What are the barriers and facilitators of on-time measles vaccination in Uganda?

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DEDICATION

This work is dedicated to my grandparents: John and Dorothy Griffith, Edith Walker, and John Williams.

ABSTRACT

Measles is a highly contagious, vaccine-preventable disease, and on-time vaccination is essential for achieving the full benefit of measles-containing vaccines. In recent years, Uganda has experienced measles outbreaks in both urban and rural areas. Investigating the prevalence of and risk factors associated with delayed measles vaccination is an important step toward addressing vaccination barriers and improving on-time measles vaccination coverage. This dissertation characterizes factors associated with on-time measles vaccination in Uganda, defined as vaccination at nine months of age.

For manuscript 1 and 2, we conducted a population-based, door-to-door survey of 999 mothers living in Kampala, Uganda. The survey included questions on mothers' use of their child's vaccination document, experience seeking vaccination for their child, and the child's date of measles vaccination.

In manuscript 1, we characterized mothers' retention and use of their child's vaccination document and evaluated the association between use of the document and achieving on-time measles vaccination for their child.

In manuscript 2, we described and characterized potential transportation-related barriers to vaccination and evaluated the association between these barriers and mothers' ability to achieve on-time measles vaccination for their child.

Lastly, for manuscript 3, we used data from the 2016 Uganda Demographic and Health Survey to assess the relationship between mothers' perceived barriers to healthcare and their ability to achieve on-time measles vaccination for their child. This was evaluated overall, and by urban/rural status.

Demographic factors of the mother and child and certain barriers to healthcare were associated with failure to achieve on-time measles vaccination. Overall, our findings contribute to the understanding of the specific factors that influence on-time measles vaccination in this setting. This informs the design of interventions to improve the timing of childhood vaccinations in the future.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ..... *i*

DEDICATION ..... *ii*

ABSTRACT ..... *iii*

LIST OF TABLES ..... *vii*

LIST OF FIGURES ..... *viii*

LIST OF ABBREVIATIONS ..... *ix*

CHAPTER 1. OVERVIEW OF Measles and measles vaccine timing *1*

Background 1

Description and epidemiology of measles disease 2

Measles Vaccine 4

Measures of vaccine coverage 7

Global progress towards measles elimination 8

Applications in the Ugandan context 8

Measles vaccine schedule in Uganda 10

Barriers to vaccination and on-time vaccination 12

Facilitators of vaccination and on-time vaccination 15

Significance of research questions 15

Specific Aims *17*

Manuscript 1: 17

Manuscript 2: 17

Manuscript 3: 17

Chapter 2 (Manuscript 1): Is there an association between mothers' use of their child's vaccination documentation and children's on-time measles vaccination in Uganda? 19

Introduction 19
Objectives 22
Methods 23
Results 30
Discussion 45
Conclusion 47
Chapter 3 (Manuscript 2): Is there an association between barriers to transportation and on-time measles vaccination in Uganda? *48*
Introduction 48
Objectives 50
Materials and Methods 51
Results 59
Discussion 73
Conclusion 75
Chapter 4 (Manuscript 3): Is there an association between mothers' perceived barriers to healthcare and children's on-time measles vaccination in Uganda in urban and rural settings? *76*
Introduction 76
Aims and objectives 77
Methods 78
Results 81
Discussion 92
Conclusion 93
References *94*
Appendicies *98*

Appendix 1: SAVE Study Survey..*98*

LIST OF TABLES

Table 2.1a Table 2.1a: Demographic characteristics of the study sample (mothers) ……..31
Table 2.1b Table 2.1b: Demographic characteristics of the children of the study sample ……..33
Table 2.2 Table 2.2: Select healthcare seeking characteristics of study sample..35
Table 2.3 Distribution of child's age in months at time of measles vaccination 36
Table 2.4 Factors associated with on-time measles vaccination …….37
Table 2.5 Measure of whether the participants correctly identified components of their child's health card ……...40
Table 2.6 Factors associated with ownership of child's vaccination document..41
Table 2.7 Factors associated with identification of information on the child's vaccine document……..43
Table 3.1a Demographic characteristics of the study sample (Mothers) ……..60
Table 3.1b Demographic characteristics of the children of the study sample …...62
Table 3.2a Distribution of regular forms of transportation ……...66
Table 3.2b Distribution of preferred forms of transportation ……66
Table 3.3 Select transportation-seeking barriers of the study sample ……68
Table 3.4 Vaccination status of all children in the sample ……..69
Table 3.5 Child's age in months at measles vaccination (MCV1) ……..69
Table 3.6 Factors associated with achieving on-time measles vaccination ……71
Table 3.7 Factors associated with achieving on-time measles vaccination, among participants with information on distance to healthcare facility ……73
Table 4.1a Demographic characteristics of the sample (mothers) ……84
Table 4.1b Characteristics of the sample (children) ……..86
Table 4.1c Characteristics of the sample (household) ……..87
Table 4.2 Proportion vaccinated for measles ……..87
Table 4.3 Perceived barriers to care ……88
Table 4.4 On time and delayed measles vaccination ……...88
Table 4.5 Model output of multivariable logistic regression with an outcome of MCV1 vaccination not on time vs. on time ……91

LIST OF FIGURES

Figure 1.1 Measles cases in Uganda……9

Figure 1.2 Uganda Ministry of Health Card……..11

Figure 2.1: Tested components of the Uganda Child Health Card ……39

Figure 3.1. Distribution of total travel time to clinic among participants in minutes ……..64

Figure 3.2: Comparison of regular form of transportation and preferred form of transportation among survey participants ……...66

Figure 3.3: Distribution of age of MCV1 vaccination in months ……..69

Figure 4.1 Overview of study sample ……...79

Figure 4.2: Age in days at measles vaccination (MCV1) ……..88

LIST OF ABBREVIATIONS

LMICs: Low- and Middle-Income Countries

WHO: World health Organization

MMA: Measles Maternal Antibodies

IgG: Immunoglobulin G

IgA: Immunoglobulin A

MCV1, MCV2: Measles-Containing vaccine 1, 2

SIAs: Supplemental Immunization Campaigns

MMR(-V): Measles Mumps Rubella (Varicella)

WHO AFRO: WHO African Region

HIV: Human Immunodeficiency Virus

WHA: World Health Assembly

UNEPI: Uganda National Expanded Program on Immunization

EPI: Expanded Programme on Immunization

SES: Socioeconomic Status

DHS: Demographic and Health Survey

AHR: Adjusted Hazard Ratio

IQR: Interquartile Range

UNMHCP: National Minimum Health Care Package

HC: Health Centre

PCV(1-3): Pneumococcal Conjugate Vaccine(1-3)

DTwPHibHepB: Diphtheria, Tetanus, Pertussis, Hemophilus influenzae and Hepatitis B Vaccine

IPV: Inactivated Polio Vaccine

EA: Enumeration Area

SOMREC: Makerere School of Medicine Research and Ethics Committee

UNCST: Uganda National Council of Science and Technology

UTM: Universal Transverse Mercator

CHAPTER 1. OVERVIEW OF MEASLES AND MEASLES VACCINE TIMING

This dissertation explores the barriers and facilitators of on-time measles vaccination in Uganda. In manuscript 1 (chapter 2), we characterized mothers' retention and use of their child's vaccination document and evaluated the association between use of the document and achieving on-time measles vaccination for their child. In manuscript 2 (chapter 3), we described and characterized potential transportation-related barriers to vaccination and evaluated the association between these barriers and mothers' ability to achieve on-time measles vaccination for their child. For manuscript 3 (chapter 4), we used data from the 2016 Uganda Demographic and Health Survey to assess the relationship between mothers' perceived barriers to healthcare and their ability to achieve on-time measles vaccination for their child. This was evaluated overall, and by urban/rural status. This chapter describes the epidemiology of measles disease, the biological significance of the timing of measles vaccination, and the current state of measles vaccination in Uganda.

Background

Measles is a highly contagious, vaccine-preventable disease. Vaccination against measles virus is critical for preventing measles infection. The success of the vaccine in protecting a population depends on a certain proportion of individuals being vaccinated at all times, in order to maintain herd immunity. In addition, the vaccine will provide the most protection to both the individual and the population if it is received at the recommended time, which differs by epidemiologic setting. In recent years, Uganda has experienced measles outbreaks in both urban and rural areas (1-3), which have been attributed to a high proportion of susceptible individuals, due to both spatial heterogeneity in vaccine coverage and late and off-schedule vaccination.

In Uganda, measles vaccination is recommended at nine months of age and mothers primarily shoulder the responsibility of getting their child vaccinated for measles at that time. This dissertation explores multiple factors that make it easier and more difficult for mothers to get their children vaccinated for measles on time.

Description and epidemiology of measles disease

Measles is a highly contagious disease caused by measles virus; it was responsible for millions of deaths worldwide annually before the introduction of measles vaccine (4). Even with a safe and effective vaccine, it is an important cause of death among young children, globally, and it remains a more common disease in low- and middle-income countries (LMICs) (5). The annual global reported measles incidence in 2018 was 49 cases per 1 million people, and the disease was responsible for annual estimated 142,300 deaths. Although there have been marked improvements in the reduction of measles-associated mortality worldwide, the Sub-Saharan Africa region still accounts for the highest measles incidence per 1 million people and the greatest proportion of measles-related deaths, compared to any other World Health Organization (WHO) region (6). The measles virus is transmitted via droplets from the nose, mouth, or throat of infected persons. Initial symptoms, which usually appear 10 to 12 days after infection, include high fever, a runny nose, bloodshot eyes, and tiny white spots on the inside of the mouth. Several days later, a rash develops, starting on the face and upper neck and gradually spreading downwards. The most serious complications include blindness, encephalitis, severe diarrhea and related dehydration, and severe respiratory infections such as pneumonia. Severe measles is more likely among young, malnourished children, particularly those who are vitamin A deficient or have a weakened immune system (5). Furthermore, the measles virus is one of the most highly contagious, directly transmitted pathogens. Outbreaks can occur in populations where fewer than 10% of people are susceptible to infection, and high population immunity is required to disrupt transmission (5, 7). In densely populated, urban settings with low vaccination coverage, measles mainly affects infants and young children, as they are the group that is most likely to be unvaccinated and therefore susceptible to measles virus. As measles vaccine coverage increases and population density decreases, the average age of cases shifts towards older children, and as population immunity through vaccination increases, the age distribution of cases shifts to adults (4). In endemic settings, measles has a temporal pattern characterized by yearly, seasonal epidemics, which occur in late winter and early spring

in temperate climates. These yearly epidemics are superimposed on longer epidemic cycles of two to five years. These cycles are a result of the changes in the number of people at risk for disease, starting with the accumulation of susceptible people over successive birth cohorts and the subsequent decline in the number of susceptible people after an outbreak. Measles transmission dynamics may also be dependent on climate in some parts of the world(8).

Measles virus immunity

At birth and in the first months of life, infants depend on measles maternal antibodies (MMA) for protection against measles infection. These maternally inherited immunoglobulin G (IgG) and secretory immunoglobulin A (IgA) antibodies, which are the result of the mother's previous measles immunization or measles infection, are passed from mother to fetus trans-placentally in pregnancy and via breastmilk. This transfer of MMA provides temporary protection against infection with measles virus, but this source of passive immunity declines over the infant's first year of life, usually lasting until six to nine months of age. This decline is gradual, due to the half-life of the maternally acquired IgG antibodies, and it varies by individual. Therefore, the age at which infants first become susceptible to measles infection due to waning immunity varies, but it is typically between six to nine months of age (9).

This protection via MMA is essential in preventing measles infection and disease in the first months of life. While some studies have found that children born to women with vaccine-induced immunity become susceptible to infection with measles virus at a younger age than those born to mothers with immunity acquired from a measles virus infection (9-11), maternal immunity remains a critically important source of protection in these first months. This is when an infant's immune system is not fully developed to the point where it can reliably and independently produce protective antibodies against measles via immunization.

Given that vaccination coverage is below the 95% herd immunity (12) threshold for measles in Uganda and the risk of exposure is high, it is important to ensure high vaccine-induced immunity in children as soon as possible, after immunity begins to

wane. Therefore, the age at which the child receives their measles vaccine is important for maximizing the child and community's protection against disease (8, 13, 14). Thus, Uganda recommends one dose of a measles-containing vaccine (MCV) at 9 months of age (15).

Measles Vaccine

Description of measles vaccine

There is a safe and effective vaccine against measles, which has been in use since the 1960s. It is one of the most highly immunogenic vaccines available, and it has been responsible for preventing an estimated 35,160,721 measles cases since its introduction in 1963 in the United States alone (16). Worldwide, increased coverage with measles-containing vaccine (MCV) administered through routine immunization programs and supplemental immunization campaigns (SIAs) contributed to an 87% decrease in reported measles cases and an 84% reduction in estimated measles mortality during 2000-2016 (17).

If vaccination against measles occurs at too early an age, the presence of MMA will neutralize the live-attenuated vaccine virus before an immune response develops, preventing the child from developing long-term immunity to measles virus. If vaccination is given before the maturation of the child's immunes system, immunization will not adequately induce immunity (18). Therefore, the likelihood of a child developing protective antibody levels following measles vaccination depends on the presence of inhibitory MMA and the maturity of their immune system. Between 85% to 90% of children develop protective antibodies after receiving one dose of MCV at nine months of age (19).

The median MCV effectiveness following a single dose of MCV administered nine to eleven months of age is 84% (IQR 72%, 95%) (19). The immunological basis for providing a second dose of MCV is to immunize children who failed to develop a sufficiently protective immune response for the first dose. Programmatically, it is also

beneficial to include a second dose of MCV in the schedule for an added opportunity for children who miss their first vaccination to get caught up (19).

The MCV is administered in several different ways, including as a monovalent standalone measles vaccine or as one component of a combination vaccine with mumps, rubella, (MMR vaccine), or with varicella, as well (MMR-V) (18). All of these variations are all referred to as MCV, regardless of the other contents of the vaccine or dose number (20).

Measles vaccine schedule

Vaccination against measles is recommended for all susceptible children and adults by WHO. The timing of measles vaccination is dependent upon the measles eliminations status of the geographical region a person is living in or traveling to (5). The recommendation for countries with endemic (ongoing) measles transmission is for the first measles-containing vaccine (MCV1) to be given at nine months of age and the second (MCV2) to be given between 15 to 18 months. Endemic measles transmission is defined as the existence of continuous transmission of indigenous or imported measles virus that persists for more than 12 months in any defined geographical area (21). The minimum interval between MCV1 and MCV2 is four weeks. While these are the recommended ages for vaccination, WHO acknowledges the importance of providing MCV1 and MCV2 for children who are identified as being behind schedule or unvaccinated for measles whenever they may come into contact with health services. Reaching all children with two doses of measles vaccine (MCV1 and MCV2) is the standard set by WHO for all national immunization programs, because of the increased effectiveness MCV with a second dose, which allows an additional opportunity for the child to mount an immune response. While two does are the standard set by WHO, some countries continue to administer only one dose of MCV at nine months of age, due to the logistical barriers to vaccinating the under-five population a second time.

In an analysis of measles cases reported to WHO from 2013-2017, the AFRO region had the highest proportion of cases (53% of all cases, 66% of 178,707 cases with known vaccination status) that were considered programmatically preventable, meaning that they

should have not occurred had individuals received age-appropriate vaccination according to current programmatic recommendations. Globally during that time, 63% of measles cases with vaccine status information were programmatically preventable (22). While it is challenging to identify the exact reasons for why such a large number of measles infections are programmatically preventable, it is clear to see how off- schedule or late measles vaccination could contribute to the incidence of measles infection among those who are not fully protected.

Importance of timely vaccination

The timing of measles vaccine doses is important for ensuring that infants and young children are protected during the critical period during which maternal immunity is waning, risk of disease exposure is high, and disease pathology can be most severe (14, 23-25). Delayed immunization is a strong risk factor for disease, and timely, on-schedule vaccination is essential for achieving the full benefit of the MCV (24, 26).

MMA is mostly IgG, actively transported through the placenta from mother to fetus and secretory IgA, acquired through breastmilk in the first months of life. Certain disease and comorbidities, such as premature birth, maternal HIV infection and maternal malaria infection, have a negative effect on the transfer of MMA and may put infants at increased risk of measles infection early in life.

The importance of the levels of MMA in an individual is twofold. First, the waning of MMA over time increases an individual's risk of measles infection. Second, the decay of MMA is inversely proportional to the potential immunogenicity of the measles vaccine, so it's presence can prevent a measles immunization from conferring protection (11). A systematic review of the rate of waning of maternal antibody in elimination vs non-elimination settings over time found that there is a lot of heterogeneity in seroprevalence within any one jurisdiction, which makes it challenging to estimate the ideal age at which measles vaccination should occur (10).

Measures of vaccine coverage

For many national immunization programs, there are challenges and limitations to estimating vaccination coverage from routinely collected administrative data (27, 28). The standard measure of vaccination coverage is the percentage of children who have received the required number of vaccine doses by a certain age (up to date) among all children eligible for the vaccine age 12-23 months. However, this estimate does not account for the timing of the vaccination. As noted above, the timing of measles vaccination has important implications for ensuring that infants develop vaccine-induced immunity as soon as maternal immunity wanes to prevent gaps in protection. While vaccination coverage as a total number of children with up-to-date vaccination is a useful metric for knowing the number of people vaccinated in a given area, there can be substantial variation in the timing of vaccine administration over that age group.
The WHO definition of on-time measles vaccination for non-elimination settings is receiving MCV1 between 38 weeks (~8.7 months) to 12 months of age, with any vaccination falling outside of that interval as early/late (19, 29). Vaccination coverage does not imply on-time vaccination (24, 30), and this makes it difficult to estimate the number of children who are protected from disease. Up to date vaccination by a given age may be a poor estimate of the vaccinated fraction of the population, and delays in vaccination might explain the persistence and recurrence of certain infections, such as measles, which can spread effectively even with a relatively low proportion of susceptibles in the population (14, 23). Studies of vaccine registries in similar settings have concluded that standard coverage surveys in 12 to 23-month-old children overestimate protection by not considering timeliness of vaccines. Since delayed vaccination can be so common, a standard measure of up to date coverage can overestimate population immunity (31).

Global progress towards measles elimination

Definition of measles elimination

Measles elimination is defined as the absence of endemic measles virus transmission in a region or other defined geographic area for ≥12 months, in the presence of a high-quality, well-performing surveillance system. Measles virus has several features that make it a good candidate for elimination, including the presence of a safe and effective vaccine, a not-prolonged contagiousness post-infection period, and the absence of an animal reservoir for the virus (4). However, both the period of infectiousness before a rash appears and the persistence of measles virus in airborne droplets form an infected person make transmission hard to control and elimination challenging (17).

In 2010, the World Health Assembly (WHA) set three milestones for measles control by 2015: 1) increase routine coverage for the first done of measles-containing vaccine (MCV1) for children less than one year of age to ≥90% at the national level and ≥80% in every district; 2) reduce global annual measles incidence to <5 cases per million population; and 3) reduce global measles mortality by 95% from the 2000 estimate. In 2012, the WHA endorsed the Global Vaccine Action Plan with the specific objectives of eliminating measles in four WHO regions by 2015 and five regions by 2020. In addition to these elimination goals, countries in all six WHO regions have adopted goals for measles elimination by or before 2020 (17). The success of measles elimination strategies is highly dependent on the ability to implement them fully in practice. Certain barriers to elimination exist, including groups of individuals with low vaccination uptake either by choice or due to other reasons (7). The recently released WHO Measles Outbreaks Strategic Response Plan for 2021-2023 emphasizes the investment in measles vaccination for the control and reduction of disease (32).

Applications in the Ugandan context

Incidence of measles in Uganda

Infection with measles virus remains a serious health concern in Uganda. There were an estimated 2,614 cases in 2018 and 895 cases in 2019, with the majority of those cases

occurring in children aged 1-4 years (Figure 1) (33). Measles surveillance in Uganda is part of the National Integrated Disease Surveillance and Response System, which requires immediate notification whenever a suspected measles case is identified (34, 35). When a measles case is suspected, a case investigation form is completed and blood samples are collected and submitted to the Uganda Virus Research Institute (UVRI) for testing (34).

Children in Uganda are at an increased risk for serious complications measles disease if unvaccinated, especially if they are malnourished or vitamin A deficient (36). Over the course of the last few years, Uganda has experienced measles outbreaks in both rural and urban areas (1-3).

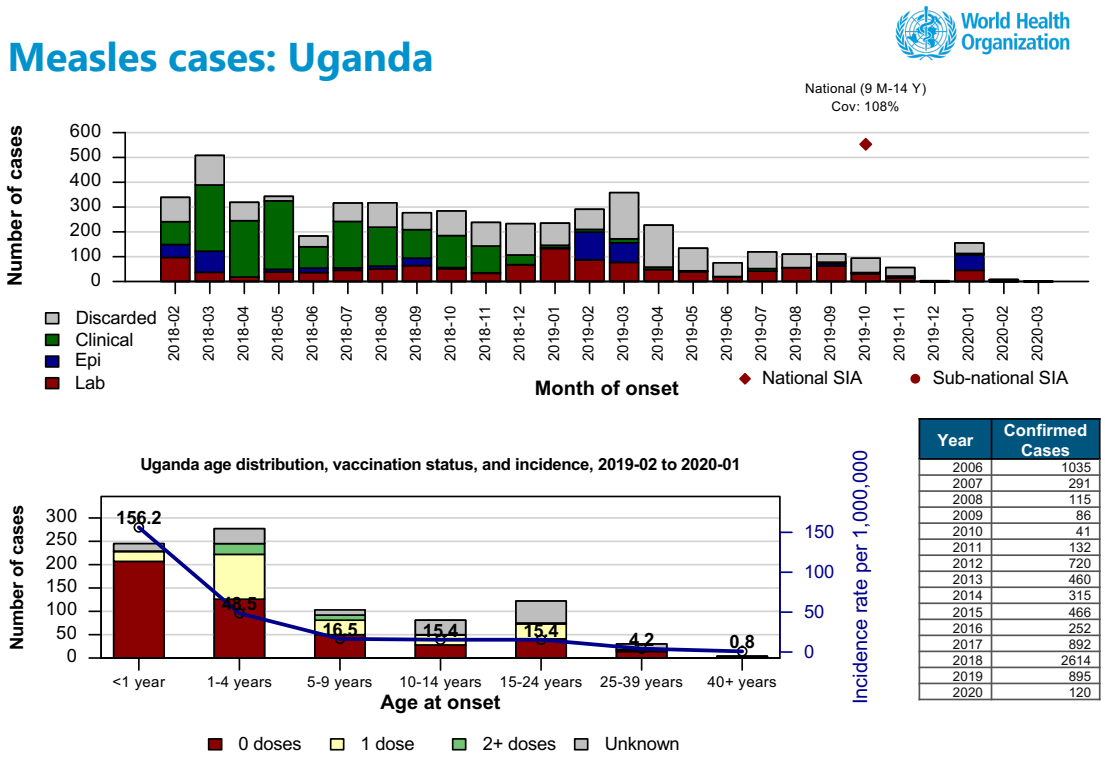

Figure 1.1: The WHO estimated number of measles cases in Uganda by age and month of onset as of March 2020. The majority of cases are in children younger than 5 years of as, the majority of which are unvaccinated. A very small proportion of children receive two doses of MCV.(33)

Measles vaccine schedule in Uganda

Uganda National Expanded Program on Immunisation (UNEPI)

The Uganda National Expanded program on immunization (UNEPI) is a national program that is designed primarily to ensure that infant and women of childbearing age have access to immunization services. It is a priority intervention within Uganda's minimum health care package, which is aligned with Uganda Ministry of Health's vision and goals. The program offers routine immunization services via health facilities and outreach programs, supplemental immunization activities (SIAs), accelerated routine immunization, disease surveillance, and outbreak response. The full list of disease/vaccines addressed by the program can be found in Appendix A. All vaccines provided by UNEPI are offered free of charge (15).

Current measles vaccine administration methods and schedule in Uganda

Uganda began to implement routine measles vaccination in the early 1980's through static clinics at health facilities and outreach posts in the community throughout the country. Supplemental measles mass vaccination (SIAs) has been provided routinely every three years since 2003 (34, 37). Routine immunization services are administered by trained health workers at designated health facilities and selected community outreach sites. Separate from routine immunization, SIAs, which are mass-vaccination campaigns targeting a specific age group or disease, are organized and conducted periodically to interrupt disease transmission and spread by boosting population immunity. SIAs may occur for vitamin A supplementation or for vaccination against measles, meningitis A, polio, rubella, tetanus, and/or yellow fever. They can occur as a traveling campaign, a mop-up activity, or as part of the twice-a-year child health day's activities.
Figure 1.2 is an example of the current Uganda child vaccination schedule as it appears in the Ministry of Health issued Uganda Child Health Card. As of the time of this dissertation, the Uganda Ministry of health only includes one dose of MCV given at nine months of age in its routine schedule.

IMMUNISATION

Immunisation protects your child against serious diseases.
Follow and complete the immunisation schedule below:

	VACCINE	PROTECTS AGAINST	HOW GIVEN	DATE GIVEN
AT BIRTH	BCG	Tuberculosis	Right Upper Arm	
	Polio 0	Polio	Mouth Drops	
At 6 Weeks	Polio 1	Polio	Mouth Drops	
	DPT-HebB+Hib1	Diphtheria/Tetanus/Whooping Cough /Hepatitis B/Haemophilus Influenzae type B	Left Upper Thigh	
At 10 Weeks	Polio 2	Polio	Mouth Drops	
	DPT-HebB+Hib 2	Diphtheria/Tetanus/Whooping Cough/ Hepatitis B/Haemophilus Influenzae type B	Left Upper Thigh	
At 14 Weeks	Polio 3	Polio	Mouth Drops	
	DPT-HebB+Hib 3	Diphtheria/Tetanus/Whooping Cough /Hepatitis B/Haemophilus Influenzae type B	Left Upper Thigh	
9 Months	Measles	Measles	Left Upper Arm	

Figure 1.2: Uganda Ministry of Health Child Health vaccination schedule, extracted from the Uganda Ministry of Health Child Health Card 2018, displaying the recommended age of children for each vaccine, in addition to the name of the vaccine and how the vaccine will be given. The table also has a space for the healthcare worker who administers the vaccine to record the date at which it was given. The current schedule only includes one dose of MCV given at nine months of age.

Measles vaccine coverage in Uganda

Many estimates of vaccination coverage are derived from surveys, which provide limited generalizability in the estimation of vaccination coverage at the regional or national level. The estimated coverage level in a given year for the number of infant vaccines recommended in Uganda is highly variable. One household survey of 812 children conducted in 2012 estimated that 80.6% of children received a measles vaccine, but only 67.5% (95%CI 60.5%,73.8%) received it on time (between 38 weeks and 12 months) (38). Estimating the on-time measles vaccination uptake is important beyond estimating coverage, as on-time measles vaccination in Uganda is suboptimal and needs to be improved. While vaccine uptake is high in Uganda, there is substantial variability in the timeliness of vaccinations within the recommended age ranges, which can lead to a great number of susceptible individuals during periods of vulnerability and outbreaks (39).

