between the two groups.

The current study showed that in Rwanda, the overall parents' age was significant in determining vaccination uptake. However, this was not true for Uganda. The 20-34 year old age group was significantly associated with full immunization coverage, whereas the 35-49 year old age group was not. However, the odds of full immunization were high for both these groups. Because a larger sample of parents were aged between 20-34 years of age compared to 35-49 years, the odds of being fully vaccinated decreased by one fold between these two groups. In Uganda, there was an observed one-fold increase of immunization coverage from the 20-34 to the 35-49 age group. Edward Bbaale found that the association between parents' age and vaccination uptake was attributed to experience accumulated over time. As parents witness fatalities linked to children not receiving immunization, their perceptions change. [22,23]

In examining the discrepancy in the distribution of vaccination coverage by age and sex of the child, our study revealed a significant difference for both these variables in Rwanda but not Uganda. Due to the nature of the study, significance should not be expected in the sex and age of child when determining full immunization. However, in Rwanda, sex was significantly associated with vaccination uptake as boys had higher odds than girls of being fully immunized. This finding was consistent with a study by Joyce Lyimo looking at uptake of measles vaccine services in Tanzania. Female children in this study were found to be less likely to receive complete immunization and more likely to remain in the non-immunization than boys.[21] Although not significant, in our study, boys in Uganda were also found to have higher odds of being fully immunized than were girls. The variation in sex could be attributed to the importance that is placed on male children compared to female children.

The inherent nature of the present study makes age significant across all categories; however, this study was interested in examining the distribution of vaccination coverage between the different categories to determine how consistent a country was in meeting the WHO recommended restriction on vaccination age administration. It was seen that in Rwanda, children aged 12-23 months had higher odds of being fully immunized, thus adhering to WHO recommendation, than did children in Uganda within the same age category. According to Edward Bbaale, this difference could be attributed to parents' lack of knowledge concerning the right vaccine dosage and age of administration; some children may receive one dose or two but not the full course.[22] Additional reasons for not receiving all vaccines could be linked to availability, personal beliefs, and circumstances out of parents' control such as political instability, war, and displacement.[22]

The assessment of measles containing vaccine (MCV) coverage rate revealed a discrepancy between the countries. Overall, the results from the study showed that in Uganda, of the 43% fully immunized children, only 68% of them received MCV. This does not meet GAVI requirement of 80% coverage needed for RCV funding consideration. Unlike Uganda, the study showed that Rwanda met the 80% MCV coverage requirement, thus explaining why they have been able to introduced RCV in their national immunization schedule. According to the researched literature, reasons for the low uptake of MCV in Uganda could be attributed to the importance parents place on vaccines.[21] With limited knowledge of the purpose of immunization, they might choose which vaccines they want their children to receive, while depriving them of other essential inoculations.[21]

Strength and Limitations:

The strength of the study is in its use of a large, nationally representative data survey with enhanced generalizability. Also, this is the first research to compare immunization measures of both these countries.

However, the study results are limited by the absence of direct measures for country-level health governance of immunization systems and services in relation to child immunization. Instead, the study attempts to measure this indicator by using population characteristics in relation to the uptake of all eight vaccines. The use of population characteristics might not give a full picture of a country's governmental ability to formulate and implement sound policies and regulations that permit and promote effective immunization activities.

This study is also limited by recall bias. Since data were collected retrospectively over the past five years, in the case of missing health cards, mothers may not have correctly recalled all the vaccines the child might have received. In addition, the study is limited to restrictions placed on immunization coverage groups (having received all eight vaccines), and those not covered (receiving 0-7 vaccines). This categorization, affected the distribution of the coverage rates for both countries, by decreasing the rate of full immunization. Lastly, the findings of the study are limited to only Rwanda and Uganda and cannot be generalized to other African countries.

