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Maternal Barriers to Childhood Vaccinations in Tanzania: An Examination of the 2004-2005 Demographic and Health Survey

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MATERNAL BARRIERS TO CHILDHOOD VACCINATIONS IN TANZANIA: AN EXAMINATION OF THE 2004-2005 DEMOGRAPHIC AND HEALTH SURVEY

by

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ABSTRACT:

Tanzania, one of many nations in Africa with high infant mortality to preventable diseases, continues to experience relatively low vaccination rates for childhood diseases. In this paper, we examine the maternal barriers to obtaining vaccines for their children in Tanzania. The risk and protective factors we analyzed include age of the mother and children, education level of the mother, number of children, maternal decision-making practices, power dynamics and others. Lack of control, limited decision practices, and decreased maternal empowerment were identified as key barriers to obtaining vaccines for children. Overall, this data is consistent with previous studies regarding barriers to vaccinations in Tanzania and other African nations.

INDEX WORDS: childhood vaccinations, maternal barriers, maternal and child health Tanzania, Demographic and Health Survey

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Chapter I

Introduction

Many nations have been successful in reducing infant deaths related to infectious childhood diseases such as measles, diphtheria, polio, mumps, and rubella. Despite this success, a child born in a developing nation is 13 times more likely to die before her fifth birthday than a child born in an industrialized nation; and child deaths in Sub-Saharan Africa account for nearly half of all deaths in the developing world (MDG Report, 2008). In 2000, child mortality rates for industrialized nations were 6 per 1000 children, but in sub-Saharan Africa the rate was 175 deaths per 1000 children (Black *et al*. 2003). The primary causes of death in children worldwide are neonatal disorders, diarrhea, pneumonia, and malaria (Armstrong Schellenberg *et al*. 2004). HIV/AIDS does play a role in some child deaths, and nearly half of all childhood deaths globally can be linked to malnutrition (Armstong Schellenberg *et al*. 2004).

A variety of public health measures have been used to give each child born a chance to lead a well and full life, barring any other major events or environmental factors. Improved sanitation, better diet, and increased knowledge and education about the transmission and etiology of childhood ailments have led to major advances in not only how we treat, but also how we prevent the spread of diseases in a given population. One of the most economical methods developed up to this point has been the vaccine (Armstrong 2007). Some studies have also shown that the cost to treat vaccine preventable diseases is nearly 30 times greater than the cost of administering the vaccine (Tadesse 2009). In 1993, vaccinations were classified by the World Bank as one of the most cost-effective public health interventions (World Bank, 1993). Nearly three million child deaths are averted annually through the immunization programs worldwide (Duclos *et al*. 2009). Despite the impressive strides made, 25% of the 10 million annual deaths

in children under age five can be attributed to vaccine preventable diseases (Black *et al*. 2003; Duclos *et al*. 2009).

First developed by accident with Edward Jenner's cowpox vaccine to treat and ultimately halt the spread of smallpox, health care workers have since used vaccines as a primary weapon in ensuring the health and safety of nearly every infant born. However, vaccines are not without controversy (Callréus 2009). Some nations are unable to provide adequate vaccine coverage to their young citizens. Another concern is the cost and profitability of vaccines. Wealthy nations are able to mandate that vaccines be given and have means of ensuring nearly all children received the required immunizations. This situation is not true for all countries; however, Tanzania is an example of the challenges developing nations face when they lack the resources to provide adequate care to facilitate a sustainable and successful vaccine intervention protocol.

In this paper, data collected from the 2004-2005 Demographic and Health Survey in Tanzania will be used to ascertain the maternal barriers, if any, to childhood vaccinations in this country. The purpose of this study is to determine what, if any, maternal barriers exist to childhood vaccinations in Tanzania. The specific barriers will be identified, and the effect each factor has on the likelihood of a mother to have her children vaccinated will be examined. The null hypothesis is that there are no maternal barriers to childhood vaccines, and the alternative hypothesis is that there are maternal barriers to childhood vaccines.

Some key barriers that have been previously studied include, wealth, indicators related to socioeconomic status (SES), literacy, and education (Jani *et al*. 2008; Ndirangu *et al*. 2009). These factors and others that impact maternal empowerment will be investigated to determine potential risk and protective factors associated with basic vaccine coverage. Understanding the

probable barriers before an intervention could improve the efficacy of interventions and increase the quality of life for those who choose to participate.

For this study, the Health Belief Model was selected to provide a framework for analysis and a model for identifying the maternal barriers that can affect vaccine outcomes. This model, first developed in the 1950s by social psychologists Hochbum, Rosenstock, and Kegels, attempts to explain why an individual may or may not exhibit certain health behaviors. For example, the health belief model was first used to explain why a free tuberculosis screening program failed (Stretcher and Rosenstock, 1997). In this model a variety of factors affects a person's perception of risk of an adverse health outcome. Many indicators can influence these outcomes and these factors can be internal or external. An example of external factors would be pressure from a spouse or other person of trust to not seek care. An internal factor can be fear of the outcome of a screening test or health behavior. HIV/AIDS testing can be used as a good example; fear of a positive test can prohibit a person from making the decision to be tested. External factors can also contribute to the decision to be tested such as the stigma of getting tested, the mixed messages from media, and so on.

This model is extremely useful in understanding the motives for why women choose to get vaccines for their children or not. Numerous studies have shown that vaccines are a safe and effective way of eliminating childhood diseases, and potentially eradicating certain childhood ailments (Armstrong-Schellenberg *et al*. 2008; Armstrong-Schellenberg *et al*. 2004; Duclos *et al*. 2009; Masanja *et al*. 2005). There are a number of programs designed to get all children vaccinated around the world at no or low costs to the consumer. Vaccinations are used to prevent a variety of illnesses in both children and adults and although some vaccines have had certain adverse outcomes, for most public health professionals the benefits of vaccines far outweigh the

risks (Armstrong 2007). However, some women still do not adopt the practice of vaccinating their children. This model could provide an illustration of the barriers many women experience that would limit their likelihood of having their child immunized.

The health belief model was modified slightly to include information that could predict and explain how and why women make the decision to have their children vaccinated (Figure. 1). In this model, the expected health outcome is complete vaccination of children under age 5 years. Factors affecting the success of this are age of the mother, wealth indicators, power concerns, socioeconomic status, literacy and education. Depending upon the influence of each of these, this model should be able to predict the likelihood that a mother will or will not choose to have her children vaccinated. In this paper, the individual perceptions of disease and specific mitigating factors such as demographics will be addresses. Other influencing issues such as media campaigns and programs will be addressed in the literature review section, but not analyzed specifically for their impact. Instead these "cues to action" will provide a framework for explaining certain outcomes observed.

In recent years, Tanzania has improved its vaccine coverage substantially (Table 1). This is mostly due to developed nations taking a leadership role in improving the quality of life for all peoples, especially women and children (Arevshatian *et al*. 2007). Because of these efforts, more women feel autonomous and can make important decisions regarding the health and well-being of their own lives as well as the lives of their children. Women in developing nations are being encouraged to exhibit control and hold positions of power that allow them to choose how they will improve their own lives and the lives of their families.

Table 1. National Vaccine Coverage Percentages for Tanzania (WHO/UNICEF Estimates 2007).

Vaccine	2007	2006	2005	2000	1995	1990	1985	1980
BCG	89	99	91	86	96	85	90	72
DTP1	89	94	95	92	93	92	86	81
DTP3	83	90	90	79	91	78	67	59
MCV	90	93	91	78	78	80	66	46
POL3	88	91	91	64	79	78	64	57

Source: WHO Website, Accessed on February 3, 2010

Understanding the maternal barriers and limitations that might normally go unnoticed is critical to retooling the programs to obtain the maximum benefit and ultimately move toward the goal of near 100% vaccination coverage in children. Since the Millennium Development Goal targets are fast approaching and since there has been and increased push to meet those goals this paper is important to determine where weaknesses are present in the system and provide a potential framework for how to address these weaknesses so that Tanzania and other countries in similar situations can better target their resources to improve vaccine program outcomes.

Chapter II

Review of Literature

According to the CIA World Factbook, Tanganyika gained independence from Britain in December 1961. On April 26, 1964, Tanzania (Tanganyika) and Zanzibar (the island off the coast) joined and are now called the United Republic of Tanzania. Tanzania now has a multi-party democracy in which Presidential and Assembly members are elected every five years, with a two-term limit for Presidents. Tanzania is divided into 21 regions and Zanzibar is subdivided into five regions. Each of those regions is further subdivided into districts (Figure 2). Tanzania has 26 regions which are listed here; Arusha, Dar es Salaam, Dodoma, Iringa, Kagera, Kigoma, Kilimanjaro, Lindi, Manyara, Mara, Mbeya, Morogoro, Mtwara, Mwanza, Pemba North, Pemba South, Pwani, Rukwa, Ruvuma, Shinyanga, Singida, Tabora, Tanga, Zanzibar Central/South, Zanzibar North, Zanzibar Urban/West. Some of these regions are on the island off the coast of Tanzania known as Zanzibar. These regions vary in climate slightly and in population. Dar es Salaam is the economic capital region of Tanzania, though Dodoma is recognized as the legislative capital.

Tanzania is in the easternmost portion of Sub Saharan Africa adjacent to the Indian Ocean and bordering Kenya and Mozambique. Tanzania is also home to a famous landmark, Mount Kilimanjaro, the highest point in Africa. This country has a tropical to temperate climate and many areas of the nation are rural and undeveloped. Many tourists come here for safari in hopes of experiencing the natural beauty of the country and its extensive wildlife population. Tanzania has a long arid spell from May to October, followed by a rainy season between November and April (CIA World Factbook).

Tanzania is largely agricultural, with most of economy dependent on its natural resources such as hydropower, tin, phosphates, iron ore, coal, diamonds, gemstones, gold, natural gas, nickel. The major cash crops for the country are coffee, cotton, tea, tobacco, cashew nuts and sisal. Tourism is also a large industry for the residents of the country. Hospitality, particularly for tourists interested in safaris, hiking, and mountain climbing provide most of the jobs for people in the region. Despite the density of natural resources, Tanzania's economy still ranks in the bottom ten percent when compared to the rest of the world. However, Tanzania is experiencing positive economic growth, despite a recession in the world, due to improved investment strategies, increased private sector support and updates in the antiquated economic infrastructure made possible by government programs to reduce poverty nationwide (CIA World Factbook, DHS Final Report Introduction). These programs which promote private sector growth can be attributed to government initiatives that are in conjunction with the National Strategy for Growth and Reduction of Poverty (NSGRP) and the Millennium Development Goals (MDGs).

Over 41 million people reside in Tanzania, with the majority of them being female and less than 64 years of age. The population of Tanzania has grown in the last 50 years, but the region is still sparsely populated, which can prove extremely challenging for public health professionals trying to serve the population. Even though there has been an increase in the number of citizens residing in urban areas, the majority of the population is still lives in rural areas (76.9%) (Table 2).