This is observed in both urban and rural areas, where there may be a record of high coverage among children, but it is compromised by the high occurrence of late vaccination (24). Heterogeneity in measles vaccination coverage, which is the result of late vaccination, is a widespread issue in this region of Africa (40), and Uganda has been identified as a region where high densities of susceptible, unvaccinated children live within low-vaccination clusters (41).

Definition of vaccine timeliness

Although the importance of receiving measles vaccination on time is not disputed, the definition of vaccine timeliness for MCV varies widely by application and setting. Several studies that investigate timing of vaccination in similar settings used a working definition for timeliness based on the WHO recommendations of a vaccination window 38 weeks (~8.7 months) to 12 months, with any vaccination falling outside of that interval as early/late (29, 39, 42). In comparison, Gibson et al. defines timeliness as within two weeks of the Expanded Programme in Immunizations (EPI) scheduled date (43). The Uganda Demographic and Health Survey simply states that measles vaccinations should be given "at or soon after" nine months of age. Other studies have classified anything before the prescribed vaccination date as early and anything beyond three months from the vaccination date as late (25). Our analyses will reflect the recommendation outlined by WHO for measles vaccination (44): a vaccination window 38 weeks-12 months, with any vaccination falling outside of that interval as early/late.

Barriers to vaccination and on-time vaccination

Previous research on the factors associated with timely vaccination has been conducted in other settings, using different measures for timeliness and different types of data sources. While factors driving the lack of timeliness of infant vaccination vary from setting to setting, evidence suggests that there are several characteristics commonly associated with late vaccination in LMICs.

Socioeconomic status (SES)

Wealth is found to be a significant predictor of vaccination timing, with a longer expected time to vaccination for families in lower wealth quintiles, compared to higher wealth quintiles in studies in Uganda (38), Ghana (45), Ethiopia (46), and an analysis of 31 countries in sub Saharan Africa (47).

Mother's education level

Mother's education level is found to be a predictor of vaccination timing in multiple settings, with lower educational status associated with delayed vaccination, when compared to higher educational attainment, in studies in Senegal (which used Demographic and Health Survey (DHS) data) (48) and in Ghana (45).

Child's birth order and total number of siblings

Birth order also influenced timely vaccination in many studies, in which being the first child was predictive of on-time vaccination and having siblings (or being the second child or later) was predictive of delayed vaccination (45, 48). This phenomenon could be due to the logistical barriers of seeking vaccination for a child when there are other children in the home. Similarly, another study found that vaccinations that were not received during the recommended timeframe were associated with a higher number of children per woman (AHR 1.84, 95% CI: 1.29, 2.64) (38, 49).

Maternal age

One study found an association with maternal age and timely vaccination in which mothers over 30 were more likely to be late vaccinating their child for measles, pentavalent1 and pentavalent3 when compared to mothers 15 to 29 yeas of age (50). It is possible that these two factors, maternal age and birth order, are correlated, in that it is expected that children with later birth orders are more likely to have older mothers.

Urban settings

A qualitative analysis by Babirye et al. that was conducted in follow up to the household survey administered in 2012 indicated that living in an urban or peri urban area does not necessarily confer access to health services that enable on-time vaccination. A study in Burkina Faso that compared vaccination timing in children in urban and rural settings found a similar trend, in which rural children had a higher odds than the urban children to be timely vaccinated, especially for pentavalent3 and measles (51). Other studies in similar settings, including The Gambia (52) and Senegal (48), found that the delayed receipt of most vaccines was associated with living in urban areas. Although, there are other studies that found that living in rural areas was associated with less timely vaccination (45-47).

Knowledge of vaccination schedule

Measles vaccine in particular is likely to be delayed in part because it's a standalone vaccine within a vaccine schedule that does not line up with other times when a mother might initiates seeking medical care for their child (30, 53). This could reflect a lack of awareness of the vaccination schedule, without other healthcare needs encouraging the mother to go to a health facility. Child health cards are one way that mothers may be prompted to remember their child's vaccination date, but these documents are usually received at the time of birth at a facility. One study found that vaccinations that were not received during the recommended timeframe were associated with non-delivery at health facilities (AHR 1.58, 95% CI: 1.02, 2.46), which could be the result of mothers not having a child health card (38).

Attitudes towards vaccination

There is limited research about how vaccine impressions or experiences may impact a mother's decision to vaccinate her child in this context. One qualitative study of mothers living in a rural district of Uganda reported that mothers reported both good views on the healthcare system, but they also reported knowing of or hearing form religious leaders and community members who expressed anti-vaccine views (54). Other studies in urban

Ugandan settings have found that mother's decision making power within the home, the supportiveness of a male partner, time and schedule constraints, and suspicion against immunization influence whether children get vaccinated for measles (55). More work needs to be done to understand how these influences are weighed against each other towards decision making for vaccination and how it impacts the likelihood of being vaccinated on time.

Facilitators of vaccination and on-time vaccination

In a large systematic review of determinants of effective vaccine coverage in low- and middle-income countries, there were several clear themes in the types of factors that determined effective vaccine uptake and therefore enable vaccination. The main themes of determinants of vaccine coverage were facility readiness, decision to vaccinate, child eligibility, and mother's ability. The main themes of determinants of vaccine effectiveness were vaccine viability and host factors.

The principle determinants of vaccine utilization were intent to vaccinate, which is described as the demand for vaccine on the part of the mother that would result in vaccination in the absence other barriers; facility readiness, which is described as supply by the health system of vaccine services to adequately meet demand; and community access, which is described as the ability or inability to successfully carry on the transaction of vaccine utilization, including barriers and facilitators between intent and readiness. Each of these principal determinants is influenced by contributing factors, such as attitudes, norms, and perceptions (56).

Significance of research questions

Determining whether vaccines are administered on time is particularly relevant to protection against specific diseases, including measles, because the success of the vaccine in a population depends on a certain proportion of individuals being vaccinated at all times, in order to achieve and sustain herd immunity. In recent years, Uganda has experienced measles outbreaks in both urban and rural areas (1-3), which have been

attributed to a high proportion of susceptible individuals caused by both spatial heterogeneity in vaccine coverage and late and off-schedule vaccination.

Even with the marked increase in measles vaccine coverage in the region, outbreaks of measles continue to occur, indicating that continued efforts to understand the complex processes that allow timely vaccination are needed. Here, we focus on timeliness of measles vaccination because of its important role in preventing measles infection by ensuring that children are vaccinated at the ideal time to optimize protection against the disease.

This body of work investigates several intertwined elements that influence timely infant measles vaccination: barriers to accessing vaccines, knowledge of the measles vaccination schedule and the child vaccination documentation, and differences in urban and rural settings. In order to investigate these elements, we will analyze two different data sources: the first is a door-to-door survey of mothers of young children living in high density, low income areas of Kampala, Uganda to identify and quantify the various barriers and facilitators of timely vaccination and the second is a nationally-representative Ugandan household survey that provides data for a wide range of monitoring and impact evaluation indicators on the areas of population health and nutrition, with a focus on women of childbearing age and their children.

SPECIFIC AIMS

Manuscript 1:

Aim 1: Assess whether a mother's ability to identify key pieces of information on her child's vaccination documentation is associated with achieving on-time measles vaccination, by quantifying mother's abilities to use the vaccination document and comparing it to the timing on their measles vaccination.

Aim 2: Assess which factors among mothers are associated with retention of their child's vaccination document by comparing those who do and do not have their document available at the time of the survey.

Aim 3: Assess which factors are associated with mother's ability to identify key pieces of information on her child's vaccination documentation, by quantifying the number of key pieces of information each participant can identify and comparing those who can and cannot identify the information.

Manuscript 2:

Aim 1: Describe the prevalence and context of transportation barriers among mothers when they seek a vaccine for their child, including the availability of transportation, the costs associated with transportation, and how much time it takes for them to travel to a clinic. This will be done by quantifying he number of participants who report experiencing each barrier.

Aim 2: Assess the association between transportation barriers and achieving on-time measles vaccination by comparing the prevalence of barriers among those who do and do not achieve on-time measles vaccination.

Manuscript 3:

Aim 1: Assess whether perceived barriers to care are associated with achieving on-time measles vaccination, compared to delayed measles vaccination, among children in Uganda, by comparing the frequency of barriers identified by mothers of children

vaccinated in the ninth month of age (on-time) to children who receive vaccination delayed.

CHAPTER 2 (MANUSCRIPT 1): IS THERE AN ASSOCIATION BETWEEN MOTHERS' USE OF THEIR CHILD'S VACCINATION DOCUMENTATION AND CHILDREN'S ON-TIME MEASLES VACCINATION IN UGANDA?

Introduction

Measles is a highly contagious, vaccine-preventable, viral disease. Vaccination against measles virus is critical for preventing measles infection. The success of the measles vaccine (MCV) in protecting a population depends on maintaining a high proportion of immune individuals at all times, either via vaccination or prior infection. It is estimated that 95% of individuals must be immune to measles in order to reach the herd immunity threshold and prevent outbreaks. In Uganda, measles vaccination is recommended as one dose at nine months of age (MCV1); an estimated 87% of children have received a measles vaccine by the time they are 12-23 months old, based on 2019 estimates drawn from WHO and UNICEF (15, 57, 58). Yet, in recent years, Uganda has reported measles outbreaks in both urban and rural settings (1-3). The occurrence of these outbreaks, despite relatively high overall vaccination coverage, is attributed to a high proportion of susceptible individuals clustered within geographical areas, due to heterogeneity in vaccination coverage (8, 58, 59).

Measles vaccination will induce the highest degree of protection to both the individual, and contribute to population-level immunity, if it is administered at the recommended ages, which varies by epidemiologic setting and other logistical constraints. The aim of vaccination is to induce immunity as quickly as possible after maternal antibody levels decline, to limit the period of time during which an infant may be susceptible to infection. An infant's risk of infection depends upon multiple factors, including the level of maternal antibodies (measles IgG and secretory IgA) acquired transplacentally during gestation and via mother's breastmilk after birth, which reach non-protective levels around six to nine months of age, on average. Their risk also depends on their exposure to infectious individuals, which itself is determined by the measles vaccine coverage among contacts (5, 18).

Given that vaccination coverage is below the 95% herd immunity (12) threshold for measles in Uganda and the risk of exposure is high, it is important to ensure high vaccine-induced immunity in children as soon as possible, after immunity begins to wane. Therefore, the age at which the child receives their measles vaccine is important for maximizing the child and community's protection against disease (8, 13, 14). Thus, Uganda recommends one dose of a measles-containing vaccine (MCV) at 9 months of age (15).

Delayed immunization is a strong risk factor for disease, because it leads to children having little to no immune protection against infection after the waning of maternal antibodies. Timely, on-schedule vaccination is essential for achieving the full benefit of measles-containing vaccines (MCV) (24, 26). An analysis of the timing of measles vaccine in Uganda found that the median delay in the administration of MCV1 was 2.7 weeks, but with and interquartile range (IQR) of 9.6 weeks, indicating a wide spread in the number of weeks delayed (29). Late vaccination is a problem in Uganda. Despite a steady improvement in Uganda's measles vaccination coverage from 70% (2008) to 87% (2019), outbreaks of measles remain common (20, 54, 60). The degree to which delayed vaccination may contribute to epidemiologic trends in measles-endemic areas is not known. Investigating the prevalence of delayed measles vaccination, the timing of the delay, and elucidating factors associated with risk of delayed measles vaccination is an important first step toward addressing barriers to vaccination and improving on-time measles vaccination coverage.

In Uganda, routine immunization services for infants are available in both private and public health sectors in Uganda, with the majority of Ugandans accessing these services through the public health sector. Public health services are provided through the basic National Minimum Health Care Package (UNMHCP) at all levels of Uganda's decentralized health system, and immunization services are available free of charge at all health centers (HC) IIs, IIIs, IVs (health sub-district), general hospitals, regional referral hospitals, and the national referral hospitals, with the exception of HC1s (Village Health Teams) (61).

Infant vaccination is available at government and private hospitals and clinics at specific times throughout the week year-round. Mothers are primarily responsible for ensuring that their children are vaccinated for measles at the recommended time (15, 55, 62) and must bring their child to the clinic along with the child's Uganda Ministry of Health Vaccination Card or other immunization documentation, typically issued at birth if the child was born in hospital, or other documentation and wait until the child can receive the vaccine. Given the recommended infant vaccination schedule, five and a half months will elapse between the administration of the 14-week vaccines [pneumococcal conjugate vaccine (PCV), diphtheria and tetanus and pertussis and Hemophilus influenzae and hepatitis B vaccine (DTwPHibHepB), and inactivated polio vaccine (IPV)] and the recommended MCV1 vaccine dose at nine months. At the 14-week visit, the date of the upcoming MCV1 is written on the card by the healthcare worker overseeing the child's vaccines at the time, and this will likely be the only reminder that the mother receives that their child is due for measles vaccine. In this situation, the child's vaccination documentation serves as a guide to let mothers know when their child is due for their next vaccine (38, 63, 64). In addition, the MCV1 at nine months does not coincide with other routine health visits, which may further reduce the chance that mothers are prompted to take their child to a clinic at that time.

Vaccination cards are the only reminders about the timing of childhood vaccines. It is not known whether vaccination cards are an effective method for conveying this information and whether mothers use their child's vaccination cards for this purpose. Understanding if and how a mother locates this information is important for determining if a child's vaccination documentation is used for determining if a child is due for vaccination, or if this information comes from elsewhere.

In this study, we aimed to assess the relationship between retention of the child's vaccination documentation, a mothers' ability to identify information on their child's vaccination documentation, and whether the child received their measles vaccination on time. We conducted a cross-sectional, door-to-door survey among mothers of young children living in a high-density, low-income district of Kampala, Uganda, to: 1) estimate

the proportion of participants who had documentation of their child's measles vaccination and determine which factors were associated with retaining that documentation, 2) estimate the proportions of participants who were able to identify specific details on their child's vaccination document and determine which factors were associated with this ability, and 3) estimate the proportion of children who were vaccinated for measles on-time compared to those who were vaccinated late and determine which factors were associated with on-time vaccination.

Objectives

1a. Calculate the proportion of children vaccinated on time (defined as received at least one measles vaccine in the ninth month of age) and vaccinated delayed (defined as received at least one measles vaccine after nine months of age) among all children surveyed, overall.
Hypothesis: A greater proportion of children will be vaccinated delayed for measles than vaccinated on time.

1b. Calculate the proportion of mothers who have retained their child's vaccination documentation at the time of the survey.
Hypothesis: A greater proportion of mothers will have retained their child's vaccination documentation than not.

1c. Assess the proportion of mothers, among those that have their child's vaccination documentation at the time of the survey, who can identify three key pieces of information on the documentation: child's birthdate, child's sex, and date of child's measles vaccination.
Hypothesis: A greater proportion of mothers will be able to some but not all three pieces of information on the documentation.

1d. Determine whether there is an association, and quantify the degree of association, between demographic characteristics of the sample and retention of the child's

vaccination documentation (compared to not having child's vaccination documentation).

Hypothesis: Child's age will have the largest association with retention of vaccination documentation, relative to other demographic characteristics.

1e. Determine whether there is an association, and quantify the magnitude of association, between demographic characteristics of the sample and mother's ability to identify the three pieces of information on the child's vaccination documentation (compared to identifying fewer than three or none).

Hypothesis: Mother's level of education (no schooling vs. primary or higher) will have the largest association with mother's ability to identify the three pieces of information, relative to other demographic characteristics.

1f. Determine whether there is an association, and quantify the degree of association, between mother's ability to identify the three pieces of information on child's vaccination documentation and delayed measles vaccination for their child (compared to achieving on-time vaccination).

Hypothesis: Being the firstborn child (vs. second born or higher) will have the largest association with on time vaccination, relative to other predictors in the model.

Methods

Study Design

We conducted a population-based cross-sectional, door-to-door survey to assess the barriers and facilitators of on-time measles vaccination in a population of mothers of young children living in Rubaga Division, a high density, low-income subcounty of Uganda, located in the city of Kampala.

Recruitment and Survey

The study area consisted of three geographically distinct Parishes within Rubaga Division. Prior to the survey administration, the study team conducted a census of each

enumeration area (EA) by enumerating all households within a circumscribed village within the Division, as directed by an appointed local representative who was familiar with village boundaries. Within each EA, a target number of 45 households were then randomly selected from the list of enumerated households to contact for assessment of eligibility and potential participation in the study each day.

Screening and Eligibility

Trained study staff recruited participants by approaching the selected households, and screening potential participants by asking to speak to the mother of the household. Potential participants were eligible if they were the mother of a child aged 1-5 years of age at the time of the survey, a resident of Kampala for more than 6 months during the past one year, a current resident of Rubaga Division, and able to understand spoken Luganda or English.

Survey Administration

Eligible participants were informed about the nature of the study and invited to participate and undergo the consent process by study staff members. Those who consented to participate were immediately administered the 264-question survey orally by the study staff in either Luganda or English (according to the participant's preferred language). Staff recorded participant responses a tablet, using a series of customized REDCap (65, 66) questionnaire forms. Because the survey asked questions about the participant and their child (the index child), participants were instructed to answer all questions based on their child who most recently celebrated their first birthday even if they had multiple children between 1 and 5 years of age. If the child was part of a multiple birth, the study staff guided the mothers through randomly selecting one child from that multiple birth by selecting one card from a shuffled pile of cards with the children's names on them and the survey questions were asked about the randomly selected child. The survey took approximately 50 minutes. Participants received a hygiene kit, containing a comb, body sponge, and bar of soap to thank them for their time. Data were collected from June to August 2019.

Survey Design

The survey captured basic demographics about both the survey participant (the index child's mother) and the index child, including child's age, child's birth order, child's sex, mother's age, mother's religion, mother's tribe, mother and father's education level, and the amount of time that the mother has been living in Rubaga Division.

The survey captured information on mothers' past healthcare seeking behaviors. This included questions on who makes decisions about a child's medical care in their household, the number of antenatal visits during pregnancy, the place of birth of the child, and where the child had been taken for healthcare previously.

The survey also included a section where the study staff member requested to view and take a photograph of the child's Uganda Child Health Card or other vaccination document. If they presented a Uganda Child Health card, study staff folded the car to only show the vaccinations page of the card, which contains information on the date at which the child received each of the childhood vaccines in the government-recommended schedule. Before the photograph was taken, study staff covered non-vaccine related information on the card, which included the Vitamin A and Deworming schedule, located on the bottom half of the page (Figure 2.1). No other part of the card was photographed. If a child's Uganda Health Card was not available, participants were asked to present any other documentation that included the child's dates of vaccination, and study staff applied the same procedures to de-identify and photograph the vaccination information.

Child's Vaccination Document

In order to evaluate mothers' ability to access key information on their child's vaccination documentation, study staff asked participants to identify the following key information on their child's Uganda Child Health Card or other vaccination documentation by pointing to the line where the information was located: the location of their child's date of birth (Part A), the location of their child's sex (Part B), and the location of their child's date of measles vaccination (Part C) (Figure 2.1). Data collectors categorized participants' answers as either "correct" or "incorrect" based on their

responses. Participants who did not have a vaccination document with this information on it, such as a notebook or loose paper, could not complete this section. Ability to locate key information, like child's sex and date of birth, was used a proxy for the ability to refer to the information on the card and ability to access the vaccination information (measles vaccination date) was used as an indicator of ability to utilize the vaccination document to determine when the child would have been due for the vaccine. We created two measures from this: 1) the participant is able to identify all three pieces of information on the document (vs. they are able to identify fewer than three or none) and 2) the participant is able to identify the measles information on the document (vs. they are not able to identify the measles information).

Age at Measles Vaccination

Data entry staff reviewed each photograph of the child's vaccination document and entered the date of measles vaccination into a REDCap database (65, 66). Data were double entered, compared, and any discrepancies resolved before being merged into the survey database by a unique participant identifier. In order to maintain privacy of medical information, only the section containing information on child's vaccinations was photographed. Date of birth was not photographed on the document, and instead was reported by the mother via recall in the survey. Mothers were asked to report the index child's month and year of birth, which were considered more accurate than asking for the information to the day. In order to calculate the child's age at time of measles vaccination (MCV1), we compared the recorded date of the child receiving MCV1 based on the immunization record to the month and year of child's birth.

Factors Associated with On-time Measles Vaccination

The primary outcome for these analyses is whether the child received measles vaccination on time, defined as at nine months of age, or delayed, defined as after nine months of age or on time based on the recommended schedule in Uganda.

To assess the factors associated with the child achieving on-time measles vaccination, we fit a multivariable logistic regression model. The outcome compared children vaccinated

on time to those vaccinated early or delayed. The covariates of interest included in the model were whether the participant is able to identify all three pieces of information on the document (vs. they are able to identify fewer than three or none), the participant is able to identify the measles information on the document (vs. they are not able to identify the measles information) and included the following demographic characteristics as predictors: Mother's is under 20 years old (vs. age 20-24; 25-29; 30-34; 35-39; 40+), mother is Muganda (vs. Muyankole; other), mother is Catholic (vs. Anglican; Muslim; Pentecostal; other), mother is employed outside the home (vs. not employed outside the home), mother received no schooling (vs. Primary education; secondary education; post-secondary education), mother is married to child's father (vs. divorced/separated; widowed; never married and never lived together; no relationship), child is the firstborn (vs. second born; third born; fourth born; fifth or higher), child's is 12-24 months old (vs. 25-36; 37-48; 49-60; 61-72; Missing), child is female (vs. male), child was delivered at home (vs. public hospital/clinic; private hospital/clinic), only the mother makes medical decisions in the household (vs. mother and husband; mother, husband, and family; mother and family; husband and family; husband; family; missing), and the participant did not move into Rubaga during her child's lifetime (vs. yes, she did). From this model, we estimated the odds of achieving on-time measles vaccination, based on the covariates of interest and demographic and healthcare-related variables included in the model.

Factors Associated with Retention of Child's Vaccination Document

We calculated the proportion of mothers who had retained their child's vaccination document at the time of the survey. Participants were stratified by those who did and did not have a vaccination document, and the distributions of demographic characteristics were reported for both groups.

To assess the factors associated with retention of their child's vaccination document, we fit a multivariable logistic regression model. The outcome compared those who retained their child's vaccination document to those who did not retain the document. The covariates of interest included in the model were the following demographic characteristics: Mother's is under 20 years old (vs. age 20-24; 25-29; 30-34; 35-39; 40+),

mother is Muganda (vs. Muyankole; other), mother is Catholic (vs. Anglican; Muslim; Pentecostal; other), mother is employed outside the home (vs. not employed outside the home), mother received no schooling (vs. Primary education; secondary education; post-secondary education), mother is married to child's father (vs. divorced/separated; widowed; never married and never lived together; no relationship), child is the firstborn (vs. second born; third born; fourth born; fifth or higher), child's is 12-24 months old (vs. 25-36; 37-48; 49-60; 61-72; Missing), child is female (vs. male), child was delivered at home (vs. public hospital/clinic; private hospital/clinic), only the mother makes medical decisions in the household (vs. mother and husband; mother, husband, and family; mother and family; husband and family; husband; family; missing), and the participant did not move into Rubaga during her child's lifetime (vs. yes she did). From this model, we estimated the odds of retention of the child's vaccination document, based on the demographic and healthcare-related variables included in the model.

Factors Associated with Ability to Identify Information on the Vaccination Document

We calculated the proportion of participants who were able to identify each piece of information on their child's vaccine document. We categorized participants based on whether they were able to identify all three pieces of information on the document (vs. they were able to identify fewer than three or none) and whether they were able to identify the measles information on the document (vs. they were not able to identify the measles information).

To assess the factors associated with ability to identify specific information on the Uganda Child Health card, we fit two multivariable logistic regression models. In the first, the outcome compared those who were able to identify all three pieces of information on the document (vs. they were able to identify fewer than three or none) and in the second, the outcome compared those who were able to identify the measles information on the document (vs. they were not able to identify the measles information). Both models included the following demographic characteristics as predictors: Mother's is under 20 years old (vs. age 20-24; 25-29; 30-34; 35-39; 40+), mother is Muganda (vs. Muyankole; other), mother is Catholic (vs. Anglican; Muslim; Pentecostal; other), mother

is employed outside the home (vs. not employed outside the home), mother received no schooling (vs. Primary education; secondary education; post-secondary education), mother is married to child's father (vs. divorced/separated; widowed; never married and never lived together; no relationship), child is the firstborn (vs. second born; third born; fourth born; fifth or higher), child's is 12-24 months old (vs. 25-36; 37-48; 49-60; 61-72; Missing), child is female (vs. male), child was delivered at home (vs. public hospital/clinic; private hospital/clinic), only the mother makes medical decisions in the household (vs. mother and husband; mother, husband, and family; mother and family; husband and family; husband; family; missing), and the participant did not move into Rubaga during her child's lifetime (vs. yes she did). From these models, we estimated the odds of being able to identify all three pieces of information on the vaccination document and the odds of being able to identify the measles information on the document, based on the demographic variables included in the model.

Sample Size

This study is powered to be able to detect a difference in vaccination timing (on time vs delayed), considering if someone can utilize their child's vaccination document.
To determine the minimum sample size sufficient to detect a difference in the proportion of children receiving MCV on time vs the proportion delayed comparing participants who have access to their preferred method of transportation vs those who do not, we estimated that 50% of children would be vaccinated on time. In order to detect a difference of plus or minus 10 percentage points between the two groups, with and alpha of 0.05 and a confidence level of 0.95, 193 participants per groups would be required for this analysis.

Analysis

We designed and administered the surveys using the REDCap electronic data capture software (65, 66). We used Stata 16 for data management and analysis (67).

Ethical Review

This study was reviewed and approved by the Makerere School of Medicine Research and Ethics Committee (SOMREC), the Uganda National Council of Science and Technology (UNCST), and the University of Minnesota Institutional Review Board.

Results

Participant Characteristics

In total, 999 participants completed the survey. Participants ranged in age from 17 to 50 years, with a mean of 28 years. The most commonly reported tribe was the Buganda tribe (53.3%), and the most commonly reported highest level of education was secondary school as their (49.6%). The most commonly reported religion was Catholic (35.2%), and participants most commonly reported not being employed outside the home (55.7%). Over half of participants reported having only one child (65.9%) (Table 2.1a).