Conclusion:

Uganda:

Given that our variables for the Uganda sample accounted for low predictability of vaccination uptake, denoted by the R^2 of .21, we have reasons to believe that other variables other than the one included in our regression model seems to be influencing uptake. Additionally, results of the study suggest that the health infrastructure of the country is comparatively deficient in achieving high immunization coverage rates. As mentioned in the discussion, factors influencing the low immunization uptake in this region are negatively affecting the efficacy of EPI services. Which, according to Ssewanyan et al, is linked to challenges with inadequate medical staffs, insufficient funding resulting in supplies stock-outs, scarcity of service provisions, and a disgruntled workforce.[24]

To address the shortcomings of EPI services and programs performance, it's imperative to first conduct a process and outcome evaluation of current health sector reforms. Understanding where breaches in policy implementations occurs, will provide crucial information about areas in the implementation process requiring further improvement. To address the challenges of scarcity highlighted by Ssewanyan et al, governmental leadership is required to increase salaries of the medical staff and increase expenditure on drugs.[22,24,25] In combination with the evaluations of health sector reforms, these efforts will help boost the quality of services provided by health facilities.

Secondly, given that our results highlighted residential disparities, efforts are needed from the government to strengthen vaccination programs in rural areas. These efforts could focus on improving roads and transportation, addressing some of the impediments vaccination officers experience in reaching children living in these communities.[22] Since previous research found that low vaccination uptake in rural communities in Uganda are linked to challenges with inadequate medical staff, insufficient funding in rural health centers and scarcity of provisions, the present study recommends that the Ministry of Health (MOH) focus its efforts in the financing of rural health centers, to hire more qualified medical personnel to fill vacancies in rural areas, and lastly, to carry out more vaccination programs in rural communities in order to educate and improve patient care.

For the last recommendation, the present study stresses the importance of targeted information campaigns. We recommend that the Health Communication Department at the Ministry of Health make use of media sources such as the radio, televisions, banners and newspapers to sensitize the general population on the importance of vaccines and the importance of children receiving all vaccine doses.

The second portion of the targeted information campaign should be geared toward one-on-one transmission of information, where (1) trained community health workers could provide prenatal care to mothers in rural communities and take advantage of this window of opportunity to stress the importance of timely immunization of babies (12-23 months), and (2) the Ministry of Education in collaboration with Ministry of Health, need to incorporate health knowledge and education into primary school curriculum in order to educate future mothers and fathers.

Rwanda:

Rwanda, on the other hand, seems to have an adequate EPI program, and is doing a reasonable job of getting children vaccinated at appropriate ages and completing vaccination courses. However, results from our regression model highlighted residential and gender disparities related to vaccination uptake. Thus, our recommendation is for the Ministry of Health to implement Mobil Health Clinics in rural communities in order to increase access to services. Efforts are also needed from the Rwandan government to enhance vaccination uptake of children residing in rural areas. Similar to recommendations made for Uganda, a way to address the issue is to improve roads and transportation infrastructures to make villages more accessible to vaccination officers.[22]

In addressing the issue of gender disparity, government efforts are need to institute programs and policies that incorporate gender into programing in order to eliminate gender-disparities in vaccination uptake.

Future studies could address limitations of the present study by using more direct measures of health governance to examine how political leadership influences vaccination coverage rates in both countries. Future studies could also address the issue of immunization coverage groups: fully vaccinated (received all 8 vaccines), the in-betweens (received 1-7 vaccines), and those not vaccinated (received 0 vaccines). To better understand causes for low vaccination uptake, it could help to examine individual doses to survey vaccines children are not receiving. Doing this, will allow for more targeted immunization campaigns to increase the uptake of these vaccines.

Summary:

Overall, this study provides insights into factors influencing immunization coverage of children in both Rwanda and Uganda. The findings of the study have significant public health implications for Uganda, as it lags behind in introducing RCV in its national immunization schedule, and Rwanda in achieving and sustaining high coverage rates of RCV.

This study found that population characteristics – intrapersonal, interpersonal, and community factors – were significantly associated with vaccination uptake. Using the coverage rate of childhood routine immunization in combination with population characteristics, the study highlighted deficiencies in EPI services and program performance. The findings suggested that in addition to governmental involvement and leadership, multifaceted approaches to interventions are imperative to improve immunization coverage in both Rwanda and Uganda. Without a systematic multilevel approach to interventions, ineffective EPI services will persist and vaccination coverage will remain low.