Table 2. Basic demographic indicators for Tanzania in selected years.

Indicator	Year			
	1967	1978	1988	2002
Population (millions)	12.3	17.5	23.1	34.4
Sex Ratio	95.2	96.2	94.2	96.0
Crude Birth rate	47	49	46	43
Total Fertility Rate	6.6	6.9	6.5	6.3
Infant Mortality Rate	155	137	115	95
Percent Urban	6.4	13.8	18.3	23.1
Density (pop./km^2)	14	20	26	39
Life Expectancy at Birth	42	44	50	51

Table Modified from Demographic and Health Survey Final Report; Original Source: Bureau of Statistics, 1967;1978;1988; National Bureau of Statistics, 2002

Tanzania, because of disease and extreme poverty, has a limited workforce, which influences the economy and the ability to afford and provide basic healthcare needs. The life expectancy in Tanzania for men and women is approximately 52 years of age (CIA World Factbook). This is twenty to thirty years less than the average life expectancy of the United States and other developed nations. Diseases such as AIDS, malaria, and other infections have caused substantial excess death in this region that public health officials have yet to fully address. Tanzania has poor health outcomes for a variety of reasons, and understanding how these factors relate to each other is an important aspect of improving quality and providing the basic health care needs that have gone unmet in this country.

Women and children are considered a vulnerable population. In certain societies, the role of women and whether or not they have power has a substantial impact on the health outcomes of her children and at times the entire community. These factors, which are referred to as "maternal empowerment" or "maternal autonomy," examine how women are given control over specific decisions regarding the health and well being of their children. Children born in Tanzania are more likely to die before their fifth birthday than any other children in the neighboring East African region. In 2000, Tanzania had 223,000 child deaths placing it ninth on a list of nations with the highest number of child deaths compiled by Black *et al*. (2003). The overall mortality rate is 69 deaths/1000 live births (male=76.2/1000; female 62.1/1000) (CIA World Factbook). Many factors contribute to this high infant mortality rate including, poor nutrition, diarrhea, infection, abandonment, complications during pregnancy, and numerous others. It has been stated that where child mortality rates are higher the health system is generally weaker (Armstrong-Schellenberg *et al*. 2008). The challenge for public health professionals trying to improve conditions to be consistent with the Integrated Management of Childhood Illnesses (IMCI) program and the MDGs is that the causes of child mortality are multifaceted and stem from a myriad of conditions that result in poor health outcomes (Armstrong-Schellenberg *et al*. 2008; Armstrong-Schellenberg *et al*. 2004; Duclos *et al*. 2009; Masanja *et al*. 2005). A key tool to improving Tanzania's health outcomes is providing adequate vaccine coverage and at no or low cost to Tanzanian families. Some studies have found a potential caveat to this strategy; when the focus is primary health care, temporary increases in inequality of care can arise due to people with higher a socioeconomic status (SES) having more access than their counterparts with lower SES (Masanja *et al*. 2005).

Women are typically responsible for households, as men are either working or are deceased (Letamo and Rakgaosi 2003). The HIV/AIDS epidemic has ravaged the country and as a result some children are born with HIV, or acquire it shortly after birth. Over 1.7 million people in Tanzania are living with HIV according to information collected in 2007 (CIA World Factbook). Tanzania is twelfth in the world with the number of people in its population who currently have HIV. These numbers are likely underreported since many people may carry the disease, or are co-infected with other diseases, but do not seek treatment or know their HIV/AIDS status. Many women perish because they unknowingly carry and spread the disease. HIV/AIDS has been shown to make the immune response to certain diseases, such as tuberculosis (TB), malaria, measles, pneumonia, diphtheria, and others weaker. A few studies have also found that HIV/AIDS can affect the immune response to vaccines thereby limiting the effectiveness of some vaccines (Farquhar *et al*. 2009; Pippi *et al*. 2008;).

Vaccine coverage in Tanzania has been limited at best. Despite increased funding and awareness about the unmet needs in this country, progress seems slow. There are several factors as to why Tanzania has struggled with vaccine coverage. Though the vaccine schedule for Tanzania contains all of the vaccines recommended by the WHO, the standard vaccines covered are not as comprehensive as other more developed countries. For example in the US, the Centers for Disease Control and Prevention (CDC) and the Advisory Council on Immunization Practices (ACIP) recommends that children be given 11 distinct vaccines before age 6, whereas Tanzania only requires the administration of four vaccines. Even when the vaccines are available there appears to be gaps in delivery (Odusanya *et al*. 2008; Armstrong-Schellenberg *et al*. 2008). Second, many vaccines require boosters to attain full protection which can mean returning to a health facility after birth, a challenge for women who have no health facility near them. Also co-

infection with diseases such as HIV/AIDS and malaria can impact the overall effectiveness of the vaccine (Farquhar *et al*. 2009). Lack of access to the appropriate resources plays a major role in whether or not the impact of an intervention is successful. So the challenge becomes how to eliminate the existing barriers and make efforts to improve vaccine coverage more effective and efficient given the present circumstances in Tanzania.

Despite these difficulties, Tanzania has made impressive strides in the last 20 years to improve its standing in regards to vaccine coverage. For example, the Tanzanian government has taken a vested interest in the health of its people and has vowed to improve the quality of life for all of its citizens. According to data collected from the Global Alliance for Vaccines and Immunisations (GAVI), the government currently spends 5.1% of its GDP on health expenditures. In addition 83% of the routine vaccines are funded by the government as well. With support and guidance from around the world, Tanzania is making great strides politically to improve its overall health standing. Tanzania does include a specific line item in its national budget for vaccines and 80% of the immunization spending is financed by the government (GAVI Tanzania Fact Sheet).

In 1992, Tanzania adopted the National Population Policy, and this strategy was used to support national development by improving the quality of life of all Tanzanians. (DHS Introduction; President's Office, the Planning Commission 1992). The policy is designed to provide an overarching guideline on how to regulate population growth, enhance population quality and improve the health and well being of women and children. There are eight major goals mentioned in the policy, the two of most importance to childhood vaccines are the first two listed: "Improve the standard of living and quality of life of the people through the protection and improvement in the provision of basic human needs in such areas as health, nutrition, clean and

safe water, housing and environment," and "Promote improvement in the health and welfare of the mother and child through the prevention of illness and premature deaths" (DHS Introduction; President's Office, the Planning Commission 1992).

The National Package of Reproductive and Child Health (RCH) is another government implemented policy that is designed to target women and children. This policy is comprised of nine different strategic plans that seek to improve the overall quality of maternal and child health. The plans are varied and range from a malaria plan, to an ending female genital mutilation plan, to a fertility and reproductive health/justice for women plan. The two plans within this national package that relate specifically to immunizations are the Expanded Programme on Immunization Strategic Plan or EPI (2002-2007), and the Integrated Management of Childhood Illness Strategy or IMCI (1998-2003). This paper will outline the specific progress of these two plans and determine whether these programs have been successful. The RCH strategy has a broad vision of establishing a healthy well-informed Tanzanian population with access to high quality reproductive care and health services for children. Its aim is to make these services affordable and accessible to the vulnerable populations that need them most. The delivery of these services will occur through a network of sustainable, integrated, efficient and effective support systems.

The United Republic of Tanzania, like much of the World Health Organization (WHO) African region, has faced substantial challenges in reducing infant mortality as it relates to vaccine preventable diseases (VPD). Some African nations have a myriad of factors that have contributed to delayed progress in reducing child mortality. A primary reason is lack of resources. In countries, like Tanzania, where the gross domestic product (GDP) is eclipsed by most other nations, they have struggled to provide adequate health resources to their citizens. A

large majority of the money, training, and medical equipment for healthcare in Tanzania comes in the form of humanitarian aid from other wealthier nations.

In the 1990s, WHO implemented the Millennium Development Goals and Target Goal 1 related to children is "To reduce by two-thirds, between 1990 and 2015, the under five mortality rate." Tanzania has improved its standing substantially, but still has not attained its goal as of yet. The number of children dying from preventable childhood diseases still remains elevated in spite of the increased efforts to improve conditions. One reason achieving this goal remains a challenge is the nature of some of the diseases themselves. A successful vaccination assumes that the child has appropriate care and nutrition at home, which is not always the case. With Tanzania exporting many of its resources as a means of economic growth, some of its residents suffer from extreme poverty and malnutrition. Malnutrition has been known to negatively the impact the immune response to vaccines thereby impacting their efficacy (Black *et al*. 2003).
Also unclean water sources, which are how many diseases are transmitted, serve as the site for many communities to drink, bathe, and wash clothes (Black *et al*. 2003). Lack of access to clean sanitation facilities and filtered water is another hindrance in the efforts to achieve these goals. Some of the most basic resources are not available in rural areas of Tanzania, and since only 25% of the population lives in urban centers, the need to find and provide healthcare to nomadic populations is a challenge. Despite these challenges, progress has been made.

The Expanded Programme for Immunization or EPI, was developed by the WHO in 1974 as a tool for increasing the vaccine coverage in countries that had experienced low coverage and high mortality to vaccine preventable diseases. Tuberculosis, diphtheria, tetanus, pertussis, polio, and measles are the six diseases targeted by the program. Through EPI, many countries, including Tanzania received financial support, medical supplies, and increased training and

human capital as a means for improving the health outcomes for children with vaccine preventable conditions. This program has been extremely successful and improved Tanzania's coverage from less than 60% in some regions to nearly 90% in most regions (Table 1). Tanzania and the EPI program are going through a revitalization, and as such more support including funding for the program has been added. EPI has been credited with averting more than 12 million deaths from 2000-2008 through maintenance of routine coverage and additional coverage through supplemental immunization activities, or SIAs (Dabbagh *et al*. 2009). In 2002, the Hepatitis B vaccine was added to the list of vaccines covered by EPI, and they have upgraded the syringes used to improve safety. The WHO has identified three main goals to improve the quality and delivery of vaccines to needy populations: 1.) Mobilizing the additional resources. 2.) Improving the reliability of resources. 3.) Improving the efficiency of the program.

The Integrated Management of Childhood Illnesses (IMCI) program is a WHO and United Nations Children's Fund (UNICEF) strategy to reduce child mortality and advance child development by improving the skills of primary health care workers, strengthening support for the health system, and improving family and community practices (Gouws 2005; Manzi *et al*. 2005). This program is designed to reduce deaths from the leading causes of post-neonatal deaths which are diarrhea (33%), pneumonia (32%), malaria (14%), HIV/AIDS (5%) and measles (2%) (Jones et al 2003). One study found the IMCI improved child health without compromising equity of care (Masanja *et al*. 2005). Another research group found that IMCI did not have an impact on the cost of child care in Tanzania and therefore cost could be eliminated as potential barrier for some women (Adams 2005).