Table 2.1a: Demographic characteristics of the study sample (mothers)

	Proportion of total		Vaccination document ownership			
	%	95% CI	No document		Document	
			n	%	n	%
Mothers age (years)						
Under 20	3.7	2.7, 5.1	16	4.7	21	3.2
20-24	26.7	24.1, 29.6	79	23.2	188	28.5
25-29	34.5	31.6, 37.5	121	35.6	224	34.0
30-34	18.5	16.2, 21.1	68	20.0	117	17.8
35-39	12.3	10.4, 14.5	45	13.2	78	11.8
40+	4.2	3.1, 5.6	11	3.2	31	4.7
Number of children						
1	65.9	62.9, 68.7	226	66.5	432	65.6
2	29.5	26.8, 32.4	95	27.9	200	30.4
3	4.1	3.0, 5.5	17	5.0	24	3.6
4	0.3	0.1, 0.9	1	0.3	2	0.3
5	0.2	0.04, 0.8	1	0.3	1	0.2
Tribe						
Muganda	53.3	50.1, 56.3	171	50.3	361	54.8
Muyankole	13.8	11.8, 16.1	57	16.8	81	12.3
Other	32.8	30.0, 35.8	111	32.7	217	32.9
Missing	0.1	0.01, 0.7	1	0.3	0	0
Highest level of education						
Did not attend/don't know	3.4	2.4, 4.7	14	4.1	20	3.0
Primary	38.2	35.3, 41.3	147	43.2	235	35.7
Secondary	49.6	46.5, 52.7	151	44.4	344	52.2
Post-secondary	8.5	6.9, 10.4	26	7.7	59	9.0
Missing	0.3	0.1, 0.9	2	0.6	1	0.2
Religion						
Catholic	35.2	32.3, 38.3	115	33.8	237	36.0
Anglican	23.2	20.7, 25.9	86	25.3	146	22.2
Muslim	21.7	19.3, 24.4	77	22.7	140	21.2
Pentecostal/Born again/Evangelical	16.5	14.3, 19.0	51	15.0	114	17.3
Other	2.4	1,6, 3.6	8	2.4	16	2.4
Missing	0.9	0.5, 1.7	3	0.9	6	0.9
Relationship status						
Married or Living together	77.2	74.5, 79.7	246	72.4	525	79.7
Divorced/Separated	13.1	11.2, 15.4	61	17.9	70	10.6
Widowed	0.7	0.3, 1.5	3	0.9	4	0.6
Never married and Never living together	7.9	6.4, 9.8	23	6.8	56	8.5
No relationship	0.8	0.4, 1.6	4	1.2	4	0.6
Missing	0.3	0.1, 0.9	3	0.9	0	0.0
Employed outside the home						
No	55.7	52.6, 58.7	179	52.7	377	57.2
Yes	44.2	41.2, 47.3	160	47.1	282	42.8
Missing	0.1	0.01, 0.7	1	0.3	0	0
Moved to Rubaga in their child's lifetime						
No	77.0	74.3, 79.5	238	70.0	531	80.6
Yes	22.5	20.0, 25.2	100	29.4	125	19.0
Missing	0.5	0.2, 1.2	2	0.6	3	0.5

Table 2.1a: Demographic characteristics of the survey sample, by whether they had a child health card or other vaccination documentation at the time of the survey (does not have a card vs. does have a card).

Table 2.1b: Demographic characteristics of the children of the study sample

	Proportion of total		Vaccination document ownership			
	%	% CI	No document		document	
			n	%	n	%
Childs age (months)						
12-24 months	37.7	34.8, 40.8	104	30.6	273	41.4
25-36 months	26.2	23.6, 29.0	87	25.6	175	26.6
37-48 months	16.5	14.3, 19.0	63	18.5	102	15.5
49-60 months	11.3	9.5, 13.4	48	14.1	65	9.9
61-72 months	6.5	5.1, 8.2	27	7.9	38	5.8
Missing	1.7	1.1, 2.7	11	3.2	6	0.9
Child's sex						
Female	47.1	44.0, 50.2	161	47.4	309	46.9
Male	52.8	49.6, 55.8	177	52.1	350	53.1
Missing	0.2	0.05. 0.8	2	0.6	0	0.0
Birth order						
First child	30.3	27.6, 33.3	82	24.1	221	33.5
Second	25.2	22.6, 28.0	96	28.2	156	23.7
Third	22.3	19.8, 25.0	765	22.1	148	22.5
Fourth	11.8	10.0, 14.0	46	13.5	72	10.9
Fifth or higher	10.3	8.6, 12.4	41	12.1	62	9.4
Part of a multiple birth						
No	97.2	96.0, 98.1	338	99.4	633	95.1
Yes	2.4	1.6, 3.6	1	0.3	23	3.5
Missing	0.4	0.2, 1.1	1	0.3	3	0.5

Table 21b: Characteristics of children of participants by whether they had a child health card or other vaccination documentation at the time of the survey (does not have a card vs. does have a card).

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The age of index children about whom data were collected ranged from 1 year to 5 years, with a mean of 33 months (2.8 years). Slightly over half of the children were male (52.8%), and the largest proportion were the first-born (30.3%) child. Only 24 (2.41%) were part of a multiple birth (Table 2.1b).

The majority of participants reported giving birth to their child in a public hospital or clinic (71.1%). Most participants completed the recommended number of antenatal visits during their pregnancy, with 40.0% reporting four visits and 34.9% of participants reporting more than four. When asked who makes decisions about medical care for their child, most participants reported that both they and their partner make decisions (66.7%), while 18.5% said that they make the decisions on their own (Table 2.2).

Table 2.2: Select healthcare seeking characteristics of study sample

	Proportion of total		Vaccination document ownership			
	%	CI	Without a document		With a document	
			n	%	n	%
Location of birth						
Public hospital/clinic	71.1	68.2, 73.8	227	66.8	483	73.3
Private hospital	23.0	20.5, 25.7	86	25.3	144	22.9
At home	5.6	4.3, 7.2	24	7.1	32	4.9
Missing	0.3	0.1, 0.9	3	0.9	0	0
Number of antenatal visits						
0 visits	1.2	0.7, 2.1	6	1.7	6	0.9
Between 1 and 4 visits	23.5	21.0, 26.3	79	23.2	156	23.7
4 visits	40.0	37.0, 43.1	142	41.8	258	39.2
More than 4 visits	34.9	32.0, 37.9	110	32.4	239	36.3
Missing	0.3	0.1, 0.9	3	0.9	0	0
Who makes decisions about medical care?						
I do alone	18.5	16.2, 21.1	75	22.1	110	16.7
My Partner/spouse and I do	66.7	63.7, 69.5	202	59.4	464	70.4
Me, partner, family member	4.6	3.5, 6.1	17	5.0	29	4.4
Me and family member	2.8	1.9, 4.0	12	3.5	16	2.4
Partner and family member	0.3	0.1, 0.9	2	0.6	1	0.2
My partner	6.4	5.0, 8.1	28	8.2	36	5.5
A family member	0.2	0.05, 0.8	2	0.6	0	0.0
Nobody does/blank/missing	0.5	0.2, 1.2	2	0.6	3	0.5

Table 2.2: Select healthcare characteristics of study sample, by whether they had a vaccination document at the time of the survey (does not have a document vs. does have a document).

Factors associated with achieving on-time measles vaccination

Of all participants with a health card or other document at the time of the survey, 50.7% (n=507) had the information on the card to calculate the age of the child at the time of measles vaccination. Of all participants who had information about their child's date of measles vaccination and birthday at the time of the survey, 43.9% (n=221) were vaccinated for measles on-time (Table 2.3). Of the factors assessed, mothers who were 20-24 years old had a higher odds of vaccinating their child on time (compared to mothers under age 20 [OR=9.6; 95%CI: 1.1, 87.3]). A similar trend was observed among mothers in older age groups (compared to mothers under 20). Second-born children had a lower odds of getting vaccination (compared to first born children [OR=0.5; 95%CI:0.3, 1.0]), and a similar trend was observed among children higher in the birth order, when compared to the first born. (Table 2.3).

Table 2.3: Distribution of child's age in months at time of measles vaccination

	n	%	Cum %	95%CI
Less than 6 months	2	0.3	0.3	0.1, 1.2
6 months	11	1.7	2.0	0.9, 3.0
7 Months	4	0.6	2.6	0.2, 1.6
8 months	12	1.8	4.4	1.0, 3.2
9 months	221	33.7	38.1	30.2, 37.4
10 months	159	24.2	62.4	21.1, 27.7
11 months	35	5.3	67.7	3.9, 7.3
12+ months	60	9.2	76.8	7.2 11.6
Missing from document	152	23.2	100.0	20.1, 26.6
	504			

Table 2.3: Distribution of child's age in months at measles vaccination (MCV1)

Table 2.4: Factors associated with on-time measles vaccination (n=421)

		OR	95%CI	P-value
Was able to identify all three pieces of information on their child's vaccination document	Identified fewer than three	ref		
	Identified all three	1.2	0.4, 3.2	0.768
Was able to identify information on measles vaccine on their child's vaccination document	No	ref		
	Yes	0.6	0.2, 1.7	0.334
Mother's age (years)	Under 20	ref	ref	Ref
	20-24	9.6	1.1, 87.3	0.044
	25-29	8.3	0.9, 77.1	0.064
	30-34	6.8	0.7, 67.3	0.099
	35-39	7.4	0.7, 79.9	0.099
	40+	9.1	0.8, 108.5	0.081
Mother's tribe	Muganda	ref		
	Muyankole	0.9	0.5, 1.6	0.665
	Other	0.9	0.6, 1.4	0.648
Mother's religion	Catholic	ref		
	Anglican	0.8	0.5, 1.4	0.436
	Muslim	1.0	0.6, 1.9	0.894
	Pentecostal	0.6	0.3, 1.2	0.139
	Other	2.6	0.6, 11.6	0.216
Mother works outside the home	No	ref		
	Yes	0.7	0.4, 1.1	0.085
Mother's education	No education	ref		
	Primary	1.4	0.2, 7.9	0.699
	Secondary	1.6	0.3, 9.1	0.591
	Post-secondary or higher	1.9	0.3, 12.0	0.502
Mother's relationship with child's father	Married			
	Divorced/Separated	0.8	0.3, 1.9	0.628
	Widowed			
	Never Married and Never Lived together	0.7	0.3, 1.9	0.514
	No relationship	1.0		
	Other			
Child's birth order	First	Ref		
	Second	0.5	0.3, 1.0	0.037
	Third	0.6	0.3, 1.2	0.148
	Fourth	0.6	0.2, 1.4	0.208
	Fifth or higher	0.5	0.2, 1.3	0.140
Child's age (months)	12-24	ref		
	25-36	0.9	0.5, 1.5	0.644
	37-48	1.5	0.8, 2.7	0.199

	49-60	0.5	0.3, 1.2	0.128
	61-72	0.8	0.3, 2.1	0.615
Child's sex	Female	ref		
	Male	1.0	0.6, 1.5	0.868
Delivery location	Public hospital/clinic	0.7	0.2, 2.7	0.626
	Private hospital	1.0	0.3, 4.0	0.969
	At home	ref		
Who makes decisions about the child's medical care?	Mother	Ref		
	Mother and partner	0.8	0.4, 1.7	0.599
	Mother, partner, family member	0.6	0.2, 1.9	0.380
	Mother and family member	1.3	0.2, 7.4	0.797
	Partner and family member	--		
	Partner	0.7	0.2, 2.3	0.599
	A family member	--		
	Nobody does/blank/missing	1.0		
Moved to Rubaga during the child's lifetime	No	ref		
	Yes	0.6	0.3, 1.0	0.064

Table 2.4: Output of multivariable logistic regression model to assess the factors associated with achieving on-time measles vaccination (vs. delayed) as the outcome

Factors Associated with Ownership of Child's Vaccination Document

Among all participants, 65.2% (n=598) had a vaccination document at the time of the survey. Of those who presented their child's vaccination document, the majority (89.9%, n=585) had a Uganda Child Health Card, while the rest presented some other form of vaccination document. Of the factors assessed, mothers who were 20 to 24 years old, compared to those who were under 20 years of age, [OR=2.6; 95%CI:1.2, 5.5]) had a greater odds of having their child's vaccination document. This was also the case in older mothers, with mothers who were 40 years old or higher having a greater odds of having their child's vaccination document (compared to mothers under 20 [OR: 8.1, 95%CI: 2.6, 25.4]). Mothers who were reporting on their second-born child or higher (compared to those reporting on their first-born child [OR=0.5; 95%CI:0.3, 0.8]) and those whose child was 49-60 months of age (compared to children who were 12-24 months [OR=0.5; 95%CI:0.3, 0.9]) had a lower odds of having their child health card (Table 2.4).

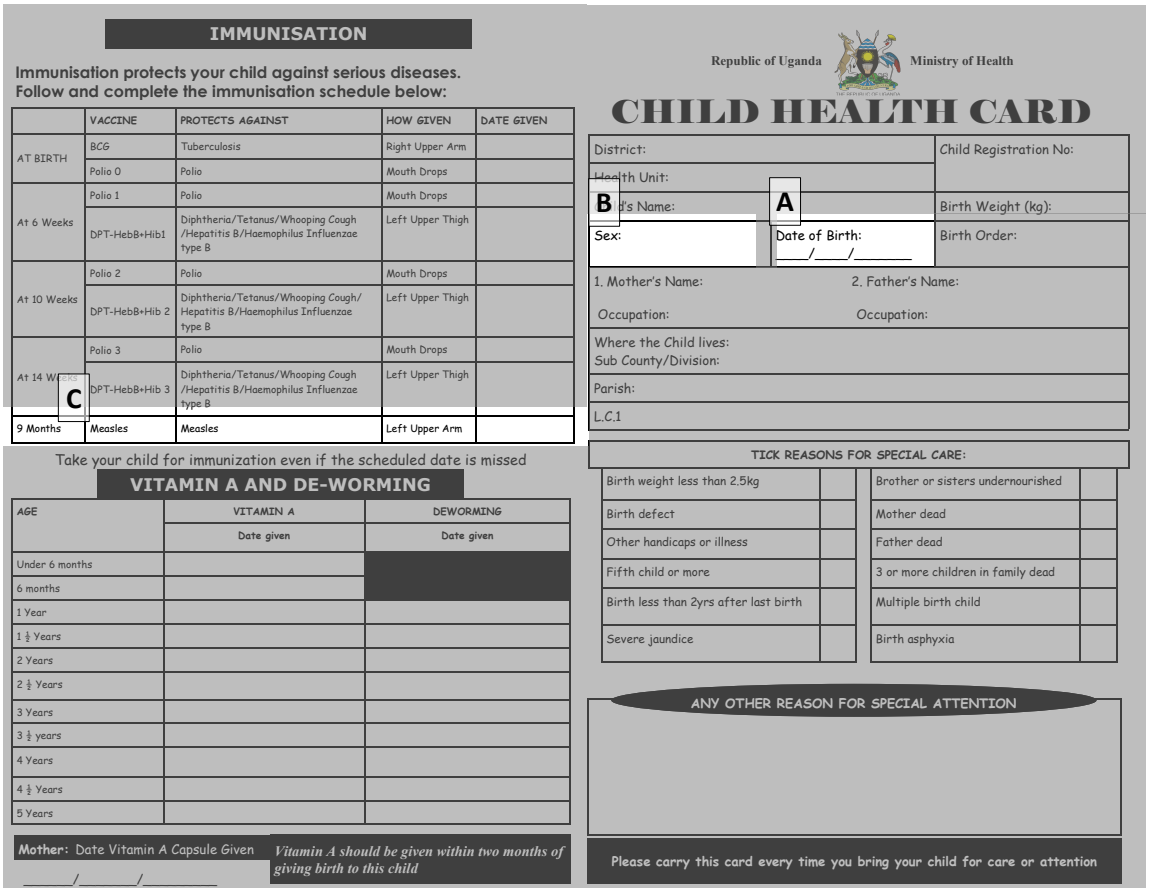

Figure 2.1: Two pages of the Uganda Child Health card that include the pieces of information the participants were asked to point to in the survey: A) Child's date of birth; B) Child's biological sex; and C) Information on child's measles vaccination, including date given. The table containing immunization information (item C) was the only portion photographed during they survey.

Table 2.5: Measure of whether the participants correctly identified components of their child's vaccination document

	n	%	95%CI	Delayed N=254		On-time N=221	
				n	%	n	%
Identified all three pieces of information on the vaccination document (n=598)							
No	336	56.2	52.2, 60.1	114	48.3	101	50.3
Yes	262	43.8	39.9, 47.8	122	51.7	100	49.8
Identified the information on the child's measles vaccine on the vaccination document (n=559)							
No	272	48.7	44.5, 52.8	103	42.9	91	45.5
Yes	287	51.3	47.2, 55.5	137	57.1	109	54.5

Table 2.5: Binary measure of participant's identification of key pieces of information on their child's vaccination document.

Table 2.6: Factors associated with ownership of child's vaccination document (N=964)

		OR	95%CI	p-value
Mother age	Under 20	ref	ref	ref
	20-24	2.6	1.2, 5.5	0.014
	25-29	2.9	1.3, 6.5	0.008
	30-34	3.6	1.5, 8.6	0.003
	35-39	4.3	1.7, 11.0	0.002
	40+	8.1	2.6, 25.4	0.001
Mother tribe	Muganda	ref	ref	ref
	Muyankole	0.7	0.5, 1.1	0.109
	Other	0.9	0.7, 1.3	0.625
Mother religion	Catholic	ref	ref	ref
	Anglican	0.8	0.5, 1.1	0.192
	Muslim	0.9	0.6, 1.3	0.46
	Pentecostal	1.0	0.7, 1.6	0.825
	Other	0.7	0.3, 1.7	0.436
Mother employment status	No	ref	ref	ref
	Yes	0.8	0.6, 1.1	0.134
Mother education level	No education	ref	ref	ref
	Primary	1.1	0.5, 2.5	0.76
	Secondary	1.5	0.7, 3.2	0.347
	Post-secondary or higher	1.3	0.5, 3.2	0.608
Marital status	Married	ref	ref	ref
	Divorced/Separated	0.7	0.4, 1.2	0.184
	Widowed	0.7	0.1, 3.8	0.649
	Never Married and Never Lived together	1.6	0.9, 3.2	0.138
	No relationship	0.5	0.1, 2.4	0.415
	Other	0.3	0.0, 4.0	0.355
Child birth order	First	ref	ref	ref
	Second	0.5	0.3, 0.8	0.002
	Third	0.6	0.4, 0.9	0.019
	Fourth	0.4	0.2, 0.7	0.003
	Fifth or higher	0.3	0.2, 0.6	0.001
Child age	12-24 months	ref	ref	ref
	25-36 months	0.7	0.5, 1.1	0.112
	37-48 months	0.7	0.4, 1.0	0.054
	49-60 months	0.5	0.3, 0.9	0.013
	61-72 months	0.6	0.3, 1.1	0.104
Child sex	Female	ref	ref	ref
	Male	1.0	0.8, 1.4	0.830
Delivery location	At home	ref	ref	ref
	Public hospital/clinic	1.8	1.0, 3.3	0.058

	Private hospital	1.3	0.7, 2.5	0.423
Who decides medical care	I do alone	ref	ref	ref
	My Partner/spouse and I do	1.3	0.8, 2.1	0.267
	Me, partner, family member	1.1	0.5, 2.3	0.836
	Me and family member	0.8	0.3, 1.9	0.601
	Partner and family member	0.1	0.0, 1.9	0.138
	My partner	0.9	0.4, 1.7	0.69
	A family member	1.0		
	Nobody does/blank/missing	1.0		
Move into Rubaga	No	ref	ref	ref
	Yes	0.6	0.4, 0.8	0.003

Table 2.6: Output of multivariable logistic regression model to assess the factors associated with retention of the vaccination document at the time of the survey (vs. no document) as the outcome

Table 2.7: Factors associated with identification of information on the child's vaccine document

		Participant identifies all three pieces of information (n=547)			Participant identifies measles information (n=545)		
		OR	95% CI	P-value	OR	95% CI	P-value
Mother's age (years)	Under 20	ref			ref		
	20-24	2.5	0.7, 8.8	0.153	1.4	0.4, 5.1	0.634
	25-29	2.8	0.8, 10.2	0.119	1.5	0.4, 5.8	0.544
	30-34	3.1	0.8, 12.2	0.098	2	0.5, 8.0	0.342
	35-39	10.0	2.3, 43.5	0.002	3.9	0.9, 17.6	0.078
	40+	2.4	0.4, 12.8	0.311	1.5	0.3, 7.8	0.661
Mother's tribe	Muganda	ref			ref		
	Muyankole	0.9	0.5, 1.6	0.669	1.2	0.7, 2.3	0.502
	Other	0.5	0.4, 0.8	0.006	0.6	0.4, 0.9	0.011
Mother's religion	Catholic	ref			ref		
	Anglican	1.0	0.6, 1.6	0.872	0.8	0.5, 1.4	0.450
	Muslim	0.9	0.5, 1.5	0.711	0.8	0.5, 1.4	0.409
	Pentecostal	1.4	0.8, 2.5	0.227	1.1	0.6, 1.9	0.803
	Other	1.1	0.3, 3.7	0.928	0.9	0.2, 3.1	0.811
Mother employed outside the home	No	ref			ref		
	Yes	1.3	0.9, 2.0	0.175	1.1	0.7, 1.7	0.576
Mother's education	No education	ref			ref		
	Primary	1.7	0.4, 6.6	0.445	2.1	0.5, 8.1	0.290
	Secondary	6.2	1.6, 24.4	0.009	5.8	1.5, 22.7	0.013
	Post-secondary or higher	21.3	4.6, 98.1	0.000	22	4.6, 108.0	0.000
Relationship to child's father	Married	ref			ref		
	Divorced/Separated	1.1	0.5, 2.5	0.743	0.8	0.4, 1.8	0.595
	Widowed	1.0			1		
	Never Married and Never Lived together	0.8	0.3,1.9	0.618	0.7	0.3, 1.6	0.338
	No relationship	1.4	0.1, 16.0	0.801	0.7	0.1, 7.9	0.764
	Other	1.0			1		
Child's birth order	First	ref			ref		
	Second	0.7	0.4, 1.2	0.154	0.7	0.4, 1.2	0.166
	Third	0.4	0.2, 0.8	0.008	0.6	0.3, 1.1	0.078
	Fourth	0.3	0.2, 0.8	0.011	0.6	0.3, 1.2	0.147
	Fifth or higher	0.5	0.2, 1.4	0.194	0.7	0.3, 1.8	0.479
Child's age (months)	12-24	ref			ref		
	25-36	1.0	0.6, 1.6	0.970	1	0.6, 1.5	0.842
	37-48	0.7	0.4, 1.1	0.139	0.8	0.5, 1.4	0.504
	49-60	0.9	0.5, 1.9	0.849	0.8	0.4, 1.6	0.512
	61-72	1.2	0.5, 3.1	0.670	1.5	0.6, 3.8	0.415

Child's sex	Female	ref			ref		
	Male	1.3	0.9, 1.9	0.237	1.1	0.7, 1.6	0.656
Delivery location	Public hospital/clinic	1.6	0.6, 4.4	0.372	1.9	0.7, 5.4	0.213
	Private hospital	2.5	0.8, 7.4	0.105	3.4	1.1, 10.2	0.031
	At home	ref			ref		
Who makes medical decisions?	I do alone	ref			ref		
	Mother and partner	2.2	1.1, 4.4	0.030	1.9	0.9, 3.7	0.080
	Mother, partner, family member	0.9	0.3, 3.1	0.916	1.2	0.4, 3.8	0.806
	Mother and family member	1.1	0.3, 4.4	0.848	1.2	0.3, 4.9	0.761
	Partner and family member	-			--		
	Partner	1.5	0.5, 4.5	0.486	1.1	0.4, 3.1	0.923
	A family member	-			--		
	Nobody	3.9	0.1, 162.6	0.475	6.5	0.5, 92.4	0.166
	does/blank/missing						
Moved to Rubaga in child's lifetime	No	ref			ref		
	Yes	0.9	0.5, 1.5	0.658	0.7	0.4, 1.3	0.270

Table 2.7: Output of multivariable logistic regression model to assess the factors associated with identifying information on the child's health document: Identified three correct (vs. less than three) and identified measles information (vs. did not)

Factors Associated with Ability to Identify Information on Vaccination Document

Of those who had their child's vaccination document present at the time of the survey, 43.8% (n=262) could identify all three pieces of information on the document when asked. (Table 4). Of the factors assessed, mothers who were part of other tribes (compared to Muganda [OR=0.5; 95%CI:0.4, 0.8]) and children who were higher in the birth order (compared to the first child, [OR=0.4; 95%CI:0.2, 0.8] for third born and [OR=0.3; 95%CI:0.2, 0.8] for the fourth born) had lower odds of being able to identify the information on the child health, while mothers with secondary education or higher (compared to no education [OR=6.2; 95%CI:1.6, 24.4]) and mothers who reported that medical decisions were shared between her and her partner (compared to making medical decisions on her own [OR=2.2; 95%CI:1.1, 4.4]) had a higher odds of being able to identify the information (Table 2.7).

Of those who had their child's vaccination document present at the time of the survey, 287 (51.3%) were able to identify the measles information when asked. (Table 4). Of the factors assessed, mothers with secondary education or higher (compared to no education [OR=5.8; 95%CI:1.5, 22.7]) and mothers who delivered their child in a private facility (compared to those who delivered at home [OR=3.4; 95%CI:1.1, 10.2]) had a higher odds of being able to identify the information (Table 2.7).

Discussion

In this study, we aimed to assess the relationship between child health card ownership, a mother's ability to identify information on their child's health card, and whether the child received their measles vaccination on time.

We found that over half of all participants were able to present documentation of their child's vaccinations at the time of the survey, but over half of those with documentation were not able to identify key pieces of information on the card that may help mothers determine when their child was to be vaccinated for measles. We also found that, among mothers with a card, mothers' ability to locate pieces of information on the card, including the child's measles vaccination information, is not associated with on-time vaccination.

A cross-sectional survey of 900 children aged less than 5 years in Kenya on 2015 found that vaccinations that were not received during the recommended timeframe were associated with non-delivery at health facilities (AHR 1.58, 95% CI 1.02, 2.46), which could be the result of mothers not having a child health card (38). A 2006 cross-sectional study of Ugandan children aged 0 to 24 months and their mother/caretakers found that 66% of children had a child health card at the time of the survey, and children delivered at a health facility were four times as likely to have a card, compared to those that were delivered at home (68). A limitation of this study is that the data for this analysis came from a surveyed population months or years after they needed the card, because the survey was administered to mothers who had children that were above the age at which they should have been vaccinated. This gap of time, which ranged from three months up to four years and three months between use of the card and this survey may have

influenced both the probability of the participants retaining the child's health card and the way participants responded to prompts about finding information on the card.

While delivery at a facility did not have a significant associating with on time measles vaccination in this study, delivery at a private facility was associated with a higher odds of being able to identify measles information on their child's card. This could be due to socioeconomic factors that both enable mothers to pursue higher education and deliver in private facilities.

In other studies, mother's education level is found to be a predictor of vaccination timing in multiple settings, with lower educational status associated with delayed vaccination in a study in Senegal which used Demographic and Health Survey (DHS) data (48), in Ghana (45), and in other LMICs (69). While this analysis did not yield a similar finding, mother's educational status was associated with the ability to correctly identify information on their child's vaccination documentation, including their child's measles vaccination, which may have influenced with timing their child's vaccinations.

Birth order also influenced timely vaccination in many studies, in which being the first child was predictive of on-time vaccination and having siblings (or being the second child or later) was predictive of delayed vaccination (45, 48). This study yielded a similar result, in which children who were second born or higher in the birth order had a lower odds of being vaccinated on time. In addition, birth order was associated with the ownership of the child's health card, with the odds of a mother having a health card were lower for second born or higher children, when compared to the firstborn. Similarly, another study in Uganda found that vaccinations that were not received during the recommended timeframe were associated with a higher number of children per woman (AHR 1.84, 95% CI 1.29, 2.64) (38, 49).