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Appendix

Figure 1. Map of Africa highlighting Rwanda and Uganda

Figure 2. Country Comparison: Rwanda & Uganda

Characteristics		
Geography	Rwanda	Uganda
Location	Central Africa, east of Democratic Republic of the Congo	East-Central Africa, west of Kenya, east of the Democratic Republic of the Congo
Climate	Temperate	Tropical
Demographics		
Population	12,012,589 (2013 est.)	34,758,809 (2013 est.)
Age Structure 0-14 years	42.3%	48.9%
Total Median Age	18.7 years	15.5 years
Birth Rate	35.49 births/1,000 population (2013 est.)	44.5 births/1,000 population (2013 est.)
Total Infant Mortality	61.03 deaths/1,000 live births (2013 est.)	62.47 deaths/1,000 live births (2013 est.)
Total Life Expectancy	58.85 years	53.98 years
Urban population	19.1% of total population (2011)	15.6% of total population (2011)
Education Expenditures	4.8% of GDP (2011)	3.3% of GDP (2012)
Health Expenditures	10.8% of GDP (2011)	9.5% of GDP (2011)
Hospital Bed Density	1.6 beds/1,000 population (2007)	0.5 beds/1,000 population (2010)
Government		
Government type	Republic	Republic
Economy		
GDP per capita (2012)	$1,500 (2012 est.)	$1,400 (2012 est.)
Population below poverty line	44.9% (2011 est.)	24.5% (2009 est.)

Source: CIA FactBook http://www.indexmundi.com/factbook/compare/rwanda.uganda

Table 1 Demographic and Background Characteristics of Sample by Countries (N=16880): RDHS 2010 and UDHS 2011

Individual Characteristics	Rwanda N = 9002 (%)	Uganda N = 7878 (%)
Sex of Child		
Female	4416 (49.1)	3934 (49.9)
Male	4586 (50.9)	3944 (50.1)
Age of Child in months (N=6347)		
<12	858 (20.8)	543 (24.5)
12-23	722 (17.5)	451 (20.4)
24-35	885 (21.4)	417 (18.8)
36-47	838 (20.3)	421 (17.3)
48-49	830 (20.1)	382 (17.3)
Received all 8 vaccines[1] (N=15776)		
Yes	6431 (75.9)	3107 (42.5)
No	2040 (24.1)	4198 (57.5)
Parents' Age (N=14851)		
<20	52 (.6)	75 (1.1)
20-34	4627 (57.7)	3700 (54.1)
35-49	3334 (41.6)	3036 (44.8)
Parents' Education (N=16320)		
No Education	1171 (13.4)	797 (10.5)
Primary	6373 (73.1)	3979 (52.3)
Secondary & Higher	1173 (13.5)	2827 (37.2)
Wealth Index		
Poorest	2082 (23.1)	2030 (25.8)
Poorer	1904 (21.2)	1550 (19.7)
Middle	1767 (19.6)	1405 (17.8)
Richer	1649 (18.3)	1230 (15.6)
Richest	1600 (17.8)	1663 (21.1)
Residence		
Urban	1225 (13.6)	1682 (21.4)
Rural	7777 (86.4)	6196 (78.6)
Insurance Coverage (N = 9082)		
Insured	6594 (73.3)	48 (58.5)
Uninsured	2406 (26.7)	34 (41.5)

[1]BCG, measles, and three doses of each pentavalent and polio vaccine

Table 2 Chi-square analysis assessing the proportion of children that received full immunization (all 8 EPI vaccines): RDHS 2010 and UDHS 2011