The Global Alliance for Vaccine and Immunisations or (GAVI) is non-profit organization that has partnered with the WHO, The Bill and Melinda Gates Foundation, UNICEF, and others

to provide $4 Billion in aid to 72 countries that need assistance in vaccines. This organization has four main goals. One is to increase the use of underutilized and new vaccine and improve the vaccine supply security. The second is strengthening the healthcare system to deliver health services and vaccines in a sustainable manner. The third goal is to increase the funding support for long-term financing of national immunization programs. Improving the visibility of GAVI as a public-private partnership through efficiency, advocacy, and innovation is the final goal of the organization (http://www.gavialliance.org/vision/strategy/goals/index.php).

Tanzania is one of the countries currently supported by GAVI. GAVI has disbursed nearly $40 million in aid to Tanzania to support implementation of new vaccine, injection safety, and immunization and support services (GAVI Fact Sheet, 2008). According to their website, GAVI is also the organization most responsible for the introduction of new vaccines into countries that need them most. For example, the expansion of vaccine coverage in 2002 to include the Hepatitis B vaccine was in part because of the efforts of GAVI. They are also moving forward on efforts to include yellow fever, rotavirus, *Haemophilus influenza* B, and another dose of measles, and pneumococcal vaccines as part of the basic immunization schedule for children, particularly those in developing nations. GAVI has experienced great success in many countries, Tanzania being one of them, but Tanzania is not currently approved for health infrastructure improvements, which is something they need desperately to continue to advance vaccine coverage in the future.

All of these programs have proved to be successful for a myriad of reasons. These programs have clear goals with measurable outcomes and deadlines for achieving their goals (Bryce *et al*. 2005). They have partnered with organizations in and outside of the country to ensure that needs are met based on the uniqueness of the populations that they serve. Worldwide

support is another key aspect of IMCI, EPI and GAVI (Duclos *et al*. 2009). In addition, all organizations that have partnered with them identify child health a primary means of reducing mortality and have stated that improved vaccination programs are an excellent intervention for reducing infant mortality. Another reason why these programs are successful is because the majority of the indigenous populations support the efforts of humanitarian aid groups, and welcomes the preventive and medical care. As the concern for improving maternal and child health around the world grows, more programs that focus efforts on women and children will improve the overall quality of life for a variety of people.

Unfortunately these programs are not with limitations. Vaccinating a large population requires numerous resources and logistics. Some programs have not been as successful as they could be due to wasting or limited resources and poor planning in some countries (Duclos *et al*. 2009; Gouws *et al*. 2005). Also gross underestimation of the need can be problematic and limited supplies force aid workers to limit care to only those in most need, ultimately excluding people who may not be of significant need, but could still benefit from the program. In some cases the country's climate can pose problems, a lack of volunteers, and warfare also cause challenges for vaccine campaigns. Aid agencies often have to be mindful of political groups that may be in opposition of the government or make it hazardous to deliver resources to those most in need. Though many people are receptive to humanitarian aid, some groups may be wary of aid groups and may even be hostile towards them (Nature 2009).

Tanzania, like many developing nations lacks a substantial health infrastructure. There is a decent mix of private hospitals, government-owned hospitals, and public-private hospitals (Table 3). Though there are clinics, dispensaries and hospitals available, however, these facilities do not always have adequate staff, resources, or funding to provide the care required for many of

the people (Gouws *et al*. 2005) In some cases, out of pocket payments at certain facilities may serve as a barrier to accessing care (Manzi *et al*. 2005). One example is birth attendance; very few women in Tanzania have an experienced birthing attendant at delivery. As a result, some women die from complications that could easily be prevented with adequate care. Also the location of some of these facilities is inconvenient for those who live rural areas and are unable to transport themselves to health facilities during emergency situations let alone for preventive care.

Table 3. Number of Health Facilities by Type of Organization.

Facility	Agency				
	Government	Parastatal	Vol/Rel	Private	Others
Consultancy/Specialized Hospitals	4	2	2	0	-
Regional Hospitals	17	0	0	0	-
District Hospitals	55	0	13	0	-
Other Hospitals	2	6	56	20	2
Health Centres	409	6	48	16	-
Dispensaries	2450	202	612	663	28
Specialized Clinics	75	0	4	22	-
Nursing Homes	0	0	0	6	-
Private Laboratories	18	3	9	184	-
Private X-Ray Units	5	3	2	16	1

Source: Tanzania Ministry of Health Website, 2000, Accessed on February 3, 2010.

Also the impact of malaria and HIV/AIDS on Tanzania has been substantial. These two diseases account for a significant number of childhood deaths in the region and often eclipse the needs of other diseases. HIV/AIDS has left many children as orphans and therefore limiting the likelihood that they will receive the adequate care they need from orphanage workers or from caregivers who choose to assist the children (Ndirangu *et al*. 2009). One study has also found that if a child is infected with HIV then the efficacy of the vaccines subsequently diminishes (Farquhar *et al*. 2009). This can be a critical concern for children who need to get vaccinated to protect them from disease, but even if they are vaccinated failure of the vaccine to work properly can be detrimental. Another study found that if a child's mother has a positive HIV status then she is less likely to have her child fully vaccinated (Ndirangu *et al*. 2009). She may have difficulty getting to a vaccination clinic because she is physically sicker and weaker than a woman who is HIV-negative (Ndirangu *et al*. 2009).

The EPI program targets specific childhood diseases which are polio, measles, tuberculosis, diphtheria, pertussis, and tetanus. Each of the diseases and the impact they have will be described in the following paragraphs. Though the program does not include all the diseases that affect children in Tanzania, they have been able to successfully address many of the causes of disease and disability in young children.

Poliovirus is transmitted via the fecal-oral route through people living in crowded and unsanitary conditions. Though polio can often be asymptomatic, when symptoms do occur they are often mild and include fever, malaise, sore throat, headache, drowsiness, vomiting, nausea, and constipation. In one percent of cases infection can result in paralytic polio, the most serious form of the disease (Sabin 1951). Cases of polio have dropped substantially from 350,000 cases in 1988 to about 1,000 cases from 2001-2004 since the eradication campaign began through

vaccine administration and active disease surveillance (Miller and Sentz 2006). At present there are two types of vaccines available against polio, the oral poliovirus vaccine (OPV) and the inactivated poliovirus vaccine (IPV). The oral vaccine is a live attenuated virus that is given orally and can induce a 95% protection rate when administered correctly. Unfortunately, since the virus is live there have been cases of paralytic polio arising from vaccine strains that reverted back to a transmissible, pathogenic form, although this occurs in less than one person per 3.3 million doses (Miller and Sentz 2006). Some countries, due to concern about the risk of vaccine related disease have switched to the IPV form of the immunization. The IPV, given as an injection, contains inactivated (killed) strains of the diseases and can result in 80-90% protection when administered correctly, although less effective, this vaccine is considered safer.

Measles is caused by the paramyxovirus and results in fever, cough, and a distinct rash (Bedford 2004). Measles is an airborne virus that is remarkably infectious and can spread easily through a vulnerable population. In fact, in order to successfully prevent the outbreak of measles in a given population ≥95% of the population needs to be immune (Goodson et al. 2009). Measles has been a problem for many children around the world. In most cases, a healthy child will recover from measles in about 8-10 days with supportive care, such as a fever reducer and ointment to treat the rash. However in some cases complications can arise, these include ear infections, encephalitis, bronchitis and pneumonia. If any of these symptoms occur the potential for an adverse outcome, such as death increases substantially; particularly if these complications are missed or not treated sufficiently (Bedford 2004).

Measles vaccination began in Tanzania in 1975 through the EPI program. All children were routinely vaccinated at age nine months and coverage jumped from 46% in 1980 to 80% in 1990. Coverage fluctuated throughout the 1990s, but increased to over 90% from 2003-2007.

Also Tanzania began supplemental immunization activity (SIA) in 1999 and 2000 in all children aged 5-9 years in high risk health areas regardless of previous immunization history, and then expanded the program nationwide to cover remaining children ages 9-14 years. This campaign was a success in Tanzania, dropping measles cases from 14,649 in 2000 to 727 in 2005 (Salama 2005). Measles vaccinations can be administered during a campaign for as little as US $.60-$1.00 per child, making it a cost effective and successful public health intervention (Salama 2005).

Africa has had difficulty over the years with vaccine coverage for measles for a variety of reasons, but improved focus on public health interventions like IMCI, GAVI, and EPI have brought an 89% decrease in measles deaths from 2000 to 2007 (Goodson 2009). Despite this accomplishment, outbreaks still occur and dealing with these outbreaks can be a challenge. During an outbreak, the recommendations are case management and identifying the cause of the outbreak, and in special situations, such as an outbreak in a school or refugee camp an outbreak response vaccination campaign (ORV) is implemented (Goodson 2009). In Tanzania from 2000-2001, an outbreak of measles occurred in a refugee camp that was hosting refugees from Burundi. Measles can be particularly devastating to refugee populations who are in a state of emergency due to migration of large numbers of people, crowding, and poor nutritional status. Under normal circumstances, according to the WHO, the case fatality rate for measles is approximately 2%, but increases to nearly 33% in humanitarian emergencies (Kamagisha 2003). It is these outbreaks that continue to threaten the attainment of the MDG targets for Tanzania.

Tuberculosis, a bacterial infection, is caused by *Mycobacterium tuberculosis* and can be transmitted via respiratory droplets. This is a highly contagious disease and is easily passed between persons in close contact with an infected individual. Symptoms can vary from person to

person based on the age of the individual, but often include an unproductive cough, shortness of breath and low grade fever. Night sweats, fatigue, irritability, weight loss, and malaise are some other common symptoms of the disease. Also, the disease can be carried latently and re-emerge later in life (Miller and Sentz 2006).

The WHO has estimated that nearly one-third of the world's population is infected with TB. Roughly 2-3 million deaths occur annually as a result of TB infections, and an estimated 8 million new cases occur each year. Co-infections with HIV have lead to an increase in the incidence of TB, particularly in Sub-Saharan Africa, despite use of the Bacille Calmette-Guérin vaccine (BCG) (Miller and Sentz 2006). The BCG is a live attenuated vaccine administered at birth and its effectiveness has been debated with a range from 0-80% (Fine 2001).
Diphtheria is an acute bacterial infection caused by *Corynebacterium diphtheria*. This upper respiratory tract infection is characterized by fatigue, fever, nausea, sore throat, vomiting, and in some cases swelling of the neck. The disease can affect the skin, but this form usually does not result in the same complications as the respiratory form of the disease. Unfortunately case estimates for Africa are difficult to ascertain because of underreporting and misclassification of the disease (Miller and Sentz 2006). The vaccine for diphtheria is administered as a combination vaccine with acellular pertussis and tetanus toxoid.