One study found an association with maternal age and timely vaccination in which mothers over 30 years were more likely to be late vaccinating their child for measles, PCV1 and PCV3 when compared to mothers 15 to 29 yeas of age (50). Our study found a contradictory result, in which children of mothers who were older (compared to those under 20 year of age) had a higher odds of being vaccinated on time. Older mothers also

had a higher odds of retaining their child's vaccination document, compared to mothers under 20 years of age.

This study can only measure association of certain factors with the outcome, rather than causal relationships, because the direction of the causality cannot be determined with the available information. The outcome measure of timeliness will only be based on information gathered from the child's vaccination document. Only a subset of the surveyed population had a vaccination document, and that the exclusion of those that do not have a document may introduce bias into the sample.

Because this study collected the mother's report of the month and year of the child's birth, it is not possible to assess the timing of the MCV1 dose to the day. Thus, we expect some misclassification for on-time MCV1 vaccination status, but we expect it to be non-differential, as birth dates would not be expected to vary within months.

Conclusion

This study indicates that on-time measles vaccination is not consistently obtained in the population, and that the majority of mothers surveyed would not be able to produce and use the child's vaccination documentation, illustrating both a vaccination access gap and a knowledge gap. Further research can shed light on additional risk factors for delayed measles vaccination, with an emphasis on other factors that may prompt or remind mothers of the time when their child is due for a vaccine.

CHAPTER 3 (MANUSCRIPT 2): IS THERE AN ASSOCIATION BETWEEN BARRIERS TO TRANSPORTATION AND ON-TIME MEASLES VACCINATION IN UGANDA?

Introduction

Measles is a highly contagious, vaccine-preventable, viral disease. Vaccination against measles virus is critical for preventing measles infection. The success of the measles vaccine (MCV) in protecting a population depends on maintaining a high proportion of immune individuals at all times, either via vaccination or prior infection. It is estimated that 95% of individuals must be immune to measles in order to reach the herd immunity threshold and prevent outbreaks. In Uganda, measles vaccination is recommended as one dose at nine months of age (MCV1); an estimated 87% of children have received a measles vaccine by the time they are 12-23 months old, based on 2019 estimates drawn from WHO and UNICEF (15, 57, 58). Yet, in recent years, Uganda has reported measles outbreaks in both urban and rural settings (1-3). The occurrence of these outbreaks, despite relatively high overall vaccination coverage, is attributed to a high proportion of susceptible individuals clustered within geographical areas, due to heterogeneity in vaccination coverage (8, 58, 59).

Measles vaccination will induce the highest degree of protection to both the individual, and contribute to population-level immunity, if it is administered at the recommended ages, which varies by epidemiologic setting and other logistical constraints. The aim of vaccination is to induce immunity as quickly as possible after maternal antibody levels decline, to limit the period of time during which an infant may be susceptible to infection, but not vaccinate so early that an adequate immune response to the vaccine will not occur. An infant's risk of infection depends upon multiple factors, including the level of maternal antibodies (measles IgG and secretory IgA) acquired transplacentally during gestation and via mother's breastmilk after birth, which reach non-protective levels around six to nine months of age, on average. Their risk also depends on their exposure to infectious individuals, which itself is determined by the measles vaccine coverage among contacts (5, 18).

Given that vaccination coverage is below the 95% herd immunity (12) threshold for measles in Uganda and the risk of exposure is high, it is important to ensure high vaccine-induced immunity in children as soon as possible, after immunity begins to wane. Therefore, the age at which the child receives their measles vaccine is important for maximizing the child and community's protection against disease (8, 13, 14). Thus, Uganda recommends one dose of a measles-containing vaccine (MCV) at 9 months of age (15).

Delayed immunization is a strong risk factor for disease, because it leads to children having little to no immune protection against infection after the waning of maternal antibodies. Timely, on-schedule vaccination is essential for achieving the full benefit of measles-containing vaccines (MCV) (24, 26). An analysis of the timing of measles vaccine in Uganda found that the median delay in the administration of MCV1 was 2.7 weeks, but with and interquartile range (IQR) of 9.6 weeks, indicating a wide spread in the number of weeks delayed (29). Late vaccination is a problem in Uganda. Despite a steady improvement in Uganda's measles vaccination coverage from 70% (2008) to 87% (2019), outbreaks of measles, remain common (20, 54, 60). The degree to which delayed vaccination may contribute to epidemiologic trends in measles-endemic areas is not known. Investigating the prevalence of delayed measles vaccination, the timing of the delay, and elucidating factors associated with risk of delayed measles vaccination is an important first step toward addressing barriers to vaccination and improving on-time measles vaccination coverage.

In Uganda, infant vaccination is available at government and private hospitals and clinics at specific times throughout the week. In order to be vaccinated, a child must be brought to the clinic with their vaccination document and wait until they can receive the vaccine. The timing of measles vaccination depends on multiple factors, including a parent's knowledge and understanding of when to get their child vaccinated and the physical means to reach the vaccination venue. In previous studies in Uganda, mothers of young children cited a lack of transportation and financial limitations as specific barriers to accessing measles vaccines and accessing measles vaccine at the recommended time in

urban, low resource settings. These barriers existed in urban areas, despite short physical distances to a vaccination facility, which did not necessarily mean that children will receive their vaccination on time (38, 49). In high-density, urban areas, mothers must rely on multiple forms of transportation to get to a hospital or clinic often walking part of the way, then taking a moto or car to arrive at their destination. Although transportation challenges, in general, have been identified as a barrier to timely measles vaccination, additional evidence is needed to understand how transportation barriers could be addressed and minimized in order to improve timely access to vaccination.

In this study, we aimed to assess the relationship between multiple aspects of transportation, including vehicle ownership, preferred modes of travel, transportation costs, how many children typically travel together with the parent, and how long it takes for them to get to a vaccination facility and on-time measles vaccination, in order to identify areas for intervention to improve the timeliness of vaccination in this population. We conducted a cross-sectional, door-to-door survey among mothers of young children living in a high-density, low-income district of Kampala, Uganda, to 1) estimate the proportions of participants who experience transportation-related barriers when accessing vaccination or their child and 2) estimate the proportion of children who were vaccinated on time compared to those who were vaccinated late, to determine which factors were associated with on-time measles vaccination.

Objectives

1a. Calculate the proportion of children vaccinated on time (defined as received at least one measles vaccine in the ninth month of age) and vaccinated delayed (defined as received at least one measles vaccine after nine months of age) among all children surveyed, overall.

Hypothesis: A greater proportion of children will be vaccinated delayed for measles than vaccinated on time.

1b. Calculate the proportion of mothers who have experienced barriers to transport, including those who have not brought their child to a facility for a vaccine (vs. those who have), those who do not own a form of transportation (vs. those who own a form

of transportation), those who travel with multiple children when taking one for vaccination (vs. those who travel with only one child), those who report that transportation costs have prevented them from getting their child vaccinated (vs. those who have not), those who have travelled for a long time or a long distance to a vaccination facility (vs. those who travel for a shorter time or distance), and those who have not used their preferred form of transportation (vs. those who have) overall, and stratified by the child's vaccination status (on time vs. delayed).

Hypothesis: Overall, a greater proportion of mothers will report not experiencing any of these barriers. There will be difference in the proportion of mothers reporting these barriers among those who have achieved on-time vaccination for their child (compared to delayed vaccination), with a greater proportion of mothers reporting barriers in the delayed group.

1c. Determine whether there is an association, and quantify the degree of association, between transportation barriers and achieving on-time measles vaccination (compared to delayed measles vaccination).

Hypothesis: Transportation ownership and short travel time to a facility will have the largest association with achieving on-time measles vaccination, relative to other barriers in the model.

Materials and Methods

Study Design and Setting

We conducted a population-based cross-sectional, door-to-door survey to assess self-reported barriers and facilitators of on-time measles vaccination among mothers of young children living in Rubaga Division, a high density, low-income subcounty of Uganda, located in the city of Kampala.

Participant Recruitment

The study area consisted of three geographically distinct Parishes within Rubaga Division. Prior to the survey administration, the study team conducted a census of each enumeration area (EA) by enumerating all households within a circumscribed village

within the Division, as directed by an appointed local representative who was familiar with village boundaries. Within each EA, a target number of 45 households were then randomly selected from the list of enumerated households each day and contacted to assess their eligibility and their willingness to participate in the study.

Screening and Eligibility

Trained study staff recruited participants by approaching a member of the selected households and asking to speak to the mother of the household. Potential participants were screened and were eligible for the study if they were the mother of a child aged 1 to 5 years of age at the time of the survey, a resident of Kampala for more that 6 months during the past one year, a current resident of Rubaga Division, and able to understand spoken Luganda or English.

Survey Administration

Study staff members informed eligible potential participants about the nature of the study and invited them to participate and undergo the consent process. Those who provided informed consent to participate were immediately administered the 264-question survey orally by the study staff in either Luganda or English (according to the participant's preferred language). Staff recorded participant responses on an electronic tablet, using a series of customized REDCap (65, 66) questionnaire forms. Because the survey asked questions about the participant and their child (the index child), participants were instructed to answer all questions based on their child who most recently celebrated their first birthday even if they had multiple children between 1 and 5 years of age. If the child was part of a multiple birth, the study staff guided the mothers through randomly selecting one child from that multiple birth by selecting one card from a shuffled pile of cards with the children's names on them and the survey questions were asked about the randomly selected child. The survey took approximately 50 minutes. Participants received a hygiene kit, containing a comb, body sponge, and bar of soap to thank them for their time. Data were collected from June to August 2019.

Survey Design

The survey collected information about participant and child demographics, measles vaccine history, in addition to six different topics related to getting a child vaccination measles: bringing a child to a facility for vaccination; ownership of a form of transportation; routinely traveling with more than one child; transportation costs and other costs association with vaccination, time spent traveling to a facility and complexity of travel; and using a preferred mode of transportation.

We collected demographic information about both the survey participant (the index child's mother) including mother's age, mother's religion, mother's tribe, mother and father's education level, and the amount of time that the mother has been living in Rubaga Division and the index child, including child's age, child's birth order, and child's sex.

We also captured information about the participant's past healthcare seeking behaviors, including questions about the number of antenatal visits during her pregnancy with the index child, the place of birth of the child, where the child had been taken for healthcare previously, and who makes decisions about the child's medical care.

To capture measles vaccination history, study staff requested the index child's Uganda Child Health Card and photographed the vaccinations page, which contains information about the date the child had received each of the childhood vaccines in the government-recommended schedule, including measles vaccine. If a child health card was not available, participants were asked to present any other documentation that included the child's dates of vaccination, and study staff applied the same procedures.

Age at Measles Vaccination

After the survey was complete, data entry staff reviewed each photograph of the child's vaccination record and entered the date of measles vaccination into a REDCap database (65, 66). Data were double-entered, compared, and any discrepancies resolved before being merged into the survey database by a unique participant identifier. The child's month and year of birth was reported by the participants during the survey. We calculated

the child's age in months at time of measles vaccination (MCV1) by comparing the recorded date that the child receiving MCV1 based on the immunization record to the month and year of child's birth. The difference in months between the month and year of the vaccination and the month and year of the child's birth was used to assess whether the child received the MCV1 vaccine on-time (at nine months) or not on time (greater than nine months).

Transportation-specific Barriers to Vaccination

Bringing their child to a facility for vaccination

In order to determine the degree of access participants had to transportation options that met their needs, we asked participants to recall a time when they went to a clinic or hospital to have their child vaccinated and to respond to the following questions based on that experience. If participants had not been to a vaccination facility, we asked them to recall a time when they went to a medical facility with their child for another reason, or, alternatively, a time they had travel outside the house with their child for any another reason. This way, all of the following questions were answered by all participants, even if they had not traveled to a vaccination facility with their child.

Ownership of a form of transportation

In order to determine if a participant had immediate access to any form of transportation, we asked participants if they owned or if a family/household member owned any of the following vehicles: car; truck; bike; motorcycle; tuk-tuk. We classified participants as either living in a household where they or another member owned a vehicle or living in a household where no one owned a vehicle.

Traveling with more than one child

In order to determine if participants had to accommodate traveling with more than one child when in transit, we asked if when they usually brought other children with them when they went to a vaccination facility, other medical facility, or traveled outside the home in general. If so, they specified the number of children with which they usually

traveled. We categorized participants as either traveling with one child (the index child) or traveling with multiple children, including the index child.

Transportation costs and other costs associated with vaccination

In order to determine whether financial constraints are a perceived barrier to vaccination and whether participants reported a lack of funds specifically for transportation, we asked participants two questions about money and transportation. we asked whether a lack of money had prevented participants from vaccinating their child (yes, 1-2 times, yes, 3 or more times; I don't remember; no). Then, we asked them to select all that apply to what they needed this money for: transportation; childcare; food; rent; to replace a day's wages; other; none of the above. From the answers to these two questions, we classified participants into three categories: vaccination was not impacted by a lack of funds; lack of funds specifically for transportation prevented vaccination, or lack of funds for other needs besides transportation prevented vaccination.

Time spent traveling to a facility and complexity of transit

In order to capture the length of time spent traveling to a vaccination facility and the complexity of the multiple modes of transportation needed to access a facility, we asked participants to specify all forms of transportation they use when they take their child to a vaccination facility (bike; taxi; motorcycle taxi; walking; car; other), and to estimate the amount of time, in minutes, they spend on each form of transportation. We used this information to describe the most commonly used modes of transportation, the time spent on each mode of transportation, and the total amount of time participants typically spent traveling to a facility. We categorized length of total travel time to the facility into quintiles.

Preferred mode of transportation

We were also interested in whether participants had access to their preferred mode of transportation, as many interventions to improve access to care have involved offering transport. First, we asked participants to rank the modes of transportation that they typically used from most often to least often (bike; taxi; motorcycle taxi; walking; car; other). Then, we asked participants to recall the same situation of traveling to a

vaccination facility with their child, and to rank modes of transportation they would prefer to use, if they could choose any mode without constraints. We compared participant's typical mode of transportation with their preferred mode and categorized them as either 'having access to their preferred mode of transportation' if their first ranked answer to both questions was the same or as 'not having access to their preferred mode of transportation if their first ranked answer to both questions were different.

Location of vaccination clinic or outreach and distance from household

In order to determine the distance between the participant's household and the location where their child could receive a vaccination, we asked participants to name the clinic, health center, or outreach post where they have gone or where they would go to get a vaccine for their child. The name of the facility was used to determine the location of the facility, by matching the name to location in the spatial database of health facilities managed by the public health sector in sub Saharan Africa by Maina et al. (70), which contains 3,792 facilities, including public and private not for profit hospitals hand health facilities level II to IV. If facility names were not found in this database, we used Google maps to find their location information.

At the time the survey was administered, study staff also captured the latitude and longitude of participant's households via the GPS coordinate recording function within the REDCap mobile application. In order to calculate the distance between participants' households and the clinics identified, we created two separate files, one containing a unique identifier, GPS coordinates for the households, and the name of the facility each participant identified, and a second containing the name and GPS coordinates for clinics, and imported them as separate layers into QGIS (71). Then, we reprojected both layers CRS 32736 UTM zone 36s, converted the coordinates to UTM (Universal Transverse Mercator) format, and then joined the two layers based on the facility names. We then subtracted the coordinates of the clinics from the households to yield the Euclidian distance between the points. This measure of distance in kilometers from household to facility was included in the analysis as a continuous variable.

Factors Associated with On-time Measles Vaccination

The primary outcome of interest is whether the child received measles vaccination on time at nine months or not on time, defined as after nine months of age.

To assess whether the potential transportation barriers described above are associated with the child's on-time measles vaccination, we fit a multivariable logistic regression model. The outcome compared children vaccinated on time to those vaccinated early or delayed. The covariates of interest included in the model were whether they took their child to a facility for a vaccine (vs. not), whether they or a household member owned a form of transportation (vs. did not own), whether they typically traveled with one child (vs. had to bring other children with them), whether money was not a barrier to vaccination (vs. yes it was, it was needed for transportation; yes it was, it was needed for another reason), they spent between 1 and 10 minutes traveling to a facility vs. 11-20, 21-30, 31-49, 50-210), and if they used their preferred form of transportation (vs. did not use their preferred form of transportation). We included the following demographic characteristics to account for potential sources of confounding in the association of interest: mother's age in years (cont.), Muganda tribe (vs. Muyankole; Other), Catholic religion (vs. Anglican; Muslim; Pentecostal; other), mother received no schooling (vs. Primary education; secondary education; post-secondary education), mother employed outside the home (vs. not), child is firstborn (vs. second born; third born; fourth born; fifth or higher), child's age in months (cont.), child is female (vs. male), mother is married to child's father (vs. divorced/separated; widowed; never married and never lived together; no relationship), and the mother did not move into Rubaga during her child's lifetime (vs. yes she did). From this model, we calculated the odds ratio of achieving the primary outcome of achieving on time vaccination.

Factors Associated with On-time Measles Vaccination, Among Participants with Information on the Distance from their Household to a Vaccination Facility

Information of the distance from a participants household to a vaccination facility was only available for a subset of the study population. For this reason, it was not included as

a variable in the main model. To assess whether the potential transportation barriers, including distance to a vaccination facility, are associated with the child's on-time measles vaccination, we fit a second multivariable logistic regression model. The outcome compared children vaccinated on time to those vaccinated early or delayed. Before fitting the model, we measured the correlation coefficient of the continuous distance and time variables. The covariates of interest included in the model were those listed in the last section, with the addition of distance to a facility being 0.06 to 0.61 kilometers (vs. 0.61-1.81; 1.81-2.7; 2.7-4.9; 5.0-227.6). We included the same demographic characteristics to account for potential confounding as in the previous model. From this model, we calculated the odds ratio of achieving the primary outcome of achieving on time vaccination.

Sample Size

This study is powered to be able to detect a difference in vaccination timing(on time vs delayed), considering if someone has access to their preferred form of transportation. To determine the minimum sample size sufficient to detect a difference in the proportion of children receiving MCV on time vs the proportion delayed comparing participants who have access to their preferred method of transportation vs those who do not, we estimated that 50% of children would be vaccinated on time. In order to detect a difference of plus or minus 10 percentage points between the two groups, with and alpha of 0.05 and a confidence level of 0.95, 193 participants per groups would be required for this analysis.

Analysis

We designed the surveys and recorded participant responses using the REDCap electronic data capture software (65, 66). We used Stata 16 for data management and analysis (67).

Ethical Review

This study was reviewed and approved by the Makerere School of Medicine Research and Ethics Committee (SOMREC), the Uganda National Council of Science and Technology (UNCST), and the University of Minnesota Institutional Review Board.

Results

Description of Study Population

In total, 999 participants completed the survey. Participants ranged in age from 17 to 50 years, with a mean age of 28 years. Participants most commonly reported being from the Buganda tribe (53.3%), completing secondary school as their highest level of education (49.6%), being Catholic (35.2%), not being employed outside the home (55.7%), and having only one child (65.9%) (Table 3.1a).

The age of index children about which data were collected ranged from 1 year to 5 years, with a mean of 33 months (2.8 years). Slightly over half of children were male (52.8%), and the largest proportion were the first-born (30.3%) child. Only 24 (2.41%) were part of a multiple birth (Table 3.1b).

Table 3.1a: Demographic characteristics of the study sample (Mothers)

	Proportion of Total		Without information on vaccination		With information on vaccination	
	%	95% CI	n	%	n	%
Age of Mother(categorized)						
Under 20	3.7	2.7, 5.1	25	5.1	12	2.4
20-24	26.7	24.1, 29.6	122	24.8	145	28.6
25-29	34.5	31.6, 37.5	165	33.5	180	35.5
30-34	18.5	16.2, 21.1	98	19.9	87	17.2
35-39	12.3	10.4, 14.5	64	13.0	59	11.6
40+	4.2	3.1, 5.6	18	3.7	24	4.7
Number of children						
1	65.9	62.9, 68.7	324	65.9	334	65.9
2	29.5	26.8, 32.4	143	29.1	152	30.0
3	4.1	3.0, 5.5	22	4.5	19	3.8
4	0.3	0.1, 0.9	2	0.4	1	0.2
5	0.2	0.04, 0.8	1	0.2	1	0.2
Tribe						
Muganda	53.3	50.1, 56.3	256	52.0	276	54.4
Muyankole	13.8	11.8, 16.1	70	14.2	68	13.4
Other	32.8	30.0, 35.8	165	33.5	163	32.2
Missing	0.1	0.01, 0.7	1	0.2	0	0.0
Highest level of education						
Did not attend/don't know	3.4	2.4, 4.7	22	4.5	12	2.4
Primary	38.2	35.3, 41.3	205	41.7	177	34.9
Secondary	49.6	46.5, 52.7	226	45.9	269	53.1
Post-secondary	8.5	6.9, 10.4	37	7.5	48	9.5
Missing	0.3	0.1, 0.9	2	0.4	1	0.2
Religion						
Catholic	35.2	32.3, 38.3	167	33.9	185	36.5
Anglican	23.2	20.7, 25.9	120	24.4	112	22.1
Muslim	21.7	19.3, 24.4	112	22.8	105	20.7
Pentecostal/Born again/Evangelical	16.5	14.3, 19.0	77	15.7	88	17.4
Other	2.4	1,6, 3.6	13	2.6	11	2.2
Missing	0.9	0.5, 1.7	3	0.6	6	1.2
Employed outside the home						
No	55.7	52.6, 58.7	269	54.7	287	56.6
Yes	44.2	41.2, 47.3	222	45.1	220	43.4
Missing	0.1	0.01, 0.7	1	0.2	0	0.0
Relationship status						
Married or Living together	77.2	74.5, 79.7	361	73.4	410	80.9
Divorced/Separated	13.1	11.2, 15.4	76	15.5	55	10.9
Widowed	0.7	0.3, 1.5	6	1.2	1	0.2
Never married and Never living together	7.9	6.4, 9.8	41	8.3	38	7.5
No relationship	0.8	0.4, 1.6	5	1.0	3	0.6
Missing	0.3	0.1, 0.9	3	0.6	0	0.0
Moved to Rubaga in their child's lifetime						
No	77	74.3, 79.5	361	73.4	408	80.5
Yes	22.5	20.0, 25.2	127	25.8	98	19.3

Missing	0.5	0.2, 1.2	4	0.8	1	0.2

Table 3.1a: Demographic characteristics of the survey sample, by whether they had information on their child's vaccination

Table 3.1b:Demographic characteristics of the children of the study sample

	Proportion of Total		Without information on vaccination		With information on vaccination	
	%	95% CI	n	%	n	%
Age of child (months), categorized						
12-24	37.7	34.8, 40.8	167	33.9	210	41.4
25-36	26.2	23.6, 29.0	134	27.2	128	25.3
37-48	16.5	14.3, 19.0	81	16.5	84	16.6
49-60	11.3	9.5, 13.4	62	12.6	51	10.1
61-72	6.5	5.1, 8.2	34	6.9	31	6.1
Missing	1.7	1.1, 2.7	14	2.9	3	0.6
Child's sex						
Female	0.5	44.0, 50.2	241	49.0	229	45.2
Male	0.5	49.6, 55.8	249	99.6	278	54.8
Missing	0.0	0.05. 0.8	2	0.4	0	0.0
Birth order						
First child	0.3	27.6, 33.3	124	25.2	179	35.3
Second	0.3	22.6, 28.0	137	27.9	115	22.7
Third	22.3	19.8, 25.0	104	21.1	119	23.5
Fourth	0.1	10.0, 14.0	65	13.2	53	10.5
Fifth or higher	0.1	8.6, 12.4	62	12.6	41	8.1
Part of a multiple birth						
No	1.0	96.0, 98.1	483	98.2	488	96.3
Yes	0.0	1.6, 3.6	7	1.4	17	3.4
Missing	0.0	0.2, 1.1	2	0.4	2	0.4

Table 3.1b: Demographic characteristics of the children of the survey sample, by whether their information on their vaccination is available

Age at Measles Vaccination

Overall, half (50.7%) of participants in the sample had their date of vaccination available at the time of the survey. Of all participants who had information about their child's date of measles vaccination and month and year of birth at the time of the survey, 43.6% (n=221) were vaccinated for measles on-time, 3.2% (n=32) of children were vaccinated before nine months of age and 50.1% (n=254) of children were vaccinated after nine months of age. the median age at measles vaccination in the sample was 10 months (IQR: 3, 57).

Barriers to On-time Vaccination

Bringing their child to a facility for vaccination

Overall, the majority of participants (89.7%, n=896) reported that they had taken their child to get vaccinated at a facility previously (Table 3.3). Only 91 (9.1%) participants reported that they had never taken their child to get vaccinated, though they had taken

their child to a facility for another reason. The proportions of participants who had taken their child to be vaccination were similar among those who were vaccinated on time and delayed, with about 10% of both groups reporting that they had not taken their child to a facility for a vaccination, but they had taken their child to a facility for another reason.

Personal or household ownership of a form of transportation

We asked participants if they owned or a member of their family/household owned any of the following vehicles: car, truck, bike, motorcycle, or tuk-tuk, and 28.2% (n=282) owned at least one of the vehicles listed, with a motorcycle (n=164) being the most common vehicle to own.

Of the 282 participants who either owned a vehicle themselves, a member of their family owned a vehicle, or both, 42.2% (n=119) reported that they used that type of vehicle to go to a facility with their child. A similar proportion of mothers of children who were vaccinated on time and delayed owned a form of transport within their households.

Traveling with more than one child

The majority of mothers reported that when they traveled to a facility, they traveled with only one child (89.6%, n=893). For the 104 mothers that reported traveling with more than one child, most (81.7%, n=85) traveled with two children, and 19 (1.9%) traveled with between 3 and 6 children. A similar proportion of mothers of children who were vaccinated on time and delayed reported having to travel with more than one child when traveling with the index child, with approximately 11% of participants traveling with more than one child.

Transportation costs and other costs associated with vaccination

We asked participants if lack of money had ever been a reason that prevented them from getting their child vaccinated in the past, and 12.9% of participants (n=45) said yes, it had been a problem and they needed the money for transport, while 4.5% of participants(n=17) said yes, it had been a problem and they needed the money for some other reason. A larger proportion of mothers of children who received a delayed measles vaccination reported that needing money for transport had prevented them from getting their child vaccinated, compared to those who received on-time vaccination (10.2% vs.

8.6%). In addition, a slightly larger proportion of mothers of children who received a delayed measles vaccine reported that money had prevented their child from getting vaccinated form some reason other than transportation, compared to those who were vaccinated on one (3.9% vs. 3.2%).

Time spent traveling to a facility and complexity of transit

The median amount of time it takes to go door-to-door from home to a vaccination facility is 25 minutes, with a range of 1 to 210 minutes. Approximately one third, 34.5% (n=340), of participants travel for more that 30 minutes to reach the facility.