Individual Characteristics	Rwanda			Uganda		
	No	Yes	X^2 (*p-value*)	No	Yes	X^2 (*p-value*)
Sex of Child			**4.950 (.026)**			**.083 (.774)**
Female	1048 (51.4)	3122 (48.5)		2107 (50.2)	1570 (50.5)	
Male	992 (48.6)	3309 (51.5)		2091 (49.8)	1537 (49.5)	
Age of Child in months			**1576.782 (<. 001)**			**290.363 (<. 001)**
<12	650 (65)	207 (6.6)		483 (37.8)	58 (6.3)	
12-23	65 (6.5)	656 (21)		229 (17.9)	220 (23.8)	
24-35	84 (8.4)	801 (25.6)		194 (15.2)	221 (23.9)	
36-47	82 (8.2)	753 (24.1)		195 (15.3)	222 (24)	
48-49	119 (11.9)	708 (22.7)		177 (13.8)	204 (22.1)	
Parents' Age			**48.977 (<. 001)**			**27.614 (<. 001)**
<20	29 (1.6)	21 (.4)		52 (1.4)	12 (.4)	
20-34	1106 (61.3)	3245 (56.5)		2030 (55.9)	1414 (52)	
35-49	670 (37.1)	2473 (43.1)		1550 (42.7)	1292 (47.5)	
Parents' Education			**4.603 (.100)**			**36.537 (<. 001)**
No Education	265 (13.5)	821 (13.1)		473 (11.7)	260 (8.7)	
Primary	1458 (74.3)	4543 (72.8)		2163 (53.5)	1514 (50.4)	
Secondary & Higher	238 (12.1)	876 (14)		1404 (34.8)	1231 (41)	
Wealth Index			**38.278 (<. 001)**			**33.009 (<. 001)**
Poorest	518 (25.4)	1420 (22.1)		1161 (27.7)	719 (23.1)	
Poorer	495 (24.3)	1297 (20.2)		836 (19.9)	586 (18.9)	
Middle	386 (18.9)	1277 (19.9)		748 (17.8)	552 (17.8)	
Richer	321 (15.7)	1228 (19.1)		636 (15.2)	509 (16.4)	
Richest	320 (15.7)	1209 (18.8)		817 (19.5)	741 (23.8)	
Residence			**12.773 (<. 001)**			**28.176 (<. 001)**
Urban	2311 (11.3)	929 (14.4)		809 (19.3)	759 (24.4)	
Rural	1809 (88.7)	5502 (85.6)		3389 (80.7)	2348 (75.6)	

Table 3 Adjusted odds ratios and 99% confidence interval for stepwise logistic regression: RDHS 2010 and UDHS 2011

Individual Characteristics	Rwanda AOR (99% CI)	Rwanda *P*	Uganda AOR (99% CI)	Uganda *P*
Sex of Child				
Female	.738 (.579 – .940)	.001	.858 (.673 – 1.093)	.103
Male	*Ref*		*Ref*	
Age of Child in months				
<12	*Ref*		*Ref*	
12-23	34.853 (23.331 – 52.064)	<. 001	8.305 (5.361 – 12.864)	.565
24-35	32.938 (22.756 – 47.675)	<. 001	9.986 (6.404 – 15.571)	.352
36-47	30.955 (21.286 – 45.014)	<. 001	9.799 (6.280 – 15.290)	.096
48-49	20.251 (14.396 – 28.487)	<. 001	9.880 (6.287 – 15.524)	.484
Parents' Age				
<20	*Ref*		*Ref*	
20-34	3.257 (1.116 – 9.503)	.005	1.898 (.523 – 6.884)	.200
35-49	2.684 (.913 – 7.892)	.018	2.076 (.570 – 7.561)	.145
Parents' Education				
No Education	*Ref*		*Ref*	
Primary	1.226 (.785 – 1.915)	.238	1.408 (.842 – 2.356)	.087
Secondary & Higher	1.624 (.918 – 2.874)	.029	1.787 (1.027 – 3.109)	.007
Wealth Index				
Poorest	*Ref*		*Ref*	
Poorer	1.121 (.787 – 1.595)	.406	.919 (.629 – 1.343)	.565
Middle	1.175 (.814 – 1.697)	.258	1.150 (.781 – 1.695)	.352
Richer	1.472 (1.002 – 2.164)	.010	1.302 (.865 – 1.959)	.096
Richest	1.243 (.779 – 1.985)	.230	.877 (.542 – 1.420)	.484
Residence				
Urban	*Ref*		*Ref*	
Rural	.644 (.410 – 1.013)	.012	.679 (.460 – 1.002)	.010
Nagelkerke R^2	.447		.207	

Table 4 MCV coverage rate of fully immunized children: RDHS 2010 and UDHS 2011

	Received all 8 EPI vaccines	
Received Measles vaccine	Rwanda N = 9002 (%)	Uganda N = 7878 (%)
Yes	6956 (82.1)	5017 (68.4)