Pertussis, more commonly known as whooping cough, is caused by the bacteria *Bordetella pertussis* and is transmitted via respiratory excretions. The disease is characterized by severe bouts of coughing followed by large gasps for air that results in the whooping sounds the disease is known for. Since breathing can be compromised, lack of oxygen (hypoxia) is a complication associated with pertussis. In 1999, estimates for the disease were about 20-40 millions cases with 200,000-400,000 deaths worldwide, most of these occurred in developing

nations (Miller and Sentz 2006). The number of cases for this disease is difficult to obtain as well because the disease is challenging to diagnose and it is often misdiagnosed as other respiratory illnesses. An acellular form of the bacteria is included in the current DTaP-HB combination vaccine.

The bacterium *Clostridium tetani*, obtained through environmental sources, is responsible for the disease tetanus. A neurotoxin, produced by the bacteria, leads to convulsions and ultimately death. Neonatal tetanus is the most common form of the disease in the developing world and can arise from infection in the umbilical stump due to contaminated instruments or application of animal dung to the wound following birth (Miller and Sentz 2006). Tetanus has an extremely high mortality rate, 25-90% with treatment and 95% without treatment. Once again, underreporting makes accurate disease case estimates a challenge. Protection from this disease is also attained from the DTP combination vaccine.

Around the world the success of vaccine programs can also be linked to the trust that participants place in the medical and public health establishment. A lack of trust can severely hinder willingness to comply with a given public health intervention. Ironically vaccines could be at fault for their own demise, as the more successful a vaccine is the less prevalent the disease it targets will be creating a perception that the threat from the disease is minimal (Callréus 2009). Reports of vaccines causing illnesses or misappropriating a causal relationship to a given vaccine can erode confidence in vaccines and vaccine safety thereby undermining the desire for some people to actively obtain vaccinations for their children. For most people vaccines are a safe and reliable way to prevent unwanted illnesses and as a result of this confidence most vaccine campaigns around the world have a achieved a high level of success.

There have been some notable exceptions, for example the suggested link between the Measles, Mumps and Rubella (MMR) and autism vaccine resulted in a decline in the uptake of MMR, which has ultimately led to outbreaks of measles in previously controlled areas (Callréus 2009). Developing nations are not immune to fears about vaccines and vaccine safety. For example, it was rumored that the polio vaccine that was being administered by Western doctors and companies was contaminated with HIV, cancer-causing agents, and chemicals that caused infertility. Even though polio cases rose by nearly 30% parents and political leaders were still unwilling to yield. Ultimately a compromise was found and the vaccination program was restored, but many children suffered as a result of the vaccine refusal (Callréus 2009).

The vaccine schedule in Tanzania is as follows, BCG vaccine at birth or first contact with a clinician, polio vaccine and DPT-HB (a recombinant vaccine that protects against diphtheria, pertussis, tetanus and Hepatitis B) at 4, 8 and 12 weeks of age, and measles vaccine at nine months of age. This schedule can pose a problem for appropriate vaccinations. Tanzania has an extremely high infant mortality rate and some children may not get fully vaccinated due to poor initial health and poor birth outcomes. This vaccine schedule is different from developed nations whose children receive far more vaccines than children in developing nations. In the United States, for example, a child can expect to receive at least 10 different vaccines before his or her fifth birthday. The United States also requires children be properly vaccinated before entering primary school as a way to prevent and control common childhood diseases.

In order for a child to be fully vaccinated based on the World Health Organization, a child born in Tanzania must receive, one dose of BCG to protect against tuberculosis, three doses each of Polio vaccine and DPT-HB, and one dose of measles vaccine before they are 12 months of age (www.who.int). The information should be recorded on a vaccination card to verify

receipt of the appropriate vaccines. Tanzanian children do not have access to the same vaccines that children from other nations have. There are a variety of reasons for why this is the case. Cost is a major barrier for why some vaccines are given in some countries and not in others. New vaccines are often expensive and few developing nations have the money to invest in introducing a new vaccine when they still struggle to ensure the current vaccines are administered properly. One of the reasons vaccine campaigns are not always effective is that the leading causes of infant death cannot always be attributed to vaccine preventable diseases. For example, diarrhea kills many children in Tanzania each year, yet most of the bacteria and viruses that cause diarrhea do not have vaccines available for them. One study showed that up to one-third of the diarrhea in Tanzania was caused by either norovirus, rotavirus, adenovirus, or astrovirus and despite having a vaccine readily available for rotavirus, vaccines are not available for the other viruses that can result in diarrhea. That results in at least two thirds of the children who would suffer from diarrhea caused by other agents (Moyo *et al*. 2007). Clean water, in this case, is the easiest method to prevent this illness. Unfortunately, limited access to clean water in parts of Tanzania can result in exposure to potentially harmful contaminants. Drinking unsafe water, limited access to clean water for hygiene and limited sanitation contribute to the 1.5 million child deaths each year and the majority of deaths attributed to diarrhea (Black *et al*. 2003). Malaria is an additional disease burden on the vulnerable population in Tanzania. Though there are ways to treat and prevent the transmission of malaria, there is still a significant struggle to meet this need for the Tanzanian population. In addition to sanitation problems and malaria, HIV/AIDS has taken a significant toll all over the world. For children whose parents have acquired the disease, and for children who have the disease themselves, this illness can render the vaccines less effective and

make children far more susceptible to preventable illnesses (Black *et al*. 2003; Farquhar *et al*. 2009; Ndirangu *et al*. 2009).

The implications of not being vaccinated, however, may far outweigh the perceived barriers to vaccinations. Tuberculosis, for example, is one of leading causes of death in developing nations; the vaccine helps prevent the spread of this debilitating disease (Mtabho *et al*. 2010). The potential threat of drug resistant TB is of a major concern and in order to prevent widespread morbidity and mortality this is an excellent tool to combat this diseases. Childhood illnesses like measles, diphtheria, whooping cough, and others kill many children before their first birthday. In some developing countries, malnutrition and Vitamin A deficiency contribute to the high death rate and can kill nearly one out of every four children who suffer from these conditions. In addition, each of these childhood diseases has the potential for severe complications that can result in disabilities such as hearing loss, blindness, and cognitive impairment as a result of encephalitis, which can have a drastic impact on the quality of life for a child.

In Tanzania, the number of children vaccinated is not sufficient to benefit from the protection of herd immunity. Herd immunity for many diseases occurs when 95% of the population is vaccinated against a disease and should an outbreak of the disease occur it would not spread rapidly and its effects would be limited because the majority of people are protected against the disease. Vaccine coverage in Tanzania can vary substantially by region. In some rural parts of Tanzania there is less than 50% of the population with complete vaccine coverage. Though coverage has improved substantially over the years and some parts of the country have 80- 90% vaccine coverage for certain vaccines; it still does not meet the herd immunity requirements. According to the 2009 WHO report on immunizations, for the measles vaccine,

only 53% of the districts reporting had coverage at 90% or above. In fact, according to this report Tanzania is showing a drop in the vaccine coverage from 2006 to 2007 (Table 1).

The most developed and wealthiest nations are among the countries with the best vaccine coverage. According to 2009 WHO Immunization Report, the US had over 92% coverage for all of the available vaccines in the country. As expected, the US has a much lower infant and under five mortality rate than Tanzania. The life expectancy for the US is also nearly 30 years longer than that of Tanzania. In data collected by the WHO, trends for the different vaccines have steadily increased globally since the 1980s. Comparison charts generated from these data show that Tanzania has strongly improved its coverage over the last three decades and in some instances briefly surpassed the US in coverage rates (Figures 3-8). Each of these figures presents percentages over time for each vaccine for selected regions such as the WHO African Region, the American Region, the European Region, the United States, the United Republic of Tanzania, and Global. To its great benefit, Tanzania also consistently fares better than the WHO African region as a whole. This could be attributed to the success of programs such as IMCI and EPI in this country and increased efforts by the Tanzanian government to make vaccines and maternal and child health a priority. Also Tanzania has been able to avoid some of the political turmoil and violence that many other nations in the area have faced. Unfortunately there has been a decline in Tanzania's vaccine coverage from about 2005 to the present.

The WHO African region as a whole struggles to achieve high levels of vaccine coverage. It consistently falls below global rates and rarely has coverage rates above 80%. Chad, South Africa, and Guinea are some of the countries in the region with the lowest coverage rates. Chad, in particular, has 45% coverage for the DPT1 vaccine and only 23% for DPT3 and MCV.

Hepatitis was recently added to the vaccine list in some countries and Tanzania in particular has already achieved a relatively high level of coverage. (Figure 6). Tanzania, however, appears to have bucked the trend for African countries and for some vaccines has achieved coverage levels comparable with the Western Pacific, Americas, and European regions which have the highest coverage rates in the world (Figure 4). These data represent national and large regional averages though and often do not indicate variances in coverage within a country.

Many barriers can prevent a woman from ensuring her child is properly vaccinated. These obstacles can vary from country to country, from region to region, and from woman to woman (Callréus 2009). In Tanzania and other developing nations, one of the biggest concerns is vaccine availability. However, in America and other developed nations a primary reason for not getting vaccinated is not availability, but rather concern about the safety of the vaccine and risk of an adverse event (Callréus 2009). The primary reason for rejecting vaccines is to reduce potential harm to the child (Jheeta and Newell 2008). An American woman, for example, may object to the vaccine for religious reasons, or because she simply does not believe the risk of childhood illness outweighs the risks of severe reaction to the vaccine, regardless of what the data indicate about the safety of the vaccine. Even with increased attention on the importance of vaccines, and increased efforts to vaccinate every child, children are still missed.

One of the most often cited is lack of access to an appropriate health facility to provide the service (Jani 2008). In addition, many facilities need money to provide the service so some may charge a small fee. This fee may be enough to deter women who do not have the money to spare for a vaccine. The Tanzanian government, with assistance from many aid organizations has made substantial strides in improving its health facility infrastructure. Unfortunately it still lacks

the adequate resources needed to provide basic care for its citizens; particularly to the country's most vulnerable populations, women and children. According to the Tanzanian government website, there are at least 179 hospitals that are either run by the government, private sector, volunteers, and other agencies. The capacity of these hospitals, however, is not mentioned. There are numerous clinics and dispensaries that can play a vital role in delivering adequate preventive care (Table 3).

Attitudes surrounding vaccines can also play a role in the success of vaccine campaigns. A recent editorial from Jheeta and Newell stated that poor interactions between mothers and health staff were significantly hindering the desire of mothers to have their children vaccinated (Jheeta and Newell 2008). Vaccine uptake is also influenced by high costs in money, time and resources. They have also found that in some areas there is a general lack of knowledge overall about vaccines, and of the people who do have some knowledge about vaccines that the information is wrong (Jheeta and Newell 2008). Primary motivations for vaccination are the perception that vaccines are inherently good or the risk of a disease is so great that the vaccine is the best option to prevent contraction of a given illness (Jheeta and Newell 2008). They have also postulated that cultural acceptance of modern practices and education was a significant contributor to the likelihood of obtaining childhood vaccinations. They also assert that lack of knowledge about vaccines does not necessarily equate to a negative view of vaccines, but rather other factors such as trust in healthcare providers and cultural opinion may be more influential (Jheeta and Newell 2008).