A greater proportion of those who were delayed for vaccination reported traveling for one to ten minutes, and overall, those who were vaccinated on time traveled for a longer amount of time, with 17.4% of those who were vaccinated on time traveling for more than 50 minutes to reach a vaccination facility (Figure 3.1).

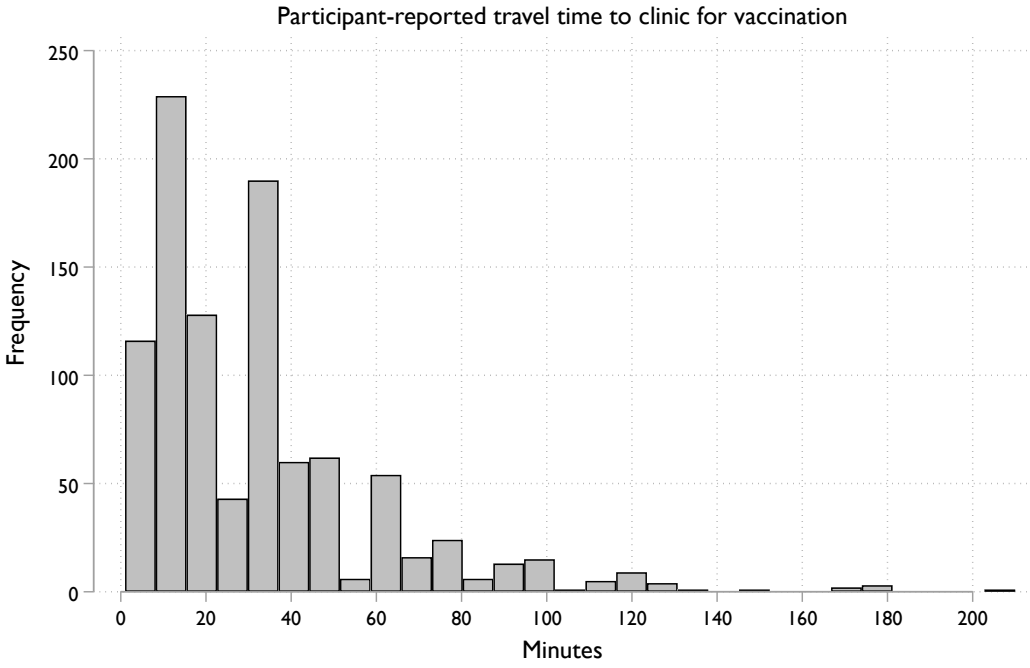

Figure 3.1. Distribution of total travel time to clinic among participants in minutes

Those who did not used their preferred form of transportation

Nearly half of participants (43.3%, n=433) said that walking was the mode of transportation they used most often, almost a third of participants (31.2%, n=312) said they most commonly took a motorcycle taxi (Table 3.2a). Nearly two thirds of participants (61.6%, n=615) said that taking a car was their preferred form of transportation, while a quarter of participants (25.7%, n=257) said they preferred to take a motorcycle taxi (Figure 3.2, Table 3.2b). Over a quarter of participants (30.6%, n=304) take their preferred form of transportation when taking their child for a vaccine. A greater proportion of those who were vaccinated on time took their preferred form of transportation, compared to the proportion of those who were delayed and took their preferred form of transportation (32.6% vs. 29.5%).

Table 3.2a: Distribution of regular forms of transportation

Regular form of transportation	n	%	95% CI
Walk	433	43.3	40.3, 46.4
Motorcycle taxi (boda boda)	312	31.2	28.4, 34.2
Taxi	235	23.5	21.0, 26.3
Car	14	1.4	0.8, 2.4
Bike	2	0.2	0.05, 0.8
Other	1	0.1	0.01, 0.7
Missing	2	0.2	0.05, 0.8
Total	**999**	**-**	

Table 3.2b: Distribution of preferred forms of transportation

Preferred form of transportation	n	%	95% CI
Car	615	61.6	58.5, 64.5
Motorcycle taxi (boda boda)	256	25.6	23.0, 28.4
Taxi	99	9.9	8.2, 11.9
Walk	20	2.0	1.2, 3.1
Bike	1	0.1	0.01, 0.7
Other	1	0.1	0.01, 0.7
Missing	7	0.7	0.3, 1.5
Total	**999**	**-**	

Tables 3.2a-b: Distribution of regular and preferred forms of transportation by type. These tables are ordered by most to least commonly ranked forms of transportation, with walking being the most common form of transportation and taking a car being the most preferred form of transportation.

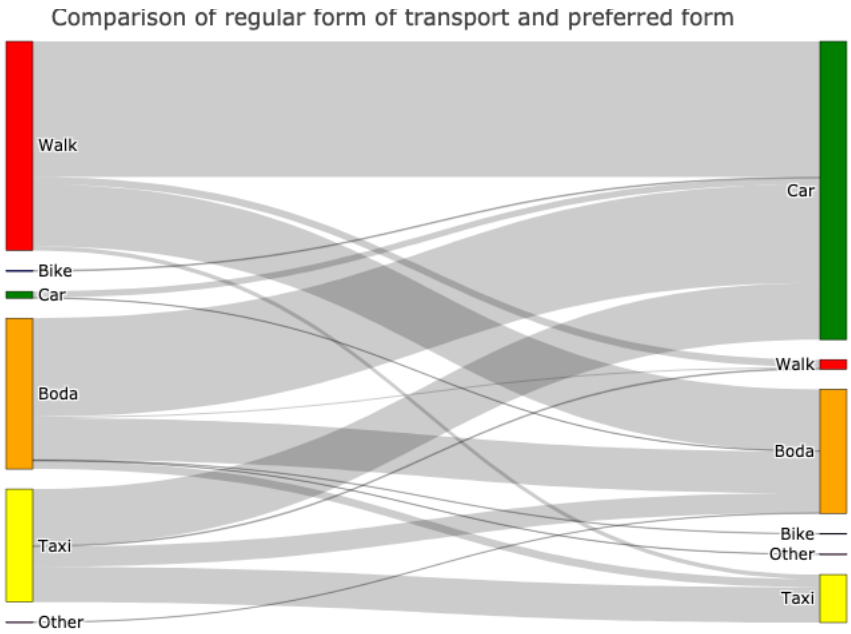

Figure 3.2: Comparison of regular form of transportation and preferred form of transportation among survey participants

Distance traveled

Participants identified 439 unique clinics, with the over half (52%) of the sample reporting one of seven clinics. Of all participants who had non-missing values for both household location and facility information, 46.8% (n=151) reported visiting a facility within 2km of their homes, while 53.3% (n=172) reported a facility between 2 and 277.6 km from their home. Participants reported visiting vaccination facilities that were between 0.07 and 277.6 km from their homes, with the median distance being 2.21km. A greater proportion of mothers of children who were vaccinated on time lived less than two kilometers from their chosen vaccination facility, compared to the proportion of children who received a delayed vaccination (51.9% vs. 44.2%).

Table 3.3: Select transportation-seeking barriers of the study sample

	Proportion of Total		Delayed vaccination		On time vaccination	
	%	95% CI	n	%	n	%
Taken child to clinic for a vaccine						
Yes	89.7	87.6, 91.4	230	90.6	197	89.1
No, but for another reason.	9.1	7.5, 11.1	23	9.1	23	10.4
No, never taken to a clinic at all, but I have taken to other locations.	0.8	0.4, 1.6	1	0.4	0	0
Missing	0.4	0.2, 1.1	0	0	1	0.5
Participant or household owns a form of transportation						
No	71.8	68.9, 74.5	183	72.1	157	71.0
Yes	28.2	25.5, 31.1	71	28.0	64	29.0
Travel with multiple children						
No	89.6	87.5, 91.3	227	89.4	196	88.7
Yes	10.4	8.7, 12.5	27	10.6	25	11.3
Money prevented their child from getting vaccinated						
No	82.6	80.1, 84.8	218	85.8	195	88.2
Yes, for transport	12.9	11.0, 15.1	26	10.2	19	8.6
Yes, for another reason	4.5	3.4, 6.0	10	3.9	7	3.2
Total travel time (minutes), categorized						
1-10	23.6	21.0, 26.3	69	27.4	43	19.6
11-20	23.4	20.8, 26.1	66	26.2	59	26.9
21-30	18.5	16.2, 21.0	51	20.2	54	24.7
31-49	15.0	12.9, 17.4	35	13.9	25	11.4
50-210	19.5	17.2, 22.1	31	12.3	38	17.4
Distance to clinic from household						
Less than 2 kilometers	46.7	41.3, 52.2	42	44.2	28	51.9
2 kilometers or more	53.3	47.8, 58.7	53	55.8	26	48.2
Take preferred form of transportation						
No	69.4	66.5, 72.2	179	70.5	148	67.0
Yes	30.6	27.8, 33.5	75	29.5	72	32.6
Missing	0.4	0.2, 1.1	0	0	1	0.5

Table 3.3: Select transportation-seeking barriers of the study sample, overall, and by whether they achieved delayed or on-time measles vaccination.

Factors Associated with Achieving On-time Measles Vaccination

Of all participants who had information about their child's date of measles vaccination and birthday at the time of the survey, 43.9% (n=221) were vaccinated for measles on-time, which is defined as within the ninth month of age (Figure 3.3, Table 3.4). Of the factors assessed, mothers who had to travel for a longer amount of time, between 21 to 30 minutes or over 50 minutes (compared to those who traveled for 10 minutes or less) [OR=2.5; 95%CI:1.3, 4.9]) had a higher odds of having their child vaccinated on time(Table 3.6). The other barriers assessed in the model did not have significant association with the outcome of on-time vaccination.

Table 3.4: Vaccination status of all children in the sample (n=999)

	n	**%**	**95% CI**
Early	32	3.2	2.3, 4.5
On time	221	22.1	19.7, 24.8
Delayed	254	25.4	22.8, 28.2
No information	492	49.3	46.2, 52.4

Table 3.4: Timing of MCV1 of the sample

Table 3.5: Child's age in months at measles vaccination (MCV1) (n=656)

Age in months	n	%	95% CI
Less than 6	2	0.3	0.1%, 1.2%
6	11	1.7	0.9%, 3.0%
7	4	0.6	0.2%, 1.6%
8	12	1.8	1.0%, 3.2%
9	221	33.7	30.2%, 37.4%
10	159	24.2	21.1%, 27.7%
11	35	5.3	3.9%, 7.3%
12 or more	60	9.2	7.2%, 11.6%
Documentation present, but date missing	152	23.2	20.1%, 26.6%

Table 3.5: Child's age in months at the time of measles vaccination, calculated using month and year of age at birth and date of measles vaccination

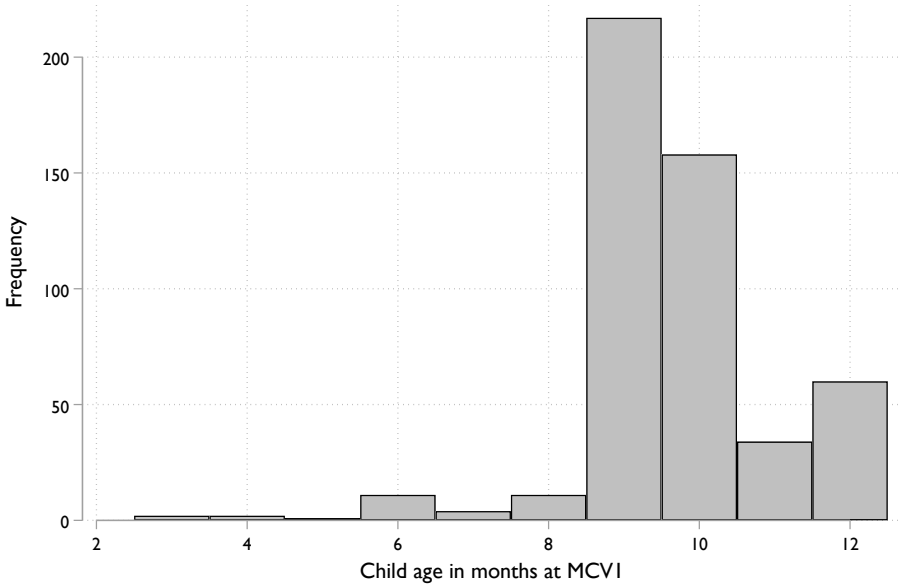

Figure 3.3: Distribution of age of MCV1 vaccination in months

Table 3.6: Factors associated with achieving on-time measles vaccination (n=461)

		OR	95% CI	p-value
Has gone to clinic for a vaccination	No	ref		
	Yes	0.7	0.4, 1.4	0.293
Self or household owns a form of transport	No	ref		
	Yes	0.9	0.6, 1.5	0.761
Travels with multiple children	No	ref		
	Yes	1.1	0.6, 2.1	0.791
Has money ever been a reason you have not gotten your child vaccinated?	No	ref		
	Yes, I needed money for transport	0.9	0.5, 1.7	0.715
	Yes, I needed money for another reason	1.0	0.4, 2.9	0.997
Travel time, categorized (minutes)	1-10	ref		
	11-20	1.6	0.9, 2.8	0.088
	21-30	1.8	1.0, 3.2	0.045
	31-49	1.2	0.6, 2.3	0.648
	50-210	2.5	1.3, 4.9	0.006
Do you take your preferred for of transportation?	No	ref		
	Yes	1.2	0.8, 1.79	0.491
Mother's age in years		1.0	1.0, 1.1	0.673
Tribe	Muganda	ref		
	Muyankole	0.8	0.4, 1.4	0.440
	Other	0.8	0.5, 1.3	0.403
Mother is employed outside the home				
	Yes	ref		
	No	1.6	1.0, 2.4	0.031
Mother's completed level of education	No schooling	ref		
	Primary	2.1	0.4, 10.9	0.362
	Secondary education	2.6	0.5, 3.0	0.256
	Post-secondary education	2.9	0.5, 16.4	0.222
Relationship to child's father	Married	Ref		
	Divorced/Separated	1.0	0.5, 2.0	0.949
	Widowed	1.0		
	Never married and never lived together	0.8	0.4, 1.7	0.588
	No relationship	1.0		
Child's birth order	Firstborn	Ref		
	Second child	0.6	0.3, 1.0	0.050
	Third child	0.5	0.3, 0.9	0.022
	Fourth child	0.5	0.2, 1.2	0.114
	Fifth or higher	0.3	0.1, 0.8	0.020
Child's age in months		1.0	1.0, 1.0	0.350
Child's sex	Female	Ref		
	Male	0.8	0.5, 1.2	0.224
Moved to Rubaga in child's lifetime	No	Ref		
	Yes	0.5	0.3, 0.9	0.019

Table 3.6: Output of multivariable logistic regression model to assess the factors associated with on-time measles vaccination (vs. delayed measles vaccination)

Factors associated with achieving on-time measles vaccination, among participants who had information on the distance from their home to a vaccination facility

For a small subset of participants who had information about their child's date of measles vaccination, we collected information on the location of their household and the vaccination facility they went to. The continuous measures of distance to a facility and time it takes to travel to a facility are not highly correlated, with a correlation coefficient of -0.013, so categorical versions of both variables were kept in the model. Similar to the previous model, mothers who had to travel for a longer amount of time, had a higher odds of achieving on-time vaccination for their child, with the highest odds among those who traveled for 21-30 minute (compared to those who traveled for 10 minutes or less [OR=9.5; 95%CI:1.9, 48.0]). Mothers who had to travel a distance of 2.7 to 4.9 kilometers from their household (compared to those who traveled for 0.61 kilometers or less) [OR=0.17; 95%CI:0.03, 0.9]) had a lower odds of having their child vaccinated on time (Table 3.7).

Table 3.7: Factors associated with achieving on-time measles vaccination, among participants with information on distance to healthcare facility (n=142)

		OR	95% CI	p value
Gone to clinic for a vaccination	No	ref		
	Yes	0.5	0.1, 1.9	0.283
Self or household owns a form of transport	No	Ref		
	Yes	1.3	0.4, 4.0	0.645
Travels with multiple children	No	Ref		
	Yes	1.0	0.1, 8.1	0.974
Has money ever been a reason you have not gotten your child vaccinated?	No	ref		
	Yes, I needed money for transport	0.4	0.1, 2.6	0.299
Travel time, categorized (minutes)	1-10	ref		
	11-20	4.3	1.03, 18.4	0.046
	21-30	9.5	1.9, 48.0	0.007
	31-49	8.1	1.2, 55.4	0.033
	50-210	6.6	1.4, 32.2	0.020
Do you take your preferred form of transportation?	No	ref		
	Yes	0.9	0.3, 2.9	0.887
Distance in kilometers from a vaccination facility	0.06-0.61	ref		
	0.61-1.81	1.0	0.2, 4.6	0.970
	1.81-2.7	0.2	0.04, 1.0	0.055
	2.7-4.9	0.2	0.03, 0.9	0.040
	5.0-277.6	0.8	0.1, 4.0	0.746
Mother's age in years		1.0	0.9, 1.1	0.845
Tribe	Muganda	Ref		
	Muyankole	0.7	0.1, 3.6	0.666
	Other	0.3	0.1, 0.9	0.035
Employed	Yes	Ref		
	No	1.3	0.5, 3.7	0.617
Mother's completed level of education	No schooling	ref		
	Primary	4.8	0.3, 90.0	0.297
	Secondary education	12.2	0.6, 233.8	0.098
	Post-secondary education	4.8	0.2, 149.2	0.373
Relationship to child's father	Married	Ref		
	Divorced/Separated	3.4	0.7, 15.9	0.126
	Widowed	0.6	0.1, 6.0	0.637
Child's birth order	Firstborn	Ref		
	Second born	1.7	0.4, 6.9	0.433
	Third born	0.7	0.2, 3.0	0.619
	Fourth bourn	6.1	0.8, 47.0	0.084
	Fifth or higher	4.1	0.3, 67.1	0.325
Child's age in months		1.0	0.9, 1.0	0.013
Child's sex	Female	ref		
	Male	0.6	0.2, 1.6	0.320
Moved to Rubaga in child's lifetime	No	ref		
	Yes	0.5	0.2, 1.6	0.259

Table 3.7: Output of multivariable logistic regression model to assess the factors associated with achieving on-time measles vaccination (vs. delayed measles vaccination),

among participants with information on the distance from their household to a vaccination facility

Discussion

In this study, we aimed to assess the relationship between transportation barriers, including financial barriers, transportation logistics, and preferred forms of transportation and whether the child received their measles vaccination on time.

We found that among those who experience a financial barrier to vaccination, paying for transportation is the most common reason. The most common regularly used form of transportation among participants was walking, while the most common preferred form of transportation was a car. Only about one third of participants were using their preferred form of transportation to take their child to a facility for a vaccine. We found that, of the barriers to transportation that were assessed in this study, only the amount of time it takes to travel to a vaccination facility and the distance to the facility had an association with the outcome of on time measles vaccination.

This study builds upon a structural framework for barriers to vaccination access to low- and middle-income countries (56) by quantifying the extent to which transportation is cited as a barrier to on-time vaccination or that parents opt to used suboptimal transportation to reach the clinic. These findings add to the analysis of the Demographic Health Survey (DHS) data on vaccination coverage in Eastern Africa, which hypothesized that transport forms and transport time may impact childhood vaccination rates(72).

Unlike a study in Mozambique that linked 10 km increases with 36% greater odds not being fully immunized (73), we did not detect a relationship between distance from the clinic and vaccination status, which is possibly a function of a greater density of clinics in an urban area and a large amount of missing data on distance in our sample. In a study of risk factors for delay of timely vaccination among Gambian children, mothers who were reliant on public transportation had a higher odds of their measles vaccine for their child being delayed [OR:1.43; 95%CI:1.12–1.83] compared to those who walked, while those that took private transportation had a lower odds of delayed vaccination (74). The delay

associated with public transportation which may be a result of both not owning a form of transportation and also taking a longer amount of time to travel on public transit as we observed in our study.

Other studies in similar settings, including The Gambia (52), Senegal (48), and Burkina Faso (51), found that the delayed receipt of most vaccines was associated with living in urban areas, which is attributable to urban children relying on their mothers' own initiative to get vaccinated, rather than the outreach services seen in rural areas (51). This suggests that there is more to do to support mothers living in urban areas when it is time for them to bring their child for a vaccination.

There was a substantial amount of missing data for the GPS coordinate locations of the households. This was attributed to a technological issue with the tablets used to collect the data and a connectivity problem, in which certain devices were unable to collect GPS coordinates due to low or no connectivity. For this reason, data on the distance to the clinic was only included in a sub analysis and not in the main model of the study. The missingness of the location data is related to at what time in the study the data was collected. GPS data collected in the first month of the study is thought to be missing at random, but in the second month of the study, additional equipment was used by data collectors to boost the likelihood of the tablets collecting location information. Before any additional analyses can be done with this data, a sensitivity analysis to determine the relationship between the timing of the data collection and the missingness of the GPS data should be conducted. Future work with this data could include imputation of the missing locations, based on adjacent GPS coordinates.

This cross-sectional study can only measure association of certain factors with the outcome, rather than causal relationships, because the direction of the causality cannot be determined with the available information. The outcome measure of timeliness are only based on information gathered from the child health cards. It is possible that there are underlying difference between those who do and do not have a health card, and that relying on assessing an outcome base on this alone could bias the sample.

Conclusion

This study is among the first to explicitly ask parents about their transportation preferences, financial barriers and distances to vaccination clinics context of understanding the impact it has on the timing of vaccination. By identifying the relationship between these gaps and on-time vaccination, this study highlights transport and financial incentives as a potential area for future research and implementation science.

CHAPTER 4 (MANUSCRIPT 3): IS THERE AN ASSOCIATION BETWEEN MOTHERS' PERCEIVED BARRIERS TO HEALTHCARE AND CHILDREN'S ON-TIME MEASLES VACCINATION IN UGANDA IN URBAN AND RURAL SETTINGS?

Introduction

Although much is understood about the factors that contribute to children receiving a measles vaccination, less is known about the specific factors that contribute to children being vaccinated on time, per the recommended schedule. In Uganda, measles vaccine (MCV1) is administered at nine months of age. Measuring the coverage of measles vaccination at a single point in time does not provide an estimate of the timeliness of the vaccination or a full picture of how protected the population is at a given time. Achieving on-time measles vaccination, defined as a child being vaccinated in the ninth month of age, maximizes the protective benefits for the child and contributes to herd immunity for measles.

Understanding the determinants of on-time measles vaccination at a national level is important for the creation of targeted interventions and national policies to improve vaccination timeliness (75). Considering timing of vaccination in addition to coverage provides a more comprehensive view of the level of immunity within a population (14).

Other studies have explored the factors associated with immunization coverage(76) and completeness of childhood vaccines(72) in Uganda with DHS data but not on timing specifically. DHS data has also been used to detect clusters of measles of low vaccination (40) and to understand the risk factors associated with delayed vaccination in children in other countries. One study of Ethiopian children, using the 2011 Ethiopia DHS, found that low wealth status, home delivery, religion, and ethnicity are risk factors for delayed vaccination of multiple childhood vaccinations, including measles (46).

Understanding the determinants of on-time measles vaccination at a national level is important for the creation of targeted interventions and national policies to improve vaccination timeliness. This study explores the determinants of on time measles

vaccination among Ugandan children using the 2016 Uganda Demographic and Health Survey (DHS) data. The combination of nationally representative vaccine information and a diverse set of health indicators collected at the individual and household level provides an opportunity to examine the relationship between factors, including urban/rural status, and vaccination at a national level.

This study investigates the association between mother's perceived barriers to care and on time measles vaccination among children in all regions of Uganda overall and by urban/rural status. In the previous two chapter, the study sample of interest has been focused on urban populations, with both analyses using data from a population of mother living in an exclusively urban environment in Kampala, Uganda. This chapter will again explore the question of what may influence the timing of a child's measles vaccination, but at a larger scale, looking at data collected from across the country.

Aims and objectives

Aim 1: Assess whether perceived barriers to care are associated with failure to achieve on-time measles vaccination, compared to ability to achieve on-time measles vaccination (MCV1), among children in Uganda, by comparing the frequency of barriers identified by mothers of children vaccinated in the ninth month of age (on-time) to children who receive vaccination not on time.

Objectives

1a: Calculate the proportion of children vaccinated on time (defined as received at least one measles vaccine in the ninth month of age), overall, and within strata defined by urban/rural status. Then, compare those proportions to see if there is an urban/rural difference.

Hypothesis: A greater proportion of children will be vaccinated for measles than not vaccinated overall, and a greater proportion of children will be vaccinated delayed in rural areas, compared to urban areas.

1b. Assess the proportion of children vaccinated early, on time, and delayed, as defined in Objective 1a, and calculate the median and IQR number of days before or after the recommended timing of vaccination.

Hypothesis: Of the children who received delayed vaccination, the median number of days delayed will be 30, indicating that most children who are delayed get vaccinated in the tenth month of age. Of the children who receive early vaccination, the median number of days delayed will be less than 90, indicating that the earlier vaccination will be in children age 6 months or older.

1b: Describe the prevalence of self-reported barriers to healthcare access among mothers of young children in Uganda. Self-reported barriers include: Lack of money for treatment, Permission to seek care, Distance to healthcare facility(HCF), and not wanting to go alone) as a problem. Compare differences in prevalence of barriers to healthcare access by urban/rural status.

Hypothesis: A greater proportion of mothers will report at least one barrier to healthcare as being a problem in rural areas, compared to those in urban areas.

1d: Determine whether there is an association, and quantify the degree of association, between each of the mothers' perceived barriers to healthcare access and failure to achieve on-time measles vaccination for their child (compared to achieving on-time vaccination). Compare differences in association by urban/rural status.

Hypothesis: Reporting that the distance to clinic is a perceived barrier to healthcare(vs. not a perceived barrier) will have the largest association with on time vaccination, relative to other perceived barriers.

Methods

Data Source

The Demographic and Health Survey is a nationally representative household survey that provides data for a wide range of monitoring and impact evaluation indicators on the areas of population health and nutrition (77). The Uganda sample is based on a stratified two-stage cluster design, which included enumeration areas (EA) drawn from the 2014

Uganda National Population and Housing Census (NPHC), conducted by the Uganda Bureau of Statistics, at the first stage. The second stage is a sampling of households from within a selection of EAs. In Uganda, an EA is a geographic area that covers an average of 130 households. DHS surveys are conducted over a period of 18-20 months (78). At the time of the NPHC, Uganda was divided administratively into 112 districts, which were grouped for this survey into 15 regions. The sample for the 2016 UDHS was designed to provide estimates of key indicators for the country as a whole, for urban and rural areas separately, and for each of the 15 regions (79). The implementing organization for the UDHS is the Uganda Bureau of Statistics (UBOS) (79). Urban and rural designations for EAs are derived from the Uganda NPHC and provided by UBOS (79).

The latest Uganda Demographic and Health Survey (UDHS) was conducted from June-December 2016 using the latest version of the DHS surveys (DHS-7). Data for this analysis was downloaded in a harmonized form from IPUMS Uganda DHS children's sample, which integrates key variables from the children, mothers, and household surveys over time (77, 80). Therefore, the characteristics of each child are linked to those of their mother and household.