Research Questions

The research questions for this paper are:

1. What are the maternal barriers, if any, to childhood vaccination in Tanzania?
2. How do these barriers impact the likelihood of vaccination?

In order to understand which barriers most influence the likelihood of a mother getting her child vaccinated appropriately in Tanzania, several indicators have been selected that, according to the literature, could affect vaccinations in children. These indicators are:

- Age of mother

The mother's age may impact the likelihood of obtaining a complete vaccine schedule for her child. Older mothers may understand more about vaccine and therefore could be more likely to get their children vaccinated than young mothers (Babalola 2009).

- Wealth indicators (Has electricity, has radio, has running water)

Wealth is usually a good predictor of whether or not an individual has access to a given public health intervention. In this instance, wealth is measured by a variety of means, including running water in the home, access to a radio, electricity in the home, and others. A mother who has more of these "luxuries" may be more likely to have a complete vaccination card for her children.

- Power concerns (who has control over money for medications)

If a mother does not have control over some of her own decision making regarding her health, then she is less likely to have control over decisions made about vaccine administration to her children. The dominant male may have control over these decisions and therefore a woman with little to no control over decisions around the house might be less likely to have control over the vaccination of her children.

- Has a job outside the home

If a woman has a job outside a home this could indicate that she is educated, it could also be an indicator of some wealth or income. This potential risk factor does exhibit power concerns with whether or not a woman has control over the money she earns or not. If a woman has a job outside the home she is probably more autonomous and therefore could be more likely to have a complete vaccination card for her children.

- Education

Education level can impact the socioeconomic status of a given individual. Completion of primary school in Tanzania is usually as far as most women achieve as you have to apply for a place in secondary school and women are often married and taking care of families at that point. It is thought that the more education a woman obtains, the more likely she is to have her child vaccinated.

- Literacy

Literacy is an additional means of determining education and comprehension of certain written health messages. According to DHS, a woman is considered literate if she can read a basic sentence in English or Swahili with no assistance. If a woman is literate she is potentially more likely to have a completed vaccination card for her child.

- Rural vs. Urban

In Tanzania the majority of the population lives in rural areas making it difficult to find children who need to be vaccinated. Those families who live in cities have to deal with rapid spread of disease due to overpopulation, unsanitary conditions, and intermittent access to clean water. Numerous studies on Tanzania have shown that people living in urban regions are more likely to have complete vaccination coverage than those living in rural areas.

- Distance to a Health Facility

Proximity to a health facility can be of critical importance to ensuring good health outcomes for any given public health intervention. Tanzania has a limited number of health facilities relative to its population. For those living a great distance from a health facility obtaining complete vaccine coverage for your child can be a challenge. As a result, those who live farther from health facilities are less likely to vaccinate than those who live near a health facility. The purpose of this study is to determine what barriers, if any, exist that impact a mother's likelihood to have her child vaccinated. If a barrier is identified then the affect the barrier has on the vaccine outcome will be explored.

Chapter III

Methods

The Demographic and Health Survey (DHS) is a data project that has provided information and support on a variety of health indicators since 1984. The MeasureDHS project collects nationally representative detailed data through household surveys on fertility, family planning, maternal and child health, HIV/AIDS, gender, malaria, and nutrition. The US Agency for International Development (USAID) funds the grant that supports the DHS project. In addition to the Standard DHS surveys several supplemental surveys ask more probing questions to ascertain more specific information on a given topic. For example, a supplemental survey for HIV/AIDS is used to glean more information that is not obtained in the standard survey. There is a similar supplemental survey for child health which is designed to measure prevention services such as access to immunization, growth monitoring, and quality of care for the sick child.

The Demographic and Health Survey collected data over an 18-20 month process. During this time experts work with in country participants to design a survey that meets the needs of the host country. This period of planning would include sample design and how the survey will be administered. Following the design and planning phase, training of staff and fieldwork begins. Fieldwork for this study was conducted between October 2004 and February 2005. Eligible households are identified and interviewed. In order to be considered an eligible household a female (or male) should be of reproductive age (15-49 for women; 15-59 for men). In some countries, only women are interviewed. Interviews were conducted primarily by females, and females serve as team leaders and field editors (DHS Website). Once the data has been collected it is processed and cleaned in a double entry method. During this time any editing, coding, verification of consistency are conducted to ensure the data released for analysis is of the highest

quality. Following this process a final report is generated and can be reported back to the country, in addition researchers from around the world are able to access cleaned data for further analysis. The full procedure for how data is collected, cleaned and made publicly available is detailed elsewhere (http://www.measuredhs.com/aboutsurveys/methodology/process.cfm). There are a variety of instruments implemented by the MeasureDHS program including the household/individual survey used in this report, facility surveys, biomarkers, anonymous HIV testing, and geographic information.

Data collected from the Tanzanian Household survey were used to analyze the research question. Some examples of the questions asked in the survey are included in Table 4. Also included in Table 4 is information on how the original responses were recoded for analysis. Though it was available, the male response was not examined because the focus was to determine how women make decisions for themselves and how they view their control over the health and well being of the children, particularly when it comes to childhood vaccines. Men may not be the primary decision makers when it comes to caring for the needs of the children, so for those reasons the male response was not included.

Table 4. Survey Questions for Selected Variables and Modifications				
Survey Question	Available Survey Response	Related Variable	Recoded	Resulting Value label
In what month and year were you born?	Numeric, 2 digit month, 4 digit year Don't know	Age	Yes	Less than 30 years of age, or 30 years of age and older
How old were you at your last birthday?	Numeric, age in years	Age	Yes	Less than 30 years of age, or 30 years of age and older
Have you ever attended school?	Yes, No	Education	No	
What is the highest level of school you attended?	Primary, secondary, or higher	Education	Yes	No Education, or At least some formal education
Can you read any part of the sentence to me?	Cannot read at all, Able to read only parts of sentence, Able to read whole sentence, No card with required language, Blind/ Visually impaired	Literacy	Yes	Unable to read at all, or Able to read at least part of a sentence,
Have you ever participated in a literacy program?	Yes, No	Literacy	No	No

The variables selected for analysis included:

- Age of mother

Study participants were asked to report their birthdays (month, year) and their age at their last birthday, and any discrepancies were addressed. During the data cleaning process this variable was divided into age categories. For this study, age of the mother, which was measured in years was subsequently recoded into a dichotomous variable that divided women into two groups; women who were less than 30 years of age and women 30 years of age and older.

- Marital Status

Women at least 15 years of age were asked about their marital status and were given the options "married/living together," "divorced/separated," "widowed," or "never married and never lived together." For the purposes of this analysis this variable was recoded and women were described as either "married" or "Single, widowed, divorced."

- Wealth indicators (Has electricity, has radio, has running water)

Wealth is usually a good predictor of whether or not an individual has access to a given public health intervention. In this instance, wealth is measured by a variety of means, including running water in the home, access to a radio, electricity in the home and others. Respondents were asked if they possessed any of these items in their place of residence and information was recorded as either a "yes" or a "no".

- Exposure to Media

Women were also asked about their exposure to media. The frequency of exposure to media outlets such as newspapers, radios and television were reported as either "almost every day," "at least once a week," "less than once a week," or "not at all." In this analysis, this variable was recoded into either "no exposure or not at all" or "exposure at least once a week or more."

- Power concerns (who has control over money for medications)

If a mother does not have control over some of her own decision making regarding her health, then she is less likely to have control over decisions made about vaccine administration to her children. The dominant male may have control over these decisions and therefore a woman with little to no control over decisions around the house is less likely to have control over the vaccination of her children. Women included in the survey were asked a series of questions about who has control over money for different purposes such as food, medications, and others. Respondents could select an answer of "I have control alone", "decision is made jointly with husband," or "no control over money". This population includes the distribution of women who received cash earnings for work in the twelve months before the survey by the person who decides how earnings are used based on current marital status.

- Has a job outside the home

Women were asked if they worked outside the home, what their occupation was, and if the work was paid. A criterion for being included in this indicator was a woman being employed in the twelve months before the survey. If the woman was paid in cash earnings then she was also asked if she was able to make decisions regarding how her earnings were spent. She could respond that she makes the "decisions alone", "jointly with husband", or "does not make decision." If a woman has a job outside a home this could indicate that she is educated, it could also be an indicator of some wealth or income. This potential risk factor does exhibit power concerns with whether or not a woman has control over the money she earns or not. If a woman has a job outside the home she is probably more autonomous and therefore more likely to have a complete vaccination card for her children.

- Education

In this study, women were asked if they had attended school and if so they were then asked for the highest level of education completed as well as the highest number of years of education completed. For this variable only the highest education level value was used. Respondents had a choice of "no education," "completed primary education," "some secondary education" or "completed secondary or higher." For the purposes of this study, this variable was dichotomized into "no formal education" or "some formal education." Education level can impact the socioeconomic status of a given individual. Completion of primary school in Tanzania is usually as far as most women achieve as you have to apply for a place in secondary school and women are often married and taking care of families at that point.

- Literacy

Literacy is an additional means of determining education and comprehension of certain written health messages. According to DHS, a woman is considered literate if she can read a basic sentence in English or Swahili with no assistance. An example of the type of sentences a woman would be asked to read are: "Children work hard at school," "Parents love their children," "Farming is hard work," or "The child is reading a book." After being asked to read the sentenced the interviewer reported whether the woman was "unable to read sentence," "able to read parts of the sentence" or "able to read full sentence." Blind/visually impaired women or women who did not have a card in their spoken language were included in questionnaire, but were treated as missing for this analysis.

- Rural vs. Urban

In Tanzania the majority of the population lives in rural areas making it difficult to find children who need to be vaccinated. Those families who live in cities have to deal with rapid spread of disease due to overpopulation, unsanitary conditions, and intermittent access to clean water. The location of the home

being in a rural or urban area was also considered and urban areas were defined by the address of the respondent and the determination of the survey staff.

- Distance to a Health Facility

Proximity to a health facility can be of critical importance to ensuring good health outcomes for any given public health intervention. Tanzania has a limited number of health facilities relative to its population. For those living a great distance from a health facility obtaining complete vaccine coverage for your child can be a challenge. As a result, those who live farther from health facilities are less likely to vaccinate than those who live near a health facility.

In order to make the data more manageable, a smaller subset of only mothers who had children 12-23 months of age any time before the survey was generated. This reduced the sample size from approximately 10,329 records to 5,371 records. In addition specific categorical variables were re-coded to create new collapsed variables that were easier to compare across groups. For the women who had children, the information from the most recently born child was utilized to assess vaccination history. A completed vaccination variable was computed by adding all of the received vaccine variables together to generate a composite score of 0-8. The composite score was then recoded into a dichotomous variable for logistic regression analysis. For data cleaning, analysis, and logistic regression modeling the statistical software package SPSS version 16.0 was used. Also SPSS, Microsoft Excel, and PowerPoint were used for figure and table generation.

Chapter IV

Results

Of the 10,329 records included in the study a total of 5,371 records met the qualifications to be included as part of the analysis (i.e., mothers of at least one child old enough to be vaccinated completely). The study included women from age 15-49, with over half (58.9%) less than age 30. Table 5 provides a summary of selected demographic variables from this study population. As seen in the table, about one quarter (24.5%) of the women had no formal education; however most women had at least some education (75.5%). Approximately one-third of the women included in this study cannot read at all, whereas a majority of the women can at least read part of sentence (67.9%). The women are nearly evenly split with 56.6% having two or more children. Most women included in the survey are married (Table 5). Only one quarter of women dwelled in an area that would be considered urban.

Though electricity is scarce overall, with only 13% of all households having access to electricity, those who live in urban areas are far more likely to have electricity (38%) than their rural counterparts (1%). A large percentage of households have access to a radio (67%), and for those with access to a radio nearly half (46.2%) listen to the programming almost every day. The radio appears to be the primary mechanism for obtaining information as most people do not read

newspapers (62.3%) or watch television (71.3%). Overall, 22% of residents obtain their water from an open public well, but there are distinct differences between urban and rural residents here as well. The top three locations for water in urban areas are; neighbor's tap (32.8%), piped directly into dwelling or yard/plot (18.6%), and finally public tap (15.5%). In rural areas, however, the top three locations are an open public well (28.5%), a river or stream (16.8%), and the public tap (16.8%). There was a slight difference between the percentage of women who had control of money for medicine (51.5%) and those who did not (48.5%).

Table 5. Frequencies for Selected Demographic Variables for Study Population

Indicator	Count	Percentage	Total (N)*
Age of Mother			5371
<30 years	3069	57.1	
≥30 years	2302	42.9	
Marital Status			5371
Single, widowed, divorced	759	14.1	
Married	4612	85.9	
Number of Children			5371
< 2 children	1177	21.9	
≥2 children	4194	78.1	
Education			5371
No formal education	1425	26.5	
Some formal education	3946	73.5	
Literacy			5371
Unable to read parts of a sentence	1889	35.2	
Able to read parts of the sentence	3479	64.8	
Type of Place of Residence			5102

Urban	975	19.1	
Rural	4127	80.9	
Has Electricity			5371
No	4631	91.0	
Yes	459	9.0	
Has Radio			5371
No	1877	36.8	
Yes	3223	63.2	
Has Television			5371
No	4783	93.9	
Yes	313	6.1	
Has Bicycle			5371
No	2620	51.5	
Yes	2471	48.0	
Has Health Card			5371
No	589	11.0	
Yes	4782	89.0	

* Total study population is N=10329, for all values less than this-missing values were not included

For those women in the study who had a child, most (89%) possessed a health card as an indication of the vaccinations obtained for the child. Of the children included in this study, 62% did not receive DPT1, 64% did not receive DPT2, and 67% did not receive DPT3. Measles vaccine coverage was markedly improved over DPT vaccine coverage with only 38% of children who had not received the MCV at the time of this study. The BCG vaccine had the highest coverage with 91% of the children in the study having had the vaccine. Polio vaccine had the second highest coverage with 90.1%, 83% and 73.1% receiving Pol1, Pol2 and Pol3,

respectively. For children who had completed all required vaccinations, 82% lived in urban areas and only 69% of children in rural areas were fully vaccinated. Only 25.7% of children had a completed vaccine schedule at the time of the survey, and approximately 4% of eligible children

Table 6. Odds Ratios for Vaccines by Selected Indicators.

Indicator	BCG	Polio*	DPT*	Measles
Age of Mother				
<30 years	REF	-	-	-
≥30 years	0.962 (.800-1.15)[a]	1.21 (1.08-1.35)	0.965 (.805-1.16)	1.24 (1.11-1.39)[†]
Education				
No	-	-	-	-
Yes	2.40 (1.99-2.90) [†]	1.65 (1.37-1.99) [†]	1.05 (.926-1.19)	1.49 (1.33-1.69) [†]
Literacy				
No	-	-	-	-
Yes	2.63 (2.18-3.18) [†]	1.04 (.926-1.167)	1.87 (1.56-2.25) [†]	1.58 (1.41-1.77) [†]
Electricity				
No	4.45 (2.43-8.15) [†]	1.03 (.843-1.25)	2.13 (1.38-3.27) [†]	1.79 (1.45-2.23) [†]
Yes	-	-	-	-
Radio				
No	1.65 (1.36-1.99) [†]	.871 (.775-.980) [†]	1.27 (1.06-1.54)	1.07 (.954-1.21)
Yes	-	-	-	-

Television				
No	3.22 (1.70-6.08) †	1.05 (.828-1.33)	1.92 (1.17-3.16) †	1.84 (1.42-2.39) †
Yes	-	-	-	-
Bicycle				
No	.878 (.726-1.062)	.868 (.775-.973) †	.844 (.701-1.02)	.854 (.763-.965) †
Yes	-	-	-	-
Type of Place of Residence				
Rural	-	-	-	-
Urban	.344 (.248-.477)	.616 (.475-.799)	1.01 (.879-1.161)	.704 (.609-.812)
Control over money for medicine				
No	-	-	-	-
Yes	1.69 (1.41-2.04) †	1.40 (1.25-1.56) †	1.66 (1.39-1.99) †	1.43 (1.28-1.59)†

*For each of these vaccines only the value for Polio1 and DPT1 were reported.

N=5371

[a] All values in parentheses are 95% confidence intervals.

[†]These values are significant at the $p<0.05$ level.

had received no vaccinations at the time of the survey. The sex of the children was also analyzed, however, sex was not found to significantly impact the likelihood of obtaining a vaccine. There was an even split between the number of female and male children included in the study population.

Cross tabulations were performed to estimate the risk ratio for selected variables and vaccinations and are presented in Table 6. The most significant contributing factors to the likelihood of a mother getting her child vaccinated are her literacy and education level. If a mother is literate she is 2.6 times as likely to have her child vaccinated than a woman who is not literate. Similarly a woman with at least some education is 1.5 times as likely to have her child vaccinated. Full vaccination coverage varied for women with and without education, 56% of mothers with no education had full vaccination for their children, whereas 79% of mothers with some education had full vaccination coverage for their children. The significance for education however is not carried throughout all vaccines, for example women with more education did not

significantly impact the likelihood of vaccinating a child against DPT. Possession of a health card was also impacted by education. Women with some formal education were 2.07 (95% CI, 1.73-2.472) times as likely to have a health card as women with no formal education.

Table 7. Odds Ratios for Frequency of Exposure to Media

Indicator	BCG	Polio*	DPT*	Measles
Frequency of Reading Newspaper				
Not at all	2.83 (2.21-3.62)	1.04 (.924-1.17)	1.91 (1.54-2.37)	1.49 (1.32-1.67)
Sometimes	-	-	-	-
Frequency of Listening to radio				
Not at all	-	-	-	-
Sometimes	2.46 (2.04-2.98)	.936 (.824-1.06)	1.62 (1.33-1.96)	1.37 (1.21-1.55)

Frequency of watching Television				
Not at all	2.69 (2.01-3.61)	1.13 (1.00-1.30)	1.87 (1.45-2.40)	1.40 (1.22-1.60)
Sometimes	-	-	-	-

*For each of these vaccines only the value for Polio1 and DPT1 were reported. Unless otherwise noted all N values are at least 5,371

In Table 7 odds ratios were calculated for the amount of time spent using a given media source. Since most people in Tanzania do not read a newspaper regularly, if at all, the odds ratios are reported in terms of a person who does not read is more likely to vaccinate. The same is true for watching television, since so few people in country have access to TV, it is more appropriate to consider that people without TV would be more likely to vaccinate than people with TV. On the other hand, a common daily practice for many people in Tanzania is listening to the radio and therefore these odds ratios were calculated using lack of radio use as the reference group. With the exception of polio, there was a significant connection between amount of time using a given media source and the likelihood of having a vaccine.

Residents of rural areas, with the exception of the DPT vaccine series, are more likely to be vaccinated than people living in urban areas (Table 4). In addition, most of the population

included in this study resided in rural areas so this information may not represent a true relationship between vaccines and location of residence.

A significant barrier to vaccination and accessing health care for other conditions, such as antenatal care during pregnancy is the distance to a health a facility. Thirty-eight percent of women reported that this was a "big problem" for them in terms of their health care. Ownership of a bicycle, a television and the presence of electricity in the home, all indicators of socioeconomic status, did significantly impact the mother's likelihood of obtaining a vaccination for her child. Control over money for medicine also was a significant factor in determining whether a mother would have her child vaccinated. Most women have control over their earnings or make decisions jointly with a partner. Only 16% of women have someone else who decides how their earnings will be used.

Table 8. Logistic Regression Predicting for BCG Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	-.007	.005	P=.945	.993 (.818-1.21)
Education	-.236	2.538	P=.111	.790 (.591-1.06)
Literacy	-.734	24.745	P<.05	.480 (.360-.641)
Residence	.873	23.408	P<.05	2.39 (1.68-3.41)
Marital Status	.048	.099	P=.753	1.05 (.777-1.42)
Intercept	2.59	707.857	P<.05	-

Logistic regression results indicate that for all vaccines, each of the barriers contribute differently depending on the vaccine used in the model. In some models for example, education has a significant effect, but in other models the effects are not significant. As seen in Table 8, the model for BCG is significantly affected by literacy, and place of residence.

Table 9. Logistic Regression Predicting for DPT1 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	.239	16.62	P<.05	1.27 (1.13-1.43)
Education	.055	.297	P=.586	1.06 (.866-1.29)
Literacy	-.020	.044	P=.834	.98 (.82-1.2)
Residence	.036	.221	P=.638	1.04 (.89-1.20)
Marital Status	-.356	18.31	P<.05	.70 (.60-.83)
Intercept	.422	63.32	P<.05	-

Table 10. Logistic Regression Predicting for Polio1 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	-.008	.006	P=.937	.992 (.821-1.19)
Education	-.006	.002	P=.966	.994 (.740-1.33)
Literacy	-.603	17.998	p<.05	.557 (.414-.723)
Residence	.324	5.194	P=.023	1.38 (1.05-1.83)
Marital Status	.357	4.939	P=.026	1.43 (1.04+1.95)
Intercept	2.39	687.14	P<.05	-

Marital status and age group are the significant contributors in the model for DPT1 (Table 9). For DPT2, marital status and age are also the significant predictors in the model (Table 11). The logistic regression model for DPT3 demonstrates that same significant contributors as the models for DPT1 and DPT2, age and marital status (Table 13). The likelihood of Polio1 vaccination is marginally affected by marital status and place of residence, but significantly affected by literacy as indicated in Table 10.