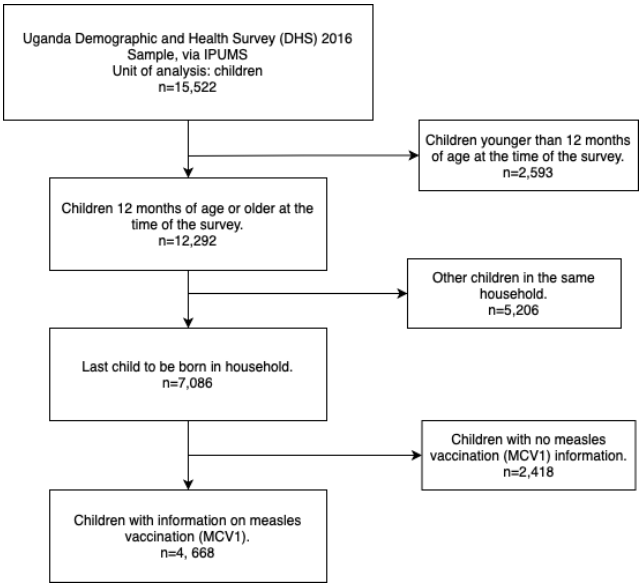

Figure 4.3: Overview of study sample

The survey collected information on 15,522 children born in the five years preceding the survey. Of them, the sample was reduced to include children who were 12 months of age or older at the time of the survey, in order to capture the timing of their measles vaccination up to 12 months of age. We reduced the sample to the 7,086 children who were the last born in the household, so duplicate information of mother or household

from other siblings is not included in the analysis. The last exclusion was of children who did not have information on their measles vaccination. The final sample includes 4668 children (Figure 4.1).

Information on Vaccination

UDHS survey administrators collected information on vaccination in two ways: from vaccination cards shown to the survey administrator and from mothers' verbal reports at the time of the survey. If the vaccination cards were available, the interviewer copied the date of each vaccination directly into the questionnaire. If the vaccination card was not retained, or if a vaccine had not been recorded on the card as being given, the respondent was asked to recall the vaccines given to her child (78).

Timing of Child's Measles Vaccination

We categorized all children in the sample as either having received or not received a measles vaccine, based on either their vaccination card or mother's verbal report. When a card with recorded dates was available, we calculated the age at vaccination by subtracting the date of vaccination from the date of their birth. Children were categorized as either being vaccinated on time, defined as receiving their vaccine between the ages of 266 and 311 days, or receiving it delayed, which included those that were vaccinated after the age of 311 days.

We calculated frequencies and descriptive statistics for demographic categories for the mother, child, and household. We reported the counts for each characteristic, along with the weighted proportion of the sample overall and by urban/rural status.

The individual-level sample weights were included in the acquisition of the DHS sample and are used in the weighted calculations. Sample weights are inversely proportional to the probability of selection and are used to correct for the under- or over-sampling of different strata during sample selection. Weighted estimates reduce the bias toward the levels and relationships in the over-sampled strata. Overall, these weights are used to correct for the sample designs of the different surveys and improve the representativeness of estimates made from the data.

Factors Associated with On-time Measles Vaccination

To assess whether potential barriers to healthcare are associated with the child's on-time measles vaccination, we fit a multivariable logistic regression model. The outcome compared children vaccinated on time to those who were vaccinated delayed. The covariates of interest included in the model were the following potential barriers to care: Not wanting to go alone is not a big problem (vs. is a big problem), distance to clinic is not a big problem (vs. is a big problem), not having enough money is not a big problem (vs. is a big problem), needing permission is not a big problem (vs. is a big problem). The model also included the following demographic characteristics as predictors mother is age in years (continuous) , mother is Not currently working (vs. skilled work; agricultural work; Services/sales; missing), mother is Catholic(vs. Anglican; Muslim; Pentecostal-based; other); mother has no education (vs. Primary; Secondary; Higher), mother is currently married (vs. never married; formerly married), mother delivered her last child at home (vs. government facility; private facility; other), child's age in months (continuous), child is male(vs. female), child is the firstborn (vs. second; third; fourth; fifth; sixth or higher), household is in Kampala region (vs. Central 1; Central 2; Busoga; Bukedi; Bugishu; Teso; Karamoja; Lango; Acholi; West Nile; Bunyoro; Tooro; Ankole; Kigezi), household is in the middle wealth quintile (vs. Poorest; Poorer; Richer; Richest) , and household is in an urban area(vs. rural). The independent variables included in the model were entered a priori. From this model, we will calculate the odds ratio of achieving the primary outcome of on time vaccination. In order to assess whether the association differed by urban/rural status, after fitting the model with the whole study sample, we stratified by urban/rural status, excluding urban/rural status as an independent variable on the model.

Results

Characteristics of the Sample

After applying the inclusion criteria, 4,668 children and their mothers were retained in the sample. Mother's ages ranged from 15 to 49 years, with a mean age of 28 years.

Participants most commonly reported being employed in agricultural work (44%), having completed primary school as their highest level of education (60.4%), being Catholic (39.3%), not being employed outside the home (55.7%), being currently married (81.3%) (Table 4.1a).

Table 4.1a: Demographic characteristics of the sample (mothers)

				Urban		Rural	
	n	Weighted %	95% CI	n	Weighted %	n	Weighted %
Age in years, categorized							
15-19	344	7.4	6.6, 8.4	55	6.0	289	7.9
20-24	1343	29.1	27.7, 30.6	291	30.3	1052	28.7
25-29	1168	25.6	24.2, 27.0	271	31.0	897	23.9
30-34	933	19.4	18.0, 20.7	188	20.0	745	19.2
35-39	565	11.9	10.9, 13.0	81	8.2	484	13.0
40-44	250	5.3	4.7, 6.1	36	3.7	214	5.8
45-49	65	1.3	1.0, 1.8	9	0.8	56	1.5
Employment status							
Not currently working	729	16.4	14.8, 18.1	206	22.4	523	14.5
Skilled work	946	19.9	18.4, 21.5	228	24.9	718	18.3
Agricultural work	2108	44.0	41.4, 46.7	143	13.8	1965	53.6
Unskilled work	262	5.5	4.5, 6.6	111	12.4	151	3.3
Services/Sales	619	14.1	12.7, 15.7	242	26.4	377	10.2
Missing	4	0.1	0.0, 0.2	1	0.1	3	0.1
Religion							
Catholic	1912	39.3	37.1, 41.6	339	36.4	1573	40.3
Anglican	1414	30.6	28.8, 32.5	240	26.2	1174	32.0
Muslim	598	14.0	12.2, 15.9	201	21.2	397	11.7
Pentecostal-based	600	13.3	12.0, 14.6	130	14.3	470	13.0
Other	144	2.8	2.3, 3.5	21	2.0	123	3.1
Education level							
No education	551	9.4	8.4, 10.6	54	4.8	497	10.9
Primary	2886	60.4	58.2, 62.5	371	38.1	2515	67.4
Secondary	958	23.3	21.5, 25.3	352	40.4	606	18.0
Higher	273	6.8	5.9, 7.9	154	16.7	119	3.7
Marital status							
Never married	270	6.2	5.4, 7.1	90	9.0	180	5.3
Currently married	3840	81.3	79.8, 82.6	715	77.4	3125	82.5
Formerly married	558	12.5	11.4, 13.8	126	13.6	432	12.2

Place of last delivery							
At home	1141	23.3	21.4, 25.3	95	11.0	1046	27.2
Government facility	2782	59.5	57.3, 61.5	598	63.3	2184	58.3
Private facility	669	15.9	14.3, 17.5	235	25.3	434	12.9
Other	76	1.4	1.1, 1.8	3	0.4	73	1.7

Table 4.1: Summary of characteristics of the mothers of children in the sample overall and by urban/rural status

Table 4.1b: Characteristics of the sample (children)

				Urban		Rural	
	n	Weighted %	95% CI	n	Weighted %	n	Weighted %
Child age							
12-17m	1399	29.9	28.4, 31.6	277	30.0	1,122	29.9
18-23m	1315	27.8	26.3, 29.2	261	27.3	1,054	27.9
24-29m	1125	23.8	22.4% 25.2	208	22.1	917	24.3
23-36m	829	18.5	17.0, 20.2	185	20.6	644	17.9
Child sex							
Male	2439	52.5	51.0, 54.0	479	52.0	1,960	52.7
Female	2229	47.5	46.0, 49.0	452	48.0	1777	47.3
Child's birth order							
First	965	21.7	20.2, 23.2	277	29.6	688	19.2
Second	865	18.7	17.4, 20.0	208	22.7	657	17.4
Third	738	16.5	15.3, 17.8	162	18.6	576	15.8
Fourth	580	12.1	11.0, 13.2	108	11.1	472	12.4
Fifth	463	9.7	8.7, 10.7	80	8.5	383	10.0
Sixth or higher	1057	21.4	19.9, 23.0	96	9.5	961	25.2

Table 4.1b: Summary of characteristics of the children in the sample overall, and by urban/rural status

The age of children ranged from 12-36 months. Slightly over half of children were male (52.5%), and 21.7% were the first-born child (Table 4.1b). The proportion of children who were lower in the birth order is higher in urban that rural areas (29.6% vs. 19.3% firstborn, and 22.7% vs. 17.4% second born). Overall, 83.2% of children were vaccinated for measles, with a slightly higher proportion vaccinated for measles in urban areas compared to rural (86.1% vs. 82.2%) (Table 4.2).

Table 4.1c: Characteristics of the sample (household)

				Urban		Rural	
	n	weighted %	95% CI	n	Weighted %	n	Weighted %
Wealth quintile							
Poorest	1,191	21.3	19.6, 23.2	93	7.7	1,098	25.6
Poorer	1,027	20.8	19.2, 22.4	49	4.6	978	25.9
Middle	844	18.1	16.7, 19.7	67	6.5	777	21.8
Richer	794	18.0	16.4, 19.8	146	15.4	648	18.8
Richest	812	21.7	19.1, 24.6	576	65.8	236	7.8
Region							
Kampala	265	4.8	3.9, 5.9	265	20.2	0	0.0
Central 1	373	12.9	10.8, 15.3	115	23.3	258	9.6
Central 2	364	10.4	9.0, 11.9	85	11.5	279	10.0
Busoga	370	8.4	7.1, 9.9	32	4.5	338	9.6
Bukedi	332	7.0	6.1, 7.9	35	3.2	297	8.1
Bugishu	233	4.7	4.1, 5.4	38	3.8	195	5.0
Teso	342	6.1	5.4, 6.9	29	3.0	313	7.0
Karamoja	242	2.5	1.9, 3.4	33	2.4	209	2.6
Lango	324	5.9	5.1, 6.7	20	1.4	304	7.3
Acholi	289	5.2	4.4, 6.0	47	4.2	242	5.5
West Nile	365	7.8	6.7, 9.0	33	3.0	332	9.3
Bunyoro	312	5.5	4.7, 6.5	46	2.9	266	6.3
Tooro	375	8.6	7.5, 9.8	75	7.8	300	8.8
Ankole	274	6.9	6.0, 7.8	53	6.8	221	6.9
Kigezi	208	3.4	3.0, 3.9	25	1.9	183	3.9

Table 4.1c: Summary of characteristics of the households in the sample overall, and by urban/rural status

Table 4.2: Proportion vaccinated for measles

				Urban		Rural	
Vaccinated for measles	n	Weighted %	95% CI	n	Weighted %	n	Weighted %
No	744	16.8	15.4, 18.4	126	13.9	648	17.8
Yes	3886	83.2	81.6, 84.6	804	86.1	3082	82.2

Table 4.2: Vaccination status of study sample, stratified by urban and rural status

A greater proportion of households in rural areas are in the two lowest wealth quintiles when compared to urban areas (25.6% in the poorest wealth quintiles. 7.7% in urban areas), which is not unexpected, considering the means of income are more limited in rural areas and more of the population work in agriculture, which is likely subsistence farming (53.6% in rural areas, compared to 13.8% in urban areas) (Table 4.1c).

Prevalence of Perceived Barriers to Care

Table 4.3: Perceived barriers to care

				Urban		Rural	
Not wanting to go alone	n	Weighted %	95% CI	n	Weighted %	n	Weighted %
Not a big problem	3693	79.1	77.4, 80.7	82 2	87.3	2871	76.6
Is big problem	975	20.9	19.3, 22.6	10 9	12.7	866	23.4
Lack money for treatment							
Not a big problem	2398	54.0	52.0, 55.9	59 1	63.7	1,80 7	50.9
Is big problem	2270	46.0	44.1, 48.0	34 0	36.3	1,93 0	49.1
Distance to facility							
Not a big problem	2,75 0	61.1	58.7, 63.4	74 4	80.1	2006	55.1
Is big problem	1,91 8	38.9	36.6, 41.3	18 7	19.9	1731	44.9
Needing permission							
Not a big problem	4417	94.9	94.0, 95.6	90 6	97.7	3511	93.9
Is big problem	251	5.1	4.4, 6.0	25	2.3	226	6.1

Table 4.3: Summary of the proportion of mothers who reported barriers to care that were and were not a big problem overall, and by urban/rural status

Overall, the most common perceived barrier to care was lacking money for treatment, with 46% (n=2270) of the sample saying it was a big problem. In rural settings, this barrier was even more common, with nearly half (49.1%, n=2270) saying it was a big problem. For all four barriers, a greater proportion of participants in rural areas reported barriers to care, compared to participants in urban areas. Needing permission before seeking healthcare was the least common, with on 5.1% (251) of participants saying it was a big problem, overall (Table 4.3).

Factors Associated with On-time Measles Vaccination

Table 4.4: On time and delayed measles vaccination

				Urban		Rural	
Vaccinated on time	n	Weighted %	95% CI	n	Weighted %	n	Weighted %
No (delayed)	760	33.7	31.4, 36.1	109	24.7	651	36.3
Yes (on time)	1,413	66.3	63.9, 68.6	303	75.3	1,110	63.7

Table 4.4: Proportion of children who were vaccinated for measles on time and delayed overall and by urban/rural status

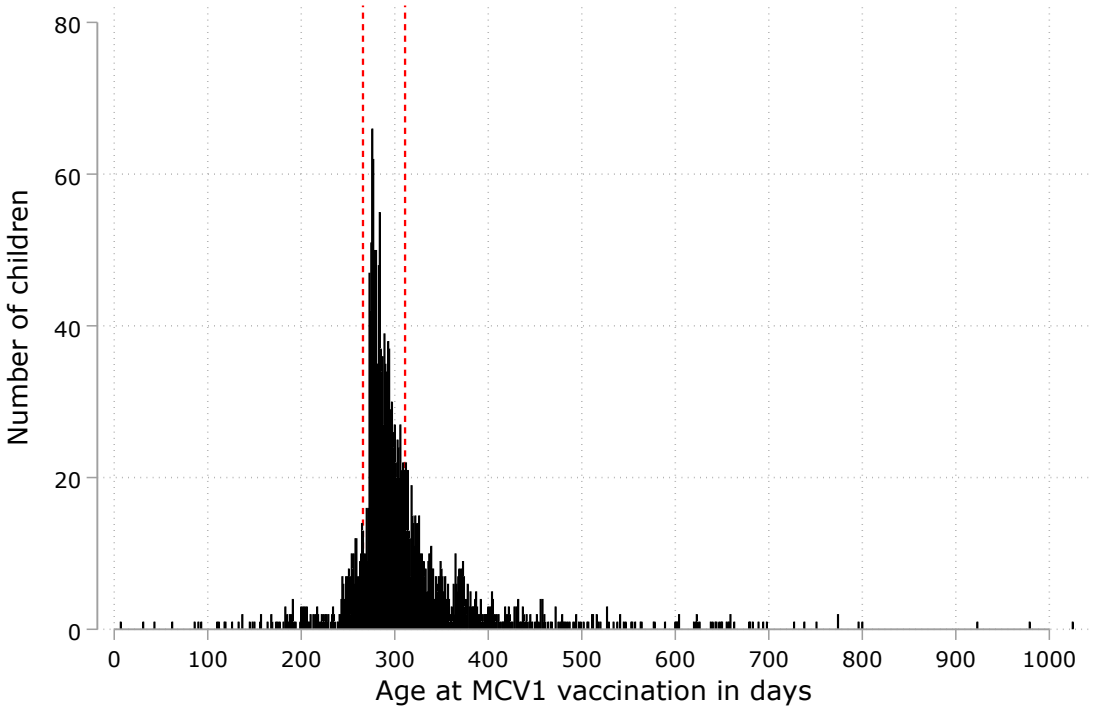

Figure 4.2: Age in days at measles vaccination (MCV1): Histogram of age in days at MCV1 vaccination of sample. The dotted lines indicate the range of days that designate an on-time vaccination for measles.

Of all participants who had information about their child's date of measles vaccination the time of the survey, 66.3% (n=1413) were vaccinated for measles on time (Table 4.4, Figure 4.2). Of the factors assessed, mothers who were currently married had a higher odds of achieving on time vaccination for their child (compared to mother who were unmarried OR=2.08; 95%CI:1.23, 3.53]). In addition, children in households in the richest wealth quintile had a higher odds of achieving on time measles vaccination (compared to children from households in the middle wealth quintile [OR=1.61; 95%CI:1.06, 2.44]).

Older children had a lower odds of being vaccinated on time with every one-month increase in age (OR=0.82; 95%CI:0.67, 0.99]) and children who were fourth in the birth

order or higher had a lower odds of being vaccinated on time (compared to the firstborn [OR=0.54; 95%CI: 0.36, 0.81], with similar trend for higher birth orders) (Table 4.5).

Factors Associated with On-time Measles Vaccination in Urban Areas

Among those living in urban areas, 75.3% (n=303) achieved on time measles vaccination., which is a higher proportion than the sample overall and a higher proportion than those living in rural areas. Of the factors assessed, mothers who said that going to a facility alone was a perceived barrier to healthcare had a lower odds of achieving on time measles vaccination or their child (compared to those who said it was not a problem [OR=0.38; 95%CI:0.16,0.87]). Similar to the full sample, children who were higher in the birth order had a lower odds of being vaccinated don time, especially those who were the sixth born or higher (compared to children who were first born [OR=0.11; 95%CI:0.03, 0.49]) (Table 4.5).

Factors Associated with On-time Measles Vaccination in Rural Areas

Among those living in rural areas, 63.7 % (n=1,110) achieved on time measles vaccination. Similar to the full study sample, mothers who were currently married had a higher odds of achieving on time vaccination or their children (compared to mothers who were never married [OR=1.96; 95%CI:1.11, 3.46]). Also similar to the full study sample, older children had a lower odds of being vaccinated on time with every one-month increase in age (OR=0.81; 95%CI:0.65, 0.99]) (Table 4.5).

Table 4.5: Model output of multivariable logistic regression with an outcome of MCV1 vaccination on time vs. delayed

	Overall (n=2,170)			Urban (n=394)			Rural (n=1,759)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Not want to go alone									
Is not a big problem	ref			ref			ref		
Is big problem	0.88	0.68, 1.12	0.288	0.38	0.16, 0.87	0.022	0.99	0.76, 1.28	0.911
Distance to facility									
Is not a big problem	ref			ref			ref		
Is big problem	0.93	0.75, 1.16	0.545	1.42	0.66, 3.05	0.368	0.92	0.73, 1.16	0.462
Lack of money for treatment									
Is not a big problem	ref			ref			ref		
Is big problem	1.13	0.91, 1.41	0.257	1.54	0.78, 3.02	0.215	1.11	0.87, 1.40	0.404
Getting permission									
Is not a big problem	ref			ref					
Is big problem	1.03	0.68, 1.56	0.885	0.92	0.16, 5.20	0.927	1.00	0.65, 1.54	1.000
Mother's age (years)	1.00	0.98, 1.03	0.860	1.04	0.97, 1.12	0.254	1.00	0.97, 1.02	0.770
Employment status									
Not currently working	ref			ref			ref		
Skilled work	0.89	0.64, 1.23	0.476	1.18	0.53, 2.64	0.687	0.83	0.57, 1.19	0.304
Agricultural work	0.90	0.68, 1.21	0.493	1.46	0.58, 3.69	0.422	0.85	0.62, 1.17	0.315
Unskilled work	1.22	0.72, 2.08	0.464	4.05	1.12, 14.72	0.033	0.92	0.50, 1.72	0.802
Services/Sales	1.04	0.72, 1.51	0.838	1.92	0.85, 4.30	0.116	0.89	0.58, 1.38	0.610
Missing	1.00	0.00, 0.00		1.00	0.00, 0.00		1.00	0.00, 0.00	
Religion									
Catholic	ref			ref			ref		
Anglican	1.02	0.81, 1.27	0.867	1.16	0.57, 2.36	0.679	1.01	0.79, 1.28	0.956
Muslim	0.73	0.52, 1.02	0.065	0.98	0.44, 2.19	0.952	0.69	0.47, 1.01	0.057
Pentecostal-based	1.00	0.73, 1.36	1.000	1.20	0.49, 2.97	0.686	0.95	0.68, 1.34	0.771
Other	1.17	0.64, 2.12	0.608	0.74	0.14, 3.83	0.719	1.32	0.69, 2.52	0.403
Level of education									
No education	ref			ref			ref		
Primary	0.91	0.64, 1.28	0.589	0.20	0.03, 1.25	0.084	0.96	0.67, 1.37	0.826
Secondary	1.08	0.71, 1.64	0.724	0.23	0.03, 1.63	0.141	1.07	0.69, 1.68	0.752
Higher	1.27	0.69, 2.31	0.442	0.17	0.02, 1.35	0.093	1.55	0.74, 3.24	0.246
Marital status									
Never married	ref			ref			ref		
Currently married	2.08	1.23, 3.53	0.006	3.09	0.65, 14.80	0.157	1.96	1.11, 3.46	0.021
Formerly married	0.95	0.68, 1.32	0.758	0.63	0.26, 1.57	0.325	1.02	0.71, 1.47	0.901
Child's delivery location									
At home	ref			ref			ref		
Government facility	1.12	0.89, 1.42	0.339	1.69	0.65, 4.38	0.283	1.10	0.86, 1.41	0.460
Private facility	1.43	1.01, 2.01	0.043	2.11	0.69, 6.49	0.191	1.46	1.00, 2.13	0.051
Other	1.03	0.50, 2.09	0.939	1.00			1.15	0.55, 2.41	0.701
Kid age in months	0.82	0.67, 0.99	0.037	0.95	0.54, 1.66	0.852	0.81	0.65, 0.99	0.041
Child's sex									
Male	ref			ref			ref		
Female	0.92	0.76, 1.10	0.366	0.79	0.46, 1.36	0.400	0.96	0.78, 1.17	0.689
Child's birth order									
First	ref			ref			ref		
Second	0.83	0.60, 1.15	0.257	0.61	0.27, 1.41	0.247	0.90	0.63, 1.29	0.557
Third	0.81	0.57, 1.15	0.229	0.78	0.31, 1.97	0.595	0.79	0.53, 1.16	0.232
Fourth	0.54	0.36, 0.81	0.003	0.30	0.10, 0.91	0.034	0.60	0.38, 0.93	0.023
Fifth	0.62	0.39, 0.97	0.037	0.37	0.10, 1.34	0.128	0.66	0.40, 1.09	0.107
Sixth or higher	0.55	0.34, 0.91	0.021	0.11	0.03, 0.49	0.004	0.67	0.39, 1.17	0.160
Household region									
Kampala	ref			ref					
Central 1	0.70	0.36, 1.35	0.288	0.84	0.31, 2.28	0.734	ref		
Central 2	1.05	0.52, 2.10	0.890	1.95	0.56, 6.79	0.295	1.35	0.75, 2.44	0.317
Busoga	0.65	0.33, 1.29	0.222	0.67	0.17, 2.68	0.572	0.87	0.50, 1.53	0.632
Bukedi	0.98	0.48, 1.98	0.954	0.57	0.14, 2.35	0.434	1.52	0.85, 2.72	0.155
Bugishu	0.86	0.41, 1.80	0.685	0.33	0.07, 1.53	0.156	1.31	0.70, 2.47	0.396
Teso	1.30	0.64, 2.63	0.474	1.00	0.00, 0.00		1.57	0.88, 2.81	0.130
Karamoja	0.40	0.18, 0.86	0.020	0.06	0.01, 0.63	0.019	0.65	0.33, 1.29	0.216
Lango	0.80	0.39, 1.62	0.531	1.32	0.21, 8.20	0.766	1.03	0.58, 1.83	0.920
Acholi	1.22	0.60, 2.47	0.587	1.56	0.41, 5.97	0.518	1.72	0.94, 3.14	0.079
West Nile	0.69	0.35, 1.35	0.279	0.55	0.15, 2.05	0.369	1.00	0.57, 1.74	0.994

Bunyoro	0.97	0.49, 1.92	0.934	4.88	0.94, 25.33	0.059	1.15	0.66, 2.01	0.612
Tooro	0.96	0.49, 1.88	0.897	1.07	0.36, 3.24	0.900	1.39	0.80, 2.42	0.246
Ankole	0.54	0.28, 1.07	0.076	0.77	0.24, 2.48	0.660	0.75	0.43, 1.31	0.310
Kigezi	0.61	0.30, 1.23	0.169	0.88	0.19, 4.06	0.865	0.84	0.48, 1.47	0.536
Wealth quintile									
Poorest	1.16	0.84, 1.59	0.374	1.00	0.29, 3.49	0.999	1.17	0.84, 1.64	0.348
Poorer	1.34	1.00, 1.78	0.049	1.40	0.36, 5.37	0.624	1.34	0.99, 1.81	0.054
Middle	ref			ref			ref		
Richer	1.16	0.86, 1.57	0.332	1.75	0.59, 5.26	0.315	1.10	0.80, 1.52	0.549
Richest	1.61	1.06, 2.44	0.025	2.49	0.85, 7.31	0.098	1.26	0.76, 2.08	0.370
Urban/Rural status									
Urban	ref								
Rural	0.93	0.68, 1.27	0.657						

Discussion

This study examined the association between barriers to health care access and timely measles vaccination using a nationally representative dataset for Uganda. We found that both measles vaccination coverage and on time vaccination was higher in urban areas, compared to rural areas. Furthermore, the overall coverage of MCV1 is lower than the administrative data reported by the WHO/UNICEF-reported coverage (60), potentially masking population susceptibility to measles.

We found that lack of money is the most common perceived barrier, and it is more common in rural areas than urban areas. This financial constraint may be tied to distance to health facilities, which had been identified as a barrier to full vaccination in a nationally representative household survey in Mozambique (73). In urban settings, not wanting to go for care along was associated with a lower odds of achieving on time vaccination. This could be due to multiple factors, including transportation or the need for childcare in order to seek medical care.

Older children had a lower odds of being vaccinated on time, compared to younger children, especially in rural areas. This could be the result of recent programmatic improvements made by the Ugandan government to increase the timeliness of measles vaccination, which would be impacting the children who were a younger age at the time this data weas collected. Previous work has highlighted the predictors of complete vaccination coverage in east African countries using DHS data, and they found that 58.4% of children in Uganda did not receive a complete schedule of recommended vaccines, with 27.6% receiving all vaccines in schedule with a proof of date (72).