Table 11. Logistic Regression Predicting for DPT2 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	.275	21.45	p<.05	1.32 (1.17-1.48)
Education	.039	.140	P=.709	1.04 (.849-1.27)
Literacy	.033	.169	p=.726	1.03 (.857-1.25)
Residence	-.031	21.45	P=.681	.969 (.835-1.13)
Marital Status	-.406	23.56	p<.05	.66 (.566-.785)
Intercept	.502	87.89	p<.05	-

Table 12. Logistic Regression Predicting for Polio2 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	-.120	2.447	P=.118	.887(.762-1.03)
Education	-.124	1.062	P=.303	.883 (.697-1.12)
Literacy	-.513	19.66	P<.05	.599 (.477-.751)
Residence	.545	27.74	P<.05	1.72 (1.37-2.17)
Marital Status	.251	4.262	P=039	1.28 (1.01-1.63)
Intercept	1.81	615.62	P<.05	-

Polio2 vaccination is similar to Polio1 vaccination except that residence becomes more of significant factor with literacy with a p value <.05, marital status however remains marginally significant (Table 12). Similar to the other vaccines in the series the Polio3 vaccine model is significantly affected by residence and literacy and marginally affected by marital status (Table 14). In the logistic regression model results in Table 15 for measles containing vaccine all variables contribute significantly with the exception of the education variable. In order to determine the values that impact the likelihood of having a completed vaccination schedule the computed variable, "completed vaccine recode" was used in the logistic regression and marital status and age were found to be the only significant contributors to this model (Table 16).

Table 13. Logistic Regression Predicting for DPT3 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	-.273	20.33	P<.05	.761(.676-.857)
Education	-.087	.676	P=.411	.917 (.746-1.13)
Literacy	-.051	.274	P=.600	.950 (.785-1.15)
Residence	.053	.470	P=.493	1.05 (.906-1.23)
Marital Status	.383	20.42	P<.05	1.47 (1.24-1.73)
Intercept	-.603	122.93	P<.05	-

Table 14. Logistic Regression Predicting for Polio3 Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio
Age of Mother	-.100	2.317	P=.128	.905 (.796-1.03)
Education	-.051	.239	P=.625	.950 (.773-1.17)
Literacy	-.565	32.37	P<.05	.568 (.468-.690)
Residence	.292	10.436	P<.05	1.3 (1.12-1.67)
Marital Status	.227	5.143	P<.05	1.3 (1.03-1.53
Intercept	1.25	420.21	P<.05	-

Table 15. Logistic Regression Predicting for MCV Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio (CI)
Age of Mother	-.247	17.46	P<.05	1.3 (1.1-1.6)
Education	-.089	.798	.372	.915 (.753-1.1)
Literacy	-.366	15.63	P<.05	.693 (.578-.831)
Residence	.257	10.79	P<.05	1.2 (1.1-1.5)

Marital Status	.272	9.56	P<.05	1.3 (1.1-1.5)
Intercept	.703	166.14	P<.05	-

Table 16. Logistic Regression Predicting for Complete Vaccination for Selected Variables

Predictor	B	Wald χ^2	P value	Odds Ratio (CI)
Age of Mother	-.320	24.3	P<.05	.726 (.639-.824)
Education	-.123	1.16	.281	.884 (.71-1.1)
Literacy	-.088	.703	.402	.916 (.75-1.1)
Residence	-.009	.012	.914	.991 (.84-1.1)
Marital Status	.329	13.4	P<.05	1.39 (1.1-1.6)
Intercept	-.880	233.5	P<.05	-

From the Tables that present results from the logistic regression, several variables were forced out of the model equation and significance for previously calculated ORs for some variables were no longer significant. Although this finding is curious, it could be the result of confounding of some of the variables. Education and literacy, for example, tend to correlate to

one another and could be influencing the effect that each variable has in the model. Potential explanations for this result will be discussed further in later sections.

Chapter V

Discussion

As indicated by the results, barriers to maternal vaccinations do exist. Though some of the results were not expected, most of them are consistent with findings from previous studies. The maternal barriers varied widely from vaccine to vaccine which was a unique finding. Through the analyses performed, the influence that each potential barrier had on a mother's likelihood to obtain a vaccine for her infant was determined. From the odds ratios calculated and the logistic regression analysis it can be seen that some factors such as marital status, education, and literacy have more of an impact than other factors such as electricity in the home of time reading the newspaper. Also factors that would be thought to have been large contributors did not consistently influence the likelihood of obtaining a vaccine across the various vaccines, explanations for this finding will be discussed later.

As expected, several factors that influence the likelihood for a mother to have her children vaccinated were indentified. For many women completion of some formal education increases her child's chances of being vaccinated, and this is consistent with previous studies (Odusanya *et al*. 2008). Educated mothers may have a superior understanding of the intrinsic health value of vaccines and therefore are more likely to ensure that their children receive this

health intervention. Also they may be better equipped to make important health decisions regarding the health of their children because of the increased education. They may also have increased knowledge about disease and disease prevention methods, including vaccines that would compel them to actively pursue childhood vaccinations.

One of the interesting findings is the barriers differed across vaccines. The implications of this could be substantial for vaccine programs. In order to be more successful public health professionals would need to consider that barriers within the target population will change for each vaccine and have to tailor their programs accordingly. Differences in rates among the vaccines could indicate that some vaccines are considered more important than others, or perhaps easier to obtain. For example there was a significant connection between BCG vaccine and education, but less so for the DPT series. It is possible that since there is only one BCG injection versus three in the DPT series it may be easier to obtain and complete. Another possibility is that tuberculosis is more widely known and understood among the population and perhaps women are more likely to actively seek out a method to prevent this. Also tuberculosis may be viewed as a serious threat, but diphtheria, pertussis and tetanus may be less of a concern. Since BCG is supposed to be administered at birth, but DPT is not, it is also a possibility that there is a better

opportunity to ensure vaccination occurs at that time rather than trying to bring the child back in a few weeks as is the case for DPT.

Another factor that influenced women is whether or not she is literate. Literacy could serve as a proxy indicator for education level and therefore carry the same benefits of education in the mother. Other studies have also reported that literacy in women translates into a higher likelihood of having a child vaccinated, so this study concurs with research from previous studies (Odusunya *et al*. 2008). Possession of a health card significantly increased the likelihood that a child would be vaccinated. The card could serve as a reminder to both mothers and medical staff of what vaccinations need to be administered at a given time, ultimately improving vaccination rates for children who have the card. This finding is also consistent with those of previous studies (Babalola 2008).

Distance to a health facility also served as a barrier for some women. This was more of a concern for women living in rural settings than for women who lived in urban areas. Finding the time, money, and transportation needed to reach a health care facility for vaccines may be difficult for some women who lack the appropriate resources.

Factors that were used as a proxy for wealth such as the presence of electricity in the home, bicycle ownership, and ownership of a television did have a significant effect on

vaccination status. Though it would seem that wealthier populations would have an advantage in terms of access and potential costs this difference is not evident in these data, in fact people who do not have access to electricity, TV or a bicycle were more likely than those who did to have completed a given vaccine. This could be attributed to successful outreach programs for both wealthy and poor populations. Since the poor represent a more vulnerable population it could be that more efforts have been targeted towards them, thereby increasing their overall vaccination status. Also wealthier groups may receive care from private clinics or physicians who may not consistently report data.

Data from this study also indicated that living in a rural area meant that a mother was more likely to have her child vaccinated. This was a curious finding, particularly because it is expected people dwelling in urban areas to have better access to health facilities and fewer barriers. One possible explanation for this finding is that vaccine campaigns target areas that are more difficult to reach, such as those living in rural areas. Also a large number of the women surveyed live in rural areas and could represent an oversampling of this population.
Despite, Tanzania being a paternalistic society, the results indicate that maternal control over money does not significantly impact child vaccination status. One possible explanation could be

that care of the children is a primary duty of women and therefore it is unlikely that men would exercise substantial control over decisions regarding children.

Limitations

This paper is not without limitations. One limitation is that only the responses of women were considered. Tanzania is a paternalistic society and power and decision-making is usually under the control of men. In future studies, to obtain more robust information the opinions of men regarding vaccines should be researched and analyzed. This data set is extremely large, and though it gives a representative sample of Tanzanian women, there is a possibility that certain findings can be found to be significant when in actuality there is no significance present. In addition this study is cross sectional and although the data is collected consistently over time, different individuals are interviewed during each data collection period. Also since the data is cross sectional, statements about causality cannot be made, but rather only show likelihood of a relationship between data variables. Also there is the possibility of bias when it comes to the survey itself. Women may want to appear to have better behavior than they do or give the interviewer a good impression so there could be respondent or interviewer bias. There also may be recall bias for some women, particularly when it comes to recalling health information about

their children if there are many of them. In order to combat recall bias, only information from the most recent born child was included in this study.

The decision to use a cross sectional data set limits the ability to track individuals and identify missed opportunities over time which could mean that certain barriers that are not specifically asked about in a survey could be overlooked. In the data analysis specifically, future research could address specific differences within a group. For example instead of dichotomizing data perhaps it can be analyzed in such a way to elicit differences that may be missed with this approach. In analyzing education, assessing whether there is an increase in vaccination levels as level of education increases may be helpful in specifically understanding what can be done and to target resources on sliding scale to make the most out of limited funds. Another limitation is analyzing only the most recent born child. Since complete vaccination coverage for all required vaccines of all children is the ultimate goal, a question that asks mothers if all the eligible children's vaccines have been fully completed or a records abstraction from the vaccine card would be helpful. The resulting model could predict what factors impacted the mothers desires to ensure all her children completed all vaccines. Future studies should consider using information from all of the children a mother has in order to determine if there are differences within each family over time.

The approach of collapsing many of the variables into two categories, though appropriate for analyzing the question in this study, can cause a loss of information and can impact the interpretation of the original research question. Future studies may want to consider analyzing the data points separately rather than dichotomizing the values in order to obtain more robust information about individuals within specific groups. Another limitation to the approaches in this study is that vaccines were analyzed as individual outcomes. Though advantageous for determining which vaccines need to be targeted for improvement or barrier reduction interventions specifically, for some studies it may be more advantageous to predict the outcome of a fully completed vaccination schedule as that is the ultimate goal of many programs. Future studies may consider asking a specific question on whether or not the child, of appropriate age, has received all of his or her vaccines. This information could also be abstracted from a completed vaccination card if available.