The finding of higher birth order children having a lower odds of being vaccination on time is consistent with the literature. In a previous study conducted in a similar urban population in Uganda, children with more siblings and children of a higher birth order have a lower odds of being vaccinated on time. This could be due to the higher costs and demands of resources caused by having more children in the household, with vaccination being in competition with other needs of the children (38, 55)

The study has several limitations. Healthcare access barriers are being measured for mother's healthcare, which may be a different situation with different circumstances than seeking a vaccine for a child. The study population was limited to children 12-36 months of age at the time of the survey, due to restrictions in the available data. It is possible that the limits put on the ages of children in the sample means that some children are misclassified as being unvaccinated and are actually vaccinated late , in that they were vaccinated after the survey was administered. This concern could be addressed with statistical methods that account for censoring.

Conclusion

This study indicates that mother's perceived barriers to healthcare may not be associated with on-time measles vaccination. Future studies could evaluate whether targeted questions on vaccination access or information on vaccination clinic days may impact the proportion of children receiving on-time measles vaccination.

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APPENDICIES

APPENDIX 1: SAVE STUDY SURVEY

English		Luganda	
Field Label	Choices, Calculations, OR Slider Labels	Field Label	Choices, Calculations, OR Slider Labels
A. Eligibility and Consent			
A1. Record ID#		A1. Record ID#	
A2. Data collector ID:		A2.	
A3. Have you lived in Kampala for six months or more in the past one year?		A3. Owezezza emyezi mukaaga n'okussukawo mu kampala?	
A3a. This individual is not eligible for the survey. Please thank them for their time and		A3a. Omuntu ono tasaanira kwetaba mukunonyereza kuno. Mwattu mwebaze obudde bwe era okomye awo okuwayamu.	

discontinue the interaction.			
A4. How many children between the ages of 1 year and 5 years do you have?	0, 0 | 1, 1 | 2, 2 | 3, 3 | 4, 4 | 5, 5 | 6, 6 | 7, 7 | 8, 8 | 9, 9 | 10, 10 | 11, 11 | 12, 12 | 13, 13 | 14, 14 | 15, 15	A4. Olina abaana bameka abali wakati w'omwaka ogumu n'emyaka ettaano?	0, 0 | 1, 1 | 2, 2 | 3, 3 | 4, 4 | 5, 5 | 6, 6 | 7, 7 | 8, 8 | 9, 9 | 10, 10 | 11, 11 | 12, 12 | 13, 13 | 14, 14 | 15, 15
A4a. This individual is not eligible for the survey. Please thank them for their time and discontinue the interaction.		A4a. Omuntu ono tasaanira kwetaba mukunonyereza kuno. Mwattu mwebaze obudde bwe era okomye awo okuwayamu.	
A5. How old were you at your last birthday?		A5. Waweza emyaka emeka ku mazaalibwago agaasembayo?	
A5a. This individual is not eligible for the survey. Please thank them for their time and discontinue the interaction.		A5a. Omuntu ono tasaanira kwetaba mukunonyereza kuno. Mwattu mwebaze obudde bwe era okomye awo okuwayamu.	
A5b. Due to the age of this individual, she requires a separate consent form and consent procedure. Please refer to SOP## for guidance on how to consent this individual.		A5b. Kulwemyaka gy'ono yeetaagisa fomu n'omutendera eby'okukkiriza ebyenjawulo. Kebera SOP## okulaba engeri eyokukikolamu.	
A5c. This person is eligible to participate. Instructions to the interviewer:		A5c. Omuntu ono asaaninidde okwetaba mukunoonyereza. Eri omunoonyera: weyongereyo	

Proceed to administering informed consent as outlined in SOP## and complete all activities, including completing two copies of the consent form before proceeding to the next page of the survey by pressing "Save and go to Next Instrument."		okumuwa foomu eyokukiriza ngabweguli mu SOP## era omalirize foomu bbiri ngatoneyongerayo . Savinga onyigge ekiddako.	
B. Participant Info			
B1. Has the correct documentation of written informed consent been obtained?		B1. Ofunye okukiriza mubuwandiike?	
B1a. Informed consent has not been obtained. Therefore, this individual cannot complete the survey. Please thank them for their time and discontinue the interaction.		B1a. Okukiriza tekufuniddwa. N'olwekyo, omuntu ono tasobola kumalayo kunonyereza kuno mwattu mwebazze obudde bwe era okomye awo okuwayamu.	
B2. Latitude		B2. Obukiika	
B3. Longitude		B3. Obuwanvu	
B4. Time and date of survey START		B4. Obudde n'enakku z'omweezi mu kutandika .	

B5. What is your tribe?	1, Muganda | 2, Other	B5. Oli waggwanga ki?	1, Muganda 2, Eddala
B5a. Other tribe:		B5a. Eggwanga eddala:	
B6. What is the highest level of school you attended?	0, Primary | 1, O level | 2, A level | 3, Tertiary | 4, University | 5, Vocational institution | 6, I don't know/don't remember | 7, Did not attend	B6. Ddaala ki muby'okussoma lyewakomako?	0, Pulayimale 1, Ssiniya eya wansi 2, Ssiniya eya waggulu 3, Ttendekero 4, Yunivasite 5, Ttendekero ly'ebyemikono 6, Ssimanyi/ Ssijjukira 7, Saassoma
B6a. What is the highest (class/year) you completed at that level?	1, 1 | 2, 2 | 3, 3 | 4, 4 | 5, 5 | 6, 6 | 7, 7 | 00, Less than 1 year completed | 999, Unknown	B6a. Kweryo eddala wakoma mukibiina ki oba mu mwaka ki?	
B7. What is your religion?	0, ANGLICAN | 1, BAHA'I | 2, BAPTIST | 3, BUDDHIST | 4, CATHOLIC | 5, HINDU | 6, JEHOVAH'SWITNESS | 7, JEWISH | 8, MAMMON | 9, MUSLIM | 10, ORTHODOX | 11, PENTECOSTAL/BORN AGAIN/EVANGELICAL | 12, PRESBYTERIAN | 13, SALVATION ARMY | 14, SEVENTH DAY ADVENTIST | 15, TRADITIONAL | 16, NO RELIGION | 17, OTHER | 18, Don't wish to report	B7. Oli wa ddiini ki?	0, Mukulisitayo 1, Mu Bahai 2, Mu Baputisiti 3, Mu Buddhist 4, Mukatoliki 5, Mu Hindu 6, Wa Jehova 7, Mu Yudaya 8, Mu Mammon 9, Muyisiramu 10, Mu Osoddokisi 11, Mulokole 12, Mu Presbyterian 13, Wa Salvation Army 14, Mu Adiventi 15, Ya kinnansi 16, Ssirina ddiini 17, Endala 18, Ssandyagadde kugyogera
B8. For how many years have you lived in Kampala?		B8. Omazze emyaka emeka mu kampala?	
B9. For how many years have you lived in		B9. Omazze emyaka emeka mu divizoni ye Rubaga.	

Rubaga division?			
B10. Do you have employment/work outside the home?		B10. Olina omulimu?	
B10a. What kind of work do you mainly do?	1, Agriculture: self employed | 2, Agriculture: employee | 3, Unskilled manual | 4, Skilled manual | 5, Domestic/housekeeping | 6, Clerical | 7, Professional | 8, Other	B10a. Okola mulimu ki?/Otela kola mulimu ki?	1, Byabulimi: nekozesa 2, Byabulimi: bankozesa 3, Egyabulijjo 4, Emisomerere 5, Egy'awaka 6, Egy'eddini 7, Egy'obukugu 8, emirala
B10b. If you said other, what kind of work do you mainly do?		B10b. Bwoba ogambye emirala gitunyonyoreko.	
B11. Do you personally own a mobile phone?	1, Yes, a smartphone | 2, Yes, but not a smartphone | 3, No, I do not own a mobile phone of any kind	B11. Olina essimu?	1, Yee, eyataachi. 2, Yee, naye yamapeesa 3, Neda, sirina ssimu.
B11a. Please list the ways you have used your phone in the past month.	1, Made a call | 2, Sent an SMS | 3, Received an SMS | 4, Downloaded an App | 5, Used WhatsApp or Imo | 6, Used other social media, such as Facebook/Instagram/Twitter	B11a. Tubuulire engeri jokozesezaamu essimmu yo mu mwezi oguwedde.	1, Nkubye 2, Nsindisse obubaka 3, Nfunye obubaka 4, Okuffuna App 5, Nkonzeseza Whatsapp oba Imo 6, Nkozeseza omikuttu emikwanira wala emirala nga Facebook/Instagram/Twitter.
B11b. Which provider[s] do you use?	1, Airtel | 2, MTN | 3, Africel | 4, Other	B11b. Okozesa mikuttu ki?	1, Airtel 2, MTN 3, Africel 4, Emirala
B11c. Other mobile provider:		B11c. Emikuttu emirala	
B12. Do you or anyone else in your household own any of the following? Select all that apply.	1, Mobile phone/cell phone | 2, Computer/laptop | 3, Radio | 4, Tablet | 5, TV | 6, None of the above	B12. Mumakago mulimu alina ekimu kubino wamanga	1, Essimu 2, Computer/laptop 3, Lediyo 4, Taabu 5, TV 6, Tewali

B12a. Which provider[s] do they use? Select all that apply.	1, Airtel | 2, MTN | 3, Africel | 4, Other	B12a. Bakozesa mikuttu ki?	1, Airtel 2, MTN 3, Africel 4, Emirala
B12b. Other mobile provider:		B12b. Emikuttu emirala	
C. Child Info			
Child Information		Ebikwata ku mwana	
C1. For the following questions, think about which of your children most recently celebrated their first birthday.		C1. Kubibuuzo ebiddako lowooza ku mwana wo asembyeyo okuwezza omwaka.	
C2. What is that child's name?		C2. Bamuyitta ani?	
C3. Is [childsname] part of a multiple birth?	1, No | 2, Yes, [childsname] is a twin | 3, Yes, [childsname] is a triplet | 4, Yes, [childsname] is quadruplet or more	C3. [erinya ly'omwana] mulongo?	1, Neda 2, Yee [erinya ly'omwana] mulongo 3, Yee bassatu 4, Yee, bana.
C3a. Instructions for the interviewer: If the child is part of a multiple birth, please use the provided cards and marker to write the name of each child on a card, shuffle their order, and present the cards to the participant name-side down for her to choose one. Then, write the selected		C3a. Eri omunoonyera: omwana waba mulongo, kozesa cardi ne marker okuwandika elinya ly'omwana. Tabika cardi oziwe eyetabyemu nga ozisulise omuwe alondeko emu. Wandika elinya ly'omwana alondedwa	

child's name above.			
C3b. For the rest of the survey, we will ask questions only about [childsname], because he/she most recently celebrated his/her first birthday. Think about [childsname] when answering these questions.		C3b. Mubibuuzo ebidako tujja kubuuza ku [erinya ly'omwana] kubanga yasembyeyo okuwezza omwaka. Lowooza ku [erinya ly'omwana] ng'oddamu ebibuuzo bino.	
C4. What is the month and year of [childsname]'s birth?		C4. Wamuzaala ddi?	
C5. What is [childsname]'s sex?	1, Male | 2, Female	C5. Wakikula ki?	1, Mulenzi 2, Muwala
C6. How many older siblings does [childsname] have?		C6. Alina bakulu be bameka?	
C7. How many younger siblings does [childsname] have?		C7. Alina batto be bameka?	
C8. What is your current relationship to [childsname]'s father?	1, Married or Living Together | 2, Divorced/Separated | 3, Widowed | 4, Never-Married and Never Lived together | 5, No relationship | 6, Other	C8. Nkolagana. ki eriwo wakati wo ne tata w'omwana?	1, Bafuumbo 2, Twayawukana 3, Namwandu 4, Simuffumbirwangako 5, Tewali nkolagana 6, ekirala
C8a. If other, please describe your relationship		C8a. Bwekiba ekirala tunyonyoleko.	

to [childsname]'s father:			
C9. I am now going to ask you 5 questions about [child's father's name]'s age, schooling, and employment. If you not feel comfortable answering these questions, tell me and we can skip them.		C9. Ngenda kubuuza ebibuuzo bitaano ebikata ku taata w'omwana ngabikwata ku myaka, obuyigirize, n'emirimu. Ebinakuzibuwalira ong'amba	
C9a. How old was [childsname]'s father at his last birthday?		C9a. Taata wo mwana alina emyaka emeka?	
C9b. What is the highest level of school attended by [childsname]'s father?	0, Primary | 1, O level | 2, A level | 3, Tertiary | 4, University | 5, Vocational institution | 6, I don't know/don't remember | 7, Did not attend	C9b. Yakoma wa mu kussoma?	0, Pulayimale 1, Ssiniya eya wansi 2, Ssiniya eya waggulu 3, Ttendekero 4, Yunivasite 5, Ttendekero ly'ebyemikono 6, Ssimanyi/ Ssijjukira 7, Saassoma
C9c. What is the highest (class/year) he completed at that level?	1, 1 | 2, 2 | 3, 3 | 4, 4 | 5, 5 | 6, 6 | 7, 7 | 00, Less than 1 year completed | 999, Unknown	C9c. Kweryo eddala yakoma mukibiina oba mwaka ki?	
C9d. Does [childsname]'s father have employment/work outside the home?	1, Yes | 0, No | 2, I don't know	C9d. Taata w'omwana akola?	1, Yee 0, Neda 2, simanyi
C9e. What kind of work does [childsname]'s father mainly do?	1, Agriculture: self employed | 2, Agriculture: employee | 3, Unskilled manual | 4, Skilled manual | 5,	C9e. Akola mulimu ki?	1, Byabulimi: nekozesa 2, Byabulimi: bankozesa 3, Egyabulijjo 4, Emisomerere 5, Egy'awaka

	Domestic/housekeeping | 6, Clerical | 7, Professional | 8, Other | 9, I don't know		6, Egy'eddini 7, Egy'obukugu 8, Emirala 9, simanyi
C10. Where did you give birth to [childsname]?	1, In a home, with a relative/family member | 2, In a home, with a traditional practitioner | 3, In a home, with a community health worker/Village Health Team | 4, A Government Hospital/Clinic | 5, A private Hospital/Clinic | 6, Other	C10. Omwana wamuzaalira wa?	1, Waka, 2, Wamulerwa 3, Waka n'owebyobilamu. 4, Ddwaliro lya governmenti 5, Ddwaliro ly'obwannanyini 6, ewalala
C10a. If other, describe where you gave birth to [childsname].		C10a. Bwewaba ewalala wa?	
C11. How many times did you attend antenatal care at a hospital or clinic during your pregnancy with [childsname]?		C11. Wagenda okunywa eddagala emirindi emeka ng'oli lubuto?	
C12. If [childsname] is feeling sick, where do you go to seek advice or treatment? Select all that apply.	1, Government Hospital/Clinic | 2, Private Hospital/Clinic | 3, Pharmacy | 4, Community Health Worker/Village Health Team | 5, Traditional practitioner | 6, Relative/family member | 7, Shop/Market | 8, Other	C12. [erinya ly'omwana] bwalwaala omujjanjabisizawa ? Londa byona ebyetagisibwa.	1, Eddwaliro lya governmenti 2, Eddwaliro ly'obwannanyini 3, Pharmacy 4, VHT 5, Ewo mussawo w'ekinnansi 6, Mubeng'anda 7, kudduuka oba mukatale 8, Ewalala
C12a. Other:		C12a. Ewalala wa?	
Think back to the last time [childsname] was sick and needed to go to a clinic or hospital. At that time, did you experience any of the following concerns? Answer with yes or no after each statement.		Lowoozamu omulundi [erinya ly'omwana] weyasembayo okulwaala nga wetagisa okumutwaala mu ddwaliro. Mubudde obwo waffunamu obuzibu bwona ku buno wamanga? Ddamu Yee oba Neda.	
C13. Have you taken	1, Yes | 0, No	C13. Wamutwala mu ddwaliro?	1, Yee 0. Nedda

[childsname] for healthcare?			
C14. Did you have enough money for medical fees?	1, Yes | 0, No	C14. Walina sente ezimala okusasulira okulaba omussawo?	1, Yee 0. Nedda
C15. Did you have enough money for treatment?	1, Yes | 0, No	C15. Walina sente ezimala okusasulira obujjanjabi?	1, Yee 0. Nedda
C16. Did you have enough money for transport?	1, Yes | 0, No	C16. Walina sente ezimala okusasulira ebyentambulira?	1, Yee 0. Nedda
C17. Did you have enough time to be away from the household?	1, Yes | 0, No	C17. Walina obudde obumala okuvvaako ewaka?	1, Yee 0. Nedda
C18. Did you have childcare for your other children?	1, Yes | 0, No	C18. walina gwolekera abaana?	1, Yee 0. Nedda
C19. Did you miss work or leave your job duties?	1, Yes | 0, No	C19. Walekawo emirimo gyo?	1, Yee 0. Nedda
C20. Could you find transport?	1, Yes | 0, No	C20. Waffuna entambula?	1, Yee 0. Nedda
C21. Did you know which facility to go to?	1, Yes | 0, No	C21. Wali omanyi eddwaliro ery'okugeendako?	1, Yee 0. Nedda
C22. Did you have permission to leave your household?	1, Yes | 0, No	C22. Waffuna olukusa okuva awaka?	1, Yee 0. Nedda
C23. Is it your husband/partner's decision?	1, Yes | 0, No	C23. Omwami wo y'asalawo?	1, Yee 0. Nedda
C24. Other (write in)	1, Yes | 0, No	C24. Omulala	1, Yee 0. Nedda
C24a. Other concern:		C24a. Obuzibu obulala	

C25. Who makes decisions about medical care, including decisions to seek care, whether to pay for care, or optional/elective procedures, for [childsname]? Select all that apply.	1, I do. | 2, My husband/partner does. | 3, A family member other than my husband/partner does. | 4, Other	C25. Ani asalawo kuby'obujjanjabi? Londako wona awasaana	1, Nze 2. Mwami 3. Oweng'anda 4. Omulala
C25a. Other medical decision maker:		C25a. Abalala abasalawo	
D. Health Card Questions			
D1. Next, we would like to ask you about [childsname]'s vaccines and about any written documentation you have that [childsname] was vaccinated.		D1. Ekiddako, twagala okubuuza kubikwata ku kugemebwa kw'omwana n'ebiwandiiko by'okugemesa kwe.	
D2. Do you have [childsname]'s Uganda Ministry of Health Child Health Card where vaccinations are written down available right now? If so, could you show it to me?	1, Yes | 0, No | 2, I don't know	D2. Olina ekipande ky'okugemesa kwa [erinya ly'omwana]? Gindageeko.	1, Yee 0, Nedda 2, Ssimannyi
D2a. May I take a picture of the page containing information on [childsname]'s vaccination		D2a. Nkube ku kifaananyi ky'omuko oguliko okugemesa kw'omwana? Sijja kukwata	

history? I will not photograph any other page or any identifying information about you or [childsname].		bifaananyi bya miko milala.	
D2b. Upload the picture of the Uganda Ministry of Health Card here:		D2b.	
D3. Do you have a different document that is a record of [childsname]'s vaccination?	1, Yes | 0, No | 2, I don't know	D3. Olinayo ekiwandiiko ekilala kyona ekikwata ku kugemesa kwa [erinya ly'omwana]?	1, Yee 0, Nedda 2, Ssimannyi
D3a. If yes, may I take a picture of the section containing information on vaccination? I will not photograph any other page or any identifying information about you or [childsname].		D3a. Bwoba nakyo, Nkube ku kifaananyi ky'omuko oguliko okugemesa kw'omwana? Sijja kukwata bifaananyi bya miko milala.	
D3b. Upload a picture of the other vaccination documentation here:		D3b.	
D4. Was a picture of the Uganda Child Health Card or other vaccination documentation taken?		D4.	

D4a. If no, describe or state why		D4a.	
D5. For the next questions, I would like to ask you about [childsname]'s health card. Instructions to interviewer: Ask the participant to perform each action below, select the appropriate response if they have success/failure or they are correct/incorrect. After the participant performs the action, look at the card and find the correct information silently to check whether they are correct. Do not inform them if they are correct or not after each item.		D5. Kubibuuzo ebiddako ng'enda kubuuza ku kipaande ky'okugemesa.	
D6. Can you point to where [childsname]'s birthdate is on the card?	1, Pointed to birthdate | 0, Did not point to birthdate | 2, Info not on card	D6. Songa awali amazaalibwa gw'omwana ku kipaande.	
D7. Can you point to where [childsname]'s gender is on the card?	1, Pointed to gender | 0, Did not point to gender | 2, Info not on card	D7. Songa awali ekikula ky'omwana.	

D8. Can you point to where the date of [childsname]'s measles vaccination is on the card?	1, Pointed to information about measles vaccination | 0, Did not point to information about measles vaccination | 2, Info not on card	D8. Songa awali ebikwata ku kugemesa measles (olunkusense).	
D9. Can you tell the month and year when [childsname] was due for their measles vaccine?		D9. Osobola okumbulira omwezi n'omwaka omwana mweyali alina okugemesebwa measles (olukussense)?	
E. Vaccine and Healthcare Questions			
Next, I'm going to read a series of situations related to people's experiences with vaccines. For each of the following statements, indicate if it is true or false in your experience for any of your children.		Ekiddako, ngenda kusomera engeri ez'enjawulo abantu zebayitamu mu kugemesa abaana. Londako byokiriza oba byotakiriza.	
E1a. My religious beliefs encouraged me to have my child vaccinated.	1, At least one time | 0, Never	E1a. Eddini yange enkubirirza okugemesa omwana	1, Wakiri omulundi ogumu 0, tekibangawo
E1b. My religious beliefs discouraged me from having my child vaccinated.	1, At least one time | 0, Never	E1b. Eddini yange eng'aana okugemesa omwana.	1, Wakiri omulundi ogumu 0, tekibangawo
E2a. I got advice from a friend/family member that encouraged me to vaccinate my child.	1, At least one time | 0, Never	E2a. Mukwano gwange oba owoluganda yankubiriza okugemesa omwana.	1, Wakiri omulundi ogumu 0, tekibangawo
E2b. I got advice from a friend/family member that discouraged me from vaccinating my child.	1, At least one time | 0, Never	E2b. Mukwano gwange oba owoluganda yange yang'aana okugemesa omwana.	1, Wakiri omulundi ogumu 0, tekibangawo

E3a. My personal beliefs led me to not vaccinate my child.	1, At least one time | 0, Never	E3a. Endowooza zange zandetera obutagemesa mwana.	1, Wakiri omulundi ogumu 0, tekibangawo
E3b. My personal beliefs led me to vaccinate my child.	1, At least one time | 0, Never	E3b. Endowooza zange zandetera okugemesa omwana	1, Wakiri omulundi ogumu 0, tekibangawo
E4a. I was concerned because one of my children fell ill soon after receiving a vaccine.	1, At least one time | 0, Never	E4a. Nelalikirimu kubanga omu kubaana bange yalwala oluvvanyuma lw'okugemesebwa.	1, Wakiri omulundi ogumu 0, tekibangawo
E4b. I was happy because one of my children stayed healthy after receiving a vaccine.	1, At least one time | 0, Never	E4b. Nali musanyufu kubanga omu kubaana bange yaba bulungi oluvvanyuma lw'okugemesebwa.	1, Wakiri omulundi ogumu 0, tekibangawo
E5. Think about the times when you have brought any of your children to a health care facility to be vaccinated in the past. Have you encountered any of the following situations? Select all that apply.	1, The clinic had a vaccine stock-out. | 2, The clinic staff were not available/present. | 3, The clinic was closed. | 4, You were told to go to another location. | 5, You were asked to pay some money in order to get the vaccine. | 6, You were told that you missed a vaccine for one of your children. | 7, You had to wait for more than 30 minutes for a vaccine.	E5. Lowooza kumilundi gyewatwaala omu ku baana bo mu ddwaliro okugemesebwa. Bino wamaanga byali bikutuuseeko? Londako byona ebyetagisa.	1, Eddaggala lyali liweddeyo 2. Abasawo bali tebaliiwo 3. Eddwaliro lyali liggale 4. Bang'aamba tugeende awalala 5. Bansaba sente okugema omwana. 6. Baakugamba nti waliwo okugemebwa o kumu omu kubaana bo kuoatafuna. 7. Nalinda eddakiika ezisuka asatu okumugema.
E6. What is the longest you've had to wait in the past to get a vaccine?		E6. Bbanga erisinga obuwanvu lyewali olinzeko nga ttonafuna buweereza bwakugema?	

E7. Vaccinating children is an important way to keep them healthy. We would like to understand how to help mothers like you get to the clinic/health centre to have their children vaccinated on time when they are due for a vaccine.		E7. Okugemesa abaana kikulu okubakuuma nga balamu. Twandiyagade okutegera engeri jetuyiinza okuyambamu ba maama nga gwe okutwaala abaana baabwe mu budde okugemesebwa.	
E8. How would you prefer health care workers or village health team member to communicate information about vaccines to you? Select all that apply.	1, An SMS reminder | 2, A handwritten letter | 3, A radio announcement to all mothers about vaccination | 4, An email | 5, An informative poster near your home | 6, A visit to your home from a Community Health Worker/Village Health Team | 7, None of these | 8, Other	E8. Wandyagade otya abasawo oba VHTs okutegeeza ku by'okugemesa? Londako byona ebisaanidde.	1, Obubaka ku ssimu 2. Okuwandikiira ebbaluwa 3. Ekirango ku lediyo ekikwaata. Ku kugemesa 4. Email 5. Ebipaande kumpi ne wobeera 6. Omusawo okukyaala ewuwo 7. Tewali 8. ebilala
E8a. Other:		E8a. Ebilala	
E9. If you had the option to take [childsname] to a clinic/health centre for a vaccine OR have a community health worker/village health team members come to your community to vaccinate [childsname],	1, Take [childsname] to a clinic | 2, Have a community health worker/village health team member come to my community | 3, I don't know	E9. Singa osobola okulonda ko wakati wokutwaala omwana mu ddwaliro okugemebwa n'omukubasawo oba VHT okujja mukitundu kyo okugema [erinya ly'omwana] ki kyewandiyagadde ?	1, Okutwaala omwana mu ddwaliro 2. Omusawo okujja nagemera mukitundu kyange 3. ssimanyi

which would you prefer?			
E10. Think back to the time when [childsname] was 9 months old and due for his/her measles vaccine. If a boda-boda driver had taken you and [childsname] to the clinic/health centre for free, would that have made it easier for you to get [childsname] vaccinated?	1, Yes | 0, No | 2, I don't know	E10. Lowooza kumwana lwe yaweza emyezi mwenda era ng'atuuse okugemesebwa measles (olunkusense). Singa owa boda yakutwalira ku bwerere, kyandikuberedde kyangu?	1, Yee 0, Nedda 2, Ssimannyi
E11. Think back to the time when [childsname] was 9 months old and due for his/her measles vaccine. If a car had taken you and [childsname] to the clinic/health centre for free, would that have made it easier for you to get [childsname] vaccinated?	1, Yes | 0, No | 2, I don't know	E11. Lowooza kumwana lwe yaweza emyezi mwenda era ng'atuuse okugemesebwa measles (olunkusense). Singa ow'emmotoka yakutwalira ku bwerere, kyandikuberedde kyangu?	1, Yee 0, Nedda 2, Ssimannyi
E12. What is the name of the clinic/health center or outreach post you usually go to get [childsname]		E12. Ddwaliro ki oba kiffo ki jotera okutwala omwana okumugema oba bwewandiyagade agemebwe?	

vaccinated or you would go to if you needed to get [childsname] vaccinated?			
E13. Think of how you typically go to [clinicname] from your home. How many minutes would you need on each mode of transportation to get there? For example, you may need to walk 15 minutes to a boda stage and then ride a boda for 10 minutes to complete the journey. Provide an approximate number of minutes for each form of transportation:		E13. Lowooza kungeri jotambulamu okuvva awaka okutuuka ku ddwaliro eryo. Kikutwalira eddakiika meka ng'okozesa entambula zino, okugeza oyinza okutambula eddakiika 15 okutuuka ku stagi ya booda ate boda nekuvvugira eddakiika 10 okutuuka ku ddwaliro. Gerageranya eddakiika zewataaga ng'okozesa entambula zino wammanga.	
E13a. Walking?		E13a. Kutambula	
E13b. Bicycle?		E13b. Akagaali	
E13c. Boda?		E13c. Booda	
E13d. Minibus taxi?		E13d. Takisi	
E13e. Car?		E13e. Emmotoka y'abuyonjo	
E14. For the next questions, we are going to ask you about your experiences paying for healthcare for [childsname].		E14. Kubibuuzo ebiddako, tugenda kubuuza kubyoyisemu ng'osasulira obujjanjabi bw'omwana.	

E15. Has lack of money ever been a reason that prevented you from getting [childsname] vaccinated in the past?	1, Yes, 1-2 times | 2, Yes, 3 or more times | 0, No | 3, I don't remember	E15. Obutaba na sente bwali bukulemesezako okugemesa [erinya ly'omwana]?	1, Yee, omulundi 1-2 2. Yee emilundi esatu n'okussukawo 0. Nedda 3. sijjukira
E15a. If yes, what amount of Uganda Shillings would you have needed to take [childsname] to get vaccinated?		E15a. Bwoba ozeemu Yee, wandyetaaze sente meka okusobola okugemesa omwana	
E15b. What did you need this money for? Select all that apply.	1, Transport | 2, Childcare | 3, Food | 4, Rent | 5, In place of a day's wages | 6, Other | 7, None of the above	E15b. Sente wali wetagisa zaaki? Londako byona ebyetagisa.	1, Entambula 2. Okulabirira abaana 3. Emmere 4. Eze nnyumba 5. Okuzzaawo z'enandikoze buli lunaku 6. Ebilala 7. Tewali
E15c. Other:		E15c. Ebilala	
E16. Has lack of money ever been a reason that prevented you from taking [childsname] to receive healthcare when he/she was sick in the past?	1, Yes, 1-2 times | 2, Yes, 3 or more times | 0, No | 3, I don't remember	E16. Obutaba na sente bwali bukulemesezako okutwala omwana wo okufuna obujjanjabi nga mulwadde.	1, Yee, omulundi 1-2 2. Yee emilundi esatu n'okussukawo 0. Nedda 3. sijjukira
E16a. If yes, what amount of Uganda shillings would you have needed to take [childsname] to receive healthcare when he/she was sick?		E16a. Bwoba ozeemu Yee, wandyetaaze sente meka okusobola okufuna obujjanjabi?	

E16b. What did you need this money for? Select all that apply.	1, Transport | 2, Childcare | 3, Food | 4, Rent | 5, In place of day's wages | 6, Other | 7, None of the above | 8, Medical costs	E16b. Sente wali wetagisa zaaki? Londako byona ebyetaga	1, Entambula 2, Okulabirira abaana 3, Emmere 4, Eze nnyumba 5, Okuzzaawo z'enandikoze buli lunaku 6, Ebilala 7, Tewali 8, sente zo kwejanjabisa
E16c. Other:		E16c. ebilala	
E17. If you had to pay a driver to take the transportation you described above to go directly from your home to the clinic/health centre or outreach post where vaccinations are available, how much would that cost?		E17. Singa walina okusasulira entambula ekujja wobeera okuttusa wogemeseza wanndyeetaze sente meka?	
E18. If you needed to take [childsname] for a vaccine, when would you need to arrange the money to cover the expenses involved?	1, At least one week before | 2, At least one day before | 3, At the clinic | 4, The day after the vaccine | 5, During the week after the vaccine	E18. Singa olina okutwaala omwana okumugema sente zewetaaga wanditandise ddi okuzikung'aanya.	1, Wakiri wiiki ng'emu 2, Wakiri mulunaku lumu 3, Ku ddwaliro 4, Mu lunaku lumu oluvvanyuma lw'okugemesa 5, Mu wiiki emu oluvvanyuma lw'okugemesa.
F. Transportation preferences			
F1. For the next set of questions, I will ask about how you move around using various forms of transportation and the types of transportation you would prefer to use.		F1. Kubibuuzo ebiddako, ng'enda kubuuza ku ntambula ez'enjawulo zokozesa nezo zewandyeyunidde.	

Do you or a member of your household own any of the following?		Gwe oba ab'omunju yo waliyo alina ekimu kubino?	
F1a. Boda boda	1, You | 2, A family/household member	F1a. Booda	1, Nze 2, Ow'omunju
F1b. Bicycle	1, You | 2, A family/household member	F1b. akagaali	1, Nze 2, Ow'omunju
F1c. Three-wheeled vehicle (tuk tuk)	1, You | 2, A family/household member	F1c. Tuku tuku	1, Nze 2, Ow'omunju
F1d. Car	1, You | 2, A family/household member	F1d. Mmotoka y'abuyonjo	1, Nze 2, Ow'omunju
F1e. Truck	1, You | 2, A family/household member	F1e. Emmotoka ennetissi	1, Nze 2, Ow'omunju
F1f. None of the above	1, You | 2, A family/household member	F1f. tewali	1, Nze 2, Ow'omunju
Have you ever used any of the following mobile app-based transportation services? Have you used any in the past month?		Wali okozesezako emu kuzino entambula ezikolera kumutimbagano. Wazikozesezako mumwezi oguyise?	
F2a. Uber (car)	1, Ever used | 2, Used in the past one month	F2a. Uber (mmotoka)	1, Nali njikozesezako 2, Mu mwezi oguyise
F2b. Uber (boda)	1, Ever used | 2, Used in the past one month	F2b. Uber (booda)	1, Nali njikozesezako 2, Mu mwezi oguyise
F2c. Taxify (car)	1, Ever used | 2, Used in the past one month	F2c. Taxify (mmotoka)	1, Nali njikozesezako 2, Mu mwezi oguyise
F2d. Taxify (boda)	1, Ever used | 2, Used in the past one month	F2d. Taxify (booda)	1, Nali njikozesezako 2, Mu mwezi oguyise
F2e. SafeBoda	1, Ever used | 2, Used in the past one month	F2e. Safe booda	1, Nali njikozesezako 2, Mu mwezi oguyise
F2f. None of the above	1, Ever used | 2, Used in the past one month	F2f. tewali	1, Nali njikozesezako 2, Mu mwezi oguyise
F2g. Other	1, Ever used | 2, Used in the past one month	F2g. ebilala	1, Nali njikozesezako 2, Mu mwezi oguyise
F2h. Other:		F2h. Ebilala	
F3. Has there been a time in the past when you have taken [childsname] to a clinic/health center to get a vaccine?	1, Yes, I have taken [childsname] to a clinic to get a vaccine. | 2, No, I have not taken [childsname] to a clinic to get a vaccine, but I have taken [childsname] to a clinic for another reason. | 3, No, I have never taken [childsname] to a clinic at all, but I have taken	F3. Wali otuteko [erinya ly'omwana] mu ddwaliro okumugemesa?	1, Yee, okumugemesa 2, Nedda, simutwalangako okumugemesa naye namutwalako kulwensonga endala 3, Nedda, naye nali muttuteko mubifo ebirala

	[childsname] to other locations.		
F4. In the past when you've taken [childsname] to a clinic/health centre or to another location if you have never taken [childsname] to a clinic, do you typically take [childsname] alone or do you typically take [childsname] along with other children?	1, I only moved with [childsname]. | 2, I moved with [childsname] and other children.	F4. Bwoba otwala [erinya ly'omwana] mu ddwaliro oba mu bifo ebirala otela okumutwala yekka oba n'abaana abalala.	1, Natwaala [erinya ly'omwana] 2. Natwaala [erinya ly'omwana] n'abaana abalala.
F4a. In total, how many children do you typically take with you to a clinic/health centre or other location?		F4a. Awamu, otela kutambula n'abaana bameka ng'ogenda mu ddwaliro oba awalala?	
F5a. For the next two questions, think about a time in the past when you have gone to clinic/health centre with [childsname] to get a vaccine for him/her.		F5a. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okumugemesa.	
F5b. For the next two questions, think about a time in the past when you have taken [childsname] to a clinic/health		F5b. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro	

centre to get a vaccine and brought other children.		okumugemesa ng'otwaliddeko n'abaana abalala.	
F5c. For the next two questions, think about a time in the past when you have taken [childsname] to a clinic/health centre for medical care for him/her.		F5c. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna obujjanjabi.	
F5d. For the next two questions, think about a time in the past when you have taken [childsname] to a clinic/health centre for medical care and brought other children.		F5d. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna obujjanjabi n'otwalirako n'abaana abalala.	
F5e. For the next two questions, think about a time in the past when you have moved to and from outside your home with [childsname].		F5e. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatambulako okuvva oba okudda awaka ne [erinya ly'omwana]	
F5f. For the next two questions, think about a time in the past when you have moved to and from outside your home with [childsname]		F5f. Mubibuuzo ebibiri ebiddako, lowooza ku mulundi ogumu lwewatambulako okuvva oba okudda awaka ne [erinya ly'omwana] n'abaana abalala.	

and brought other children.			
Rank the following modes of transportation based on the ones you used most often to least often.		Seengeka entambula zino okutandikira ku josinga okukozesa, osembyeyo jotatera kukozesa.	
F6a. Walk	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6a. okutambula	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6b. Take a car	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6b. Okukozesa emmotoka	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6c. Take a bicycle	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6c. Okukozesa akagaali	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6d. Take a minibus taxi	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6d. Okukozesa takisi	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6e. Take a boda boda	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6e. Okukozesa booda	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6f. Other	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F6f. endala	1, jensiinga 2, Yakubiri 3, Yakussatu 4, Yakuna 5, Sitera
F6g. Specify other mode of transport:		F6g. Tunyonyoleko entambula endala	
F7a. Again, think about a time in the past when you have gone to clinic/health centre with [childsname] to		F7a. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okumugemesa.	

get a vaccine for him/her.			
F7b. Again, think about a time in the past when you have taken [childsname] to a clinic/health centre to get a vaccine and brought other children.		F7b. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okumugemesa ng'otwaliddeko n'abaana abalala.	
F7c. Again, think about a time in the past when you have taken [childsname] to a clinic/health centre for medical care for him/her.		F7c. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna obujjanjabi.	
F7d. Again, think about a time in the past when you have taken [childsname] to a clinic/health centre for medical care and brought other children.		F7d. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna abujjanjabi ng'otwaliddeko n'abaana abalala.	
F7e. Again, think about a time in the past when you have moved to and from outside your home with [childsname].		F7e. Nsaba oddemu. Olowooze ku mulundi ogumu lwewatambulako okuvva oba okudda awaka ne [erinya ly'omwana]	
F7f. Again, think about a time in the past when you have		F7f. Nsaba oddemu. Olowooze ku mulundi ogumu	

moved to and from outside your home with [childsname] and brought other children.		lwewatambulako okuvva oba okudda awaka ne [erinya ly'omwana] n'abaana abalala	
What are your top three considerations when you're moving around? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebissatu byosinga okugoberera ng'onaatambula? Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F8a. Speed	1, First most important | 2, Second most important | 3, Third most important	F8a. obwangu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8b. Safety	1, First most important | 2, Second most important | 3, Third most important	F8b. Eri seefu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F8c. Enyanguyira	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F8d. Nkozesa emmotoka yange eyabuyonjo	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8e. Cost	1, First most important | 2, Second most important | 3, Third most important	F8e. Ebissale	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8f. Other	1, First most important | 2, Second most important | 3, Third most important	F8f. ekirala	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F8g. Specify other concern:		F8g. Tunyonyoleko ensonga endala	
F9a. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have gone to clinic/health centre with [childsname] to get a vaccine for him/her.		F9a. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okumugemesa	

F9b. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have gone to clinic/health centre with [childsname] to get a vaccine for him/her and brought other children.		F9b. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okumugemesa ng'otutte n'abaana abalala.	
F9c. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have gone to clinic/health centre with [childsname] for medical care for him/her.		F9c. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna obujjanjabi.	
F9d. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have gone to clinic/health centre with [childsname] for medical care for him/her and brought other children.		F9d. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatwaala [erinya ly'omwana] mu ddwaliro okufuna obujjanjabi ng'otutte n'abaana abalala.	

F9e. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have moved to and from outside your home with [childsname].		F9e. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatambulako okuvva n'okudda awaka ne [erinya ly'omwana].	
F9f. Now, we are interested in your preferred modes of transportation. Think again about a time in the past when you have moved to and from outside your home with [childsname] and brought other children.		F9f. Kati, twagala kumanya entambula zosinga okwagala okukozesa. Nsaba oddemu olowooze ku mulundi ogumu lwewatambulako okuvva n'okudda awaka ne [erinya ly'omwana] ng'otutte n'abaana abalala..	
Rank the following modes of transportation based on your preference from most preferred to least preferred.		Seengeka entambula zino okutandikira ku josinga okwagala okukozesa, osembyeyo gyosembyaayo okwagala okukozesa.	
F10a. Walk	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10a. Okutambula	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F10b. Take a car	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10b. Okukozesa emmotoka	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F10c. Take a bicycle	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10c. Okukozesa akagaali	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.

F10d. Take a minibus taxi	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10d. Okulinya takisi	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F10e. Take a boda boda	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10e. Okulinya booda	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F10f. Other	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F10f. Ebirala	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F10g. Specify other mode of transport:		F10g. Tunyonyole entambula endala	
What are the factors that make you prefer the mode of transportation you ranked 1st? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebikwagazisa entambula zino ng'abwozisengese. Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F11a. Speed	1, First most important | 2, Second most important | 3, Third most important	F11a. obwangu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11b. Safety	1, First most important | 2, Second most important | 3, Third most important	F11b. Eri seefu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F11c. okwanguyira	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F11d. Okukozesa emmotoka yange eyobwannanyini.	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11e. Cost	1, First most important | 2, Second most important | 3, Third most important	F11e. Ebissale	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11f. Other	1, First most important | 2, Second most important | 3, Third most important	F11f. ebilala	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F11g. Specify other concern:		F11g. Tunyonyoleko ebilala	
F12a. Now that you've told us how you would move to the		F12a. Kati nga bwotubulidde engeri jotambulamu	

clinic with only [childsname], think about what you would do if you had to move to the clinic to get [childsname] vaccinated and you had to bring other children along.		n'omwana lowooza ku kyewandikoze okutwaala [erinnya ly'omwana] mu ddwaliro okugemesebwa naye nga olina okutwalilako n'abaana ablalala.	
F12b. Now that you've told us how you would take [childsname] and other children to the clinic, think about what you would do if you took [childsname] by himself/herself to a clinic/health centre to get vaccinated.		F12b. Kati nga bwotubulidde engeri jotambulamu ne [erinya ly'omwana] n'abaana abalala okugenda mu ddwaliro, lowooza ku kyewandikoze okutwaala [erinnya ly'omwana] yekka mu ddwaliro okugemesebwa	
F12c. Now that you've told us how you would move to the clinic/health centre with only [childsname], think about what you would do if you had to move to the clinic/health centre to get medical care for [childsname] and you had to bring other children along.		F12c. Kati nga bwotunyonyode ku ngeli gyatambulamu ne [erinya ly'omwana] ng'ogenda ku ddwaliro, lowoozamu ku kyewandikoze nga olina okutambula okugenda ku ddwaliro okufuna obujjanjabi bwa [erinya ly'omwana] ng'olina okuleeterako abaana abalala.	

F12d. Now that you've told us how you would take [childsname] and other children to the clinic/health centre, think about what you would do if you took [childsname] by himself/herself to a clinic to get medical care.		F12d. Kati nga bwotunyonyode ku ngeli gyotambulamu ne [erinya ly'omwana] n'abaana abalala ng'ogenda ku ddwaliro, lowoozamu ku kyewandikoze nga olina okutambula ne [erinya ly'omwana] yekka okufuna obujjanjabi.	
F12e. Now that you've told us how you would move to and from outside your home with only [childsname], think about what you would do if you had to move to and from outside your home with [childsname] and you had to bring other children along.		F12e. Kati nga bwotunyonyode ku ngeri gyotambulamu okuvva n'okudda awaka ne [erinya ly'omwana] lowoozamu ku kyewandikoze singa olina okutambula okuvva n'okudda awaka ne [erinnya ly'omwana] ng'olina okuleterako n'abaana abalala.	
F12f. Now that you've told us how you would move to and from outside your home with [childsname] and other children, think about what you would do if you had to move to and from outside your home with		F12f. Kati nga bwotunyonyode ku ngeri gyotambulamu okuvva n'okudda awaka ne [erinya ly'omwana] n'abaana abalala, lowoozamu ku kyewandikoze singa olina okutambula okuvva n'okudda awaka ne [erinnya	

only [childsname].		ly'omwana] yekka.	
Rank the following modes of transportation based on the ones you would use most often to least often.		Seengeka entambula zino okutandikira ku josinga okukozesa, osembyeyo jotatera kukozesa.	
F13a. Walk	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13a. okutambula	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13b. Take a car	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13b. Okukozesa emmotoka	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13c. Take a bicycle	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13c. Okukozesa akagaali	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13d. Take a minibus taxi	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13d. Okukozesa takisi	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13e. Take a boda boda	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13e. Okukozesa booda	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13f. Other	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F13f. endala	1. Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F13g. Specify other mode of transport:		F13g. Tunyonyoleko entambula endala	
What would be your top three considerations when you're moving around? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebissatu byosinga okugoberera ng'onaatambula? Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F14a. Speed	1, First most important | 2, Second most important | 3, Third most important	F14a. obwangu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo

F14b. Safety	1, First most important | 2, Second most important | 3, Third most important	F14b. Eri seefu	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F14c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F14c. okwanguyira	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F14d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F14d. Okukozesa emmotoka yange eyobwannanyini.	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F14e. Cost	1, First most important | 2, Second most important | 3, Third most important	F14e. Ebissale	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F14f. Other	1, First most important | 2, Second most important | 3, Third most important	F14f. ebilala	1, Ekisinga obukulu 2, Ekyokukubiri 3, Ekisembayo
F14g. Specify other concern:		F14g. Tunyonyoleko ebilala	
F15a. Now, we are interested in your preferred modes of transportation. Think about what you would prefer if you went to the clinic with [childsname] and other children to get [childsname] a vaccine.		F15a. Kati, twagala okumanya entambula zosinga okwagala. Lowooza kukyewandiyagadde ng'ogenze ku ddwaliro ne [erinya ly'omwana] n'abaana abalala okugemesa [erinya ly'omwana].	
F15b. Now, we are interested in your preferred modes of transportation. Think about what you would prefer if you went to the clinic with only [childsname] to get [childsname] a vaccine.		F15b. Kati, twagala okumanya entambula jewandisinze okwagala. Lowooza ku kyewandiyagadde ng'ogenze ku ddwaliro ne [erinya ly'omwana] yekka okumugemesa	

F15c. Now, we are interested in your preferred modes of transportation. Think about what you would prefer if you went to the clinic with [childsname] and other children to get medical care for [childsname].		F15c. Kati, twagala okumanya entambula zosinga okwagala. Lowooza kukyewandiyagadde ng'ogenze ku ddwaliro ne [erinya ly'omwana] n'abaana abalala okufuna obujjanjabi bwa [erinya ly'omwana].	
F15d. Now, we are interested in your preferred modes of transportation. Think about what you would prefer if you went to the clinic with only [childsname] to get medical care for [childsname].		F15d. Kati, twagala okumanya entambula jewandisinze okwagala. Lowooza ku kyewandiyagadde ng'ogenze ku ddwaliro ne [erinya ly'omwana] yekka okufuna obujjanjabi.	
F15e. Now, we are interested in your preferred modes of transportation. Think about what you would prefer if you moved to and from outside your home with [childsname] and other children.		F15e. Kati, twagala okumanya entambula jewandisinze okwagala. Lowooza ku kyewandiyagadde ng'otambula okuvva n'okudda awaka ne [erinya ly'omwana] n'abaana abalala.	
F15f. Now, we are interested in your preferred modes of		F15f. Kati, twagala okumanya entambula	

transportation. Think about what you would prefer if you moved to and from outside your home with only [childsname].		jewandisinze okwagala. Lowooza ku kyewandiyagadde ng'otambula okuvva n'okudda awaka ne [erinya ly'omwana] yekka..	
Rank the following modes of transportation based on your preference from most preferred to least preferred.		Seengeka entambula zino okutandikira ku josinga okwagala okukozesa, osembyeyo gyosembyaayo okwagala okukozesa.	
F16a. Walk	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16a. Okutambula	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F16b. Take a car	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16b. Okukozesa emmotoka	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F16c. Take a bicycle	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16c. Okukozesa akagaali	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F16d. Take a minibus taxi	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16d. Okulinya takisi	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F16e. Take a boda boda	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16e. Okulinya booda	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F16f. Other	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F16f. Ebirala	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F16g. Specify other mode of transport:		F16g. Tunyonyole entambula endala	

What are the factors that make you prefer this mode of transportation? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebikwagazisa entambula zino ng'abwozisengese. Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F17a. Speed	1, First most important | 2, Second most important | 3, Third most important	F17a. obwangu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17b. Safety	1, First most important | 2, Second most important | 3, Third most important	F17b. Eri seefu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F17c. okwanguyira	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F17d. Okukozesa emmotoka yange eyobwannanyini.	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17e. Cost	1, First most important | 2, Second most important | 3, Third most important	F17e. Ebissale	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17f. Other	1, First most important | 2, Second most important | 3, Third most important	F17f. ebilala	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F17g. Specify other concern:		F17g. Tunyonyoleko ebilala	
F18. For the next two questions, think about what you would do if you had to move to clinic/health centre with [childsname] to get a vaccine for him/her.		F18.	
Rank the following modes of transportation based on the ones you would use most often to least often.		Seengeka entambula zino okutandikira ku josinga okukozesa, osembyeyo jotatera kukozesa.	
F19a. Walk	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19a. okutambula	1, Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F19b. Take a car	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19b. Okukozesa emmotoka	1, Jensiinga 2. Yakubiri 3. Yakussatu

			4. Yakuna 5. Sitera
F19c. Take a bicycle	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19c. Okukozesa akagaali	1, Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F19d. Take a minibus taxi	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19d. Okukozesa takisi	1, Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F19e. Take a boda boda	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19e. Okukozesa booda	1, Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F19f. Other	1, Most often | 2, 2nd | 3, 3rd | 4, 4th | 5, Least often	F19f. endala	1, Jensiinga 2. Yakubiri 3. Yakussatu 4. Yakuna 5. Sitera
F19g. Specify other mode of transport:		F19g. Tunyonyoleko entambula endala	
What would be your top three considerations when you're moving around? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebissatu byosinga okugoberera ng'onaatambula? Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F20a. Speed	1, First most important | 2, Second most important | 3, Third most important	F20a. obwangu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F20b. Safety	1, First most important | 2, Second most important | 3, Third most important	F20b. Eri seefu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F20c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F20c. okwanguyira	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F20d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F20d. Okukozesa emmotoka yange eyobwannanyini.	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F20e. Cost	1, First most important | 2, Second most important | 3, Third most important	F20e. Ebissale	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F20f. Other	1, First most important | 2, Second most important | 3, Third most important	F20f. ebilala	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo

F20g. Specify other concern:		F20g. Tunyonyoleko ebilala	
F21. For the next two questions, think about what you would prefer to do if you had to move to clinic to get a vaccine for [childsname].		F21. Kubibuuzo ebibiri ebiddako lowooza kungeri gyewandiyagadde okutambulamu ng'ogenda mu ddwaliro okugemesa [erinya ly'omwana]	
Rank the following modes of transportation based on what your preference would be from most preferred to least preferred.		Seengeka entambula zino okutandikira ku josinga okwagala okukozesa, osembyeyo gyosembyaayo okwagala okukozesa.	
F22a. Walk	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22a. Okutambula	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala.
F22b. Take a car	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22b. Okukozesa emmotoka	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F22c. Take a bicycle	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22c. Okukozesa akagaali	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F22d. Take a minibus taxi	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22d. Okulinya takisi	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F22e. Take a boda boda	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22e. Okulinya booda	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala
F22f. Other	1, Most preferred | 2, 2nd | 3, 3rd | 4, 4th | 5, Least preferred	F22f. Ebirala	1, Josinga okwagala 2. Eyokubiri 3. Eyokussatu 4. Eyokuna 5. Josembyayo okwagala

F22g. Specify other mode of transport:		F22g. Tunyonyole entambula endala	
What are the factors that would make you prefer this mode of transportation? Please select the 1st, 2nd, and 3rd most important.		Bintu ki ebikwagazisa entambula zino ng'abwozisengese. Londako ng'otandika n'ekisinga obukulu, osembyeeyo kyotatera kugoberera.	
F23a. Speed	1, First most important | 2, Second most important | 3, Third most important	F23a. obwangu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23b. Safety	1, First most important | 2, Second most important | 3, Third most important	F23b. Eri seefu	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23c. Convenience	1, First most important | 2, Second most important | 3, Third most important	F23c. okwanguyira	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23d. Using a vehicle I own	1, First most important | 2, Second most important | 3, Third most important	F23d. Okukozesa emmotoka yange eyobwannanyini.	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23e. Cost	1, First most important | 2, Second most important | 3, Third most important	F23e. Ebissale	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23f. Other	1, First most important | 2, Second most important | 3, Third most important	F23f. ebilala	1, Ekisinga obukulu 2. Ekyokukubiri 3. Ekisembayo
F23g. Specify other concern:		F23g. Tunyonyoleko ebilala	
G. Survey Finalization			
G1. Would you be willing to be contacted in the future to be invited to participate in a follow-up study?		G1. Wandiyagade okutuukirirwa mubiseera ebyo mumaso okwataba mukunoonyereza okuddako?	
G2. What is the best phone number to reach you?		G2. Nnamba ki eye ssimu gyetuyinza okwanguyirwa okutukikirako?	
G3. Who owns this phone?	1, I do | 2, My partner does | 3, A family member does	G3. Ennamba eno yaani?	1, Yange 2, Ya mwami 3, Yawa Luganda.
G4. Time and date of survey END		G4.	