Recommendations

Future studies should ask more specific questions about perceptions vaccine barriers, such as direct opposition from a spouse or family member, religious barriers, and social approval and a woman's ability to overcome such barriers. An additional strategy that future studies could consider is evaluating medical/hospital records for missed opportunities for vaccines. This could

help discover weaknesses in the delivery of the program that result in an incomplete vaccination status. Another contributing factor that can be explored is the affect of poor nutrition on vaccine status and vaccine effectiveness since the underlying cause of many childhood illnesses is malnutrition (Black *et al*. 2003; Fotso *et al*. 2007). Underweight and infectious diseases have been found to have a synergistic relationship on increasing child mortality (Black *et al*. 2003). Therefore, designing programs that target malnutrition in conjunction with vaccine programs could address two large contributors to child death and ultimately bring Tanzania closer to achieving child health goals. A broad understanding of the barriers women in developing nations face could lead public health professionals to develop more effective vaccine interventions that can mitigate these hurdles and function successfully in local and national delivery systems. Vaccine programs must consider a variety of factors when they are being implemented in countries with low vaccine coverage. It is difficult to consider all possible barriers to vaccines and eliminate or minimize them, but efforts made to reduce these barriers could greatly improve the health and well being of children.

Future programs should take an integrated approach to vaccine campaigns. One tool that has been touted by some public health officials is the "Reaching Every District" approach. In a letter to the *Bulletin of the World Health Organization*, Vandelaer *et al*. report the five

components of this method. The steps include, re-establishing outreach services, on-site training and support supervision for staff, linking the community and service delivery, data monitoring for use in active prevention strategies, better planning, allocation, and management of financial resources and human capital (2008). This approach can serve as a framework for how to create and expand programs that can be adopted by existing entities to improve the quality and delivery of primary care. It has also been suggested that a critical piece that should be included in vaccine programs is an assessment of the local knowledge and attitudes about vaccines to specifically address what issues are affecting demand in a given area. In doing these small studies, potential concerns can be addressed early contributing to the overall success of the program (Jheeta and Newell 2008).

Considering that women are often the primary caregiver, public health workers should understand the different factors that influence the desire to have a child vaccinated or not and how best to overcome them. Factors not included in this study that could influence a mother's decision to vaccinate her child could also be examined in future studies. For example, some studies have found that poor interactions between clients and medical staff serve as a potential barrier to childhood vaccinations.

In addition, it is critical to understand weaknesses in both the supply and demand aspects for vaccines. Much support is targeted towards the supply side (improving infrastructure, staff training, etc.) yet little attention is placed on improving demand side factors (maternal education, low service utilization, high transportation costs, etc.) (Babalola 2009). Interventions that can successfully integrate strategies to impact supply and demand for vaccines are probably more likely to positively improve vaccine outcomes. Vaccine campaigns that disseminate health information through appropriate media, such as radio programs are probably more likely to succeed than those that do not. Also government, private sector, and community investment in ensuring that women achieve higher levels of education and literacy can also improve vaccination rates in the future. Another factor to consider is maternal HIV status. One study conducted in South Africa found that a positive maternal HIV status resulted in decreased vaccine coverage for children. Since Tanzania has a high incidence of HIV/AIDS, this should be examined as a potential barrier to childhood vaccines as well (Ndirangu et al. 2009). Also, more emphasis should be placed on strengthening the healthcare infrastructure in developing nations and incorporating more preventive strategies like vaccines into the national budget. Another strategy is to reduce the number of missed opportunities to vaccinate. If a mother brings her child in for an illness this can be a potential opportunity to examine the child's health card and

determine if he/she needs vaccinations, and then make a point to follow-up and ensure that the child receives the vaccination if it is not possible to do so at that visit.

Overall there is much that can be done to achieve the goals that public health professionals have set out for Tanzania and the rest of the developing world. Through an in depth understanding of the challenges that will be faced, programs can be designed and re-tooled to make adjustments for these difficulties and ultimately improve the quality of life for children around the world.

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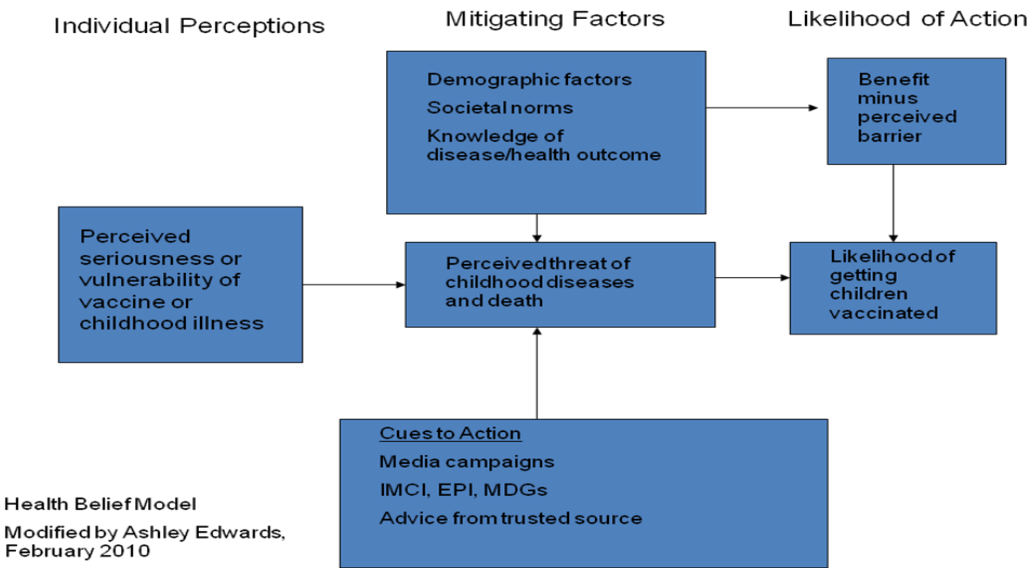

Individual Perceptions
Mitigating Factors
Likelihood of Action
Demographic factors
Societal norms
Knowledge of disease/health outcome
Benefit minus perceived barrier
Perceived seriousness or vulnerability of vaccine or childhood illness
Perceived threat of childhood diseases and death
Likelihood of getting children vaccinated
Cues to Action
Media campaigns
IMCI, EPI, MDGs
Advice from trusted source
Health Belief Model
Modified by Ashley Edwards, February 2010

Figure 2.


UGANDA
Lake Victoria
Bukoba
Musoma
RWANDA
Mwanza
BURUNDI
SERENGETI PLAIN
KENYA
Kilimanjaro
Arusha
Kigoma
Tabora
Tanga
Pemba
Dodoma
(legislative capital)
Mkoani
Lake Tanganyika
Zanzibar
Zanzibar
DAR ES SALAAM
Mafia Island
DEM. REP. OF THE CONGO
Iringa
Rufiji
INDIAN OCEAN
Sumbawanga
Mbeya
Lake Nyasa
Mtwara
ZAMBIA
Songea
MALAWI
MOZAMBIQUE
0 100 200 km
0 100 200 mi

Figure 3

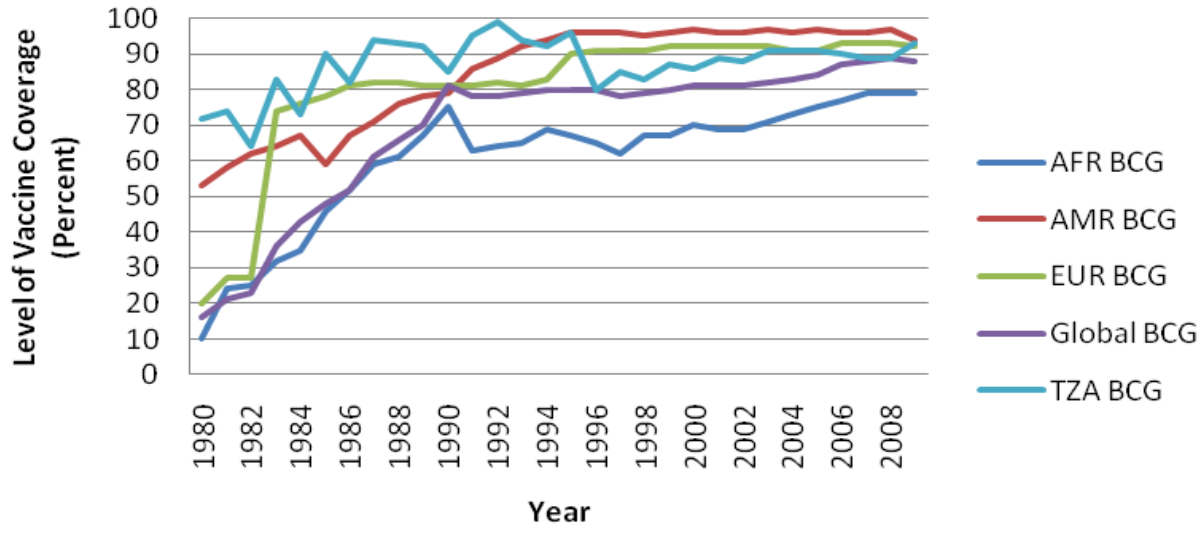


Figure 4

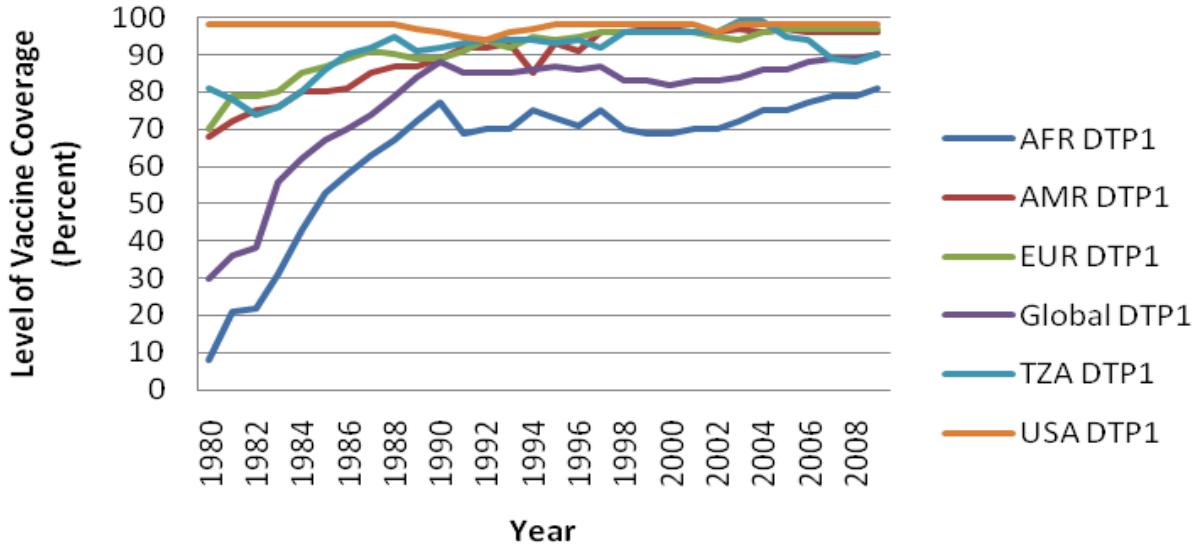


Figure 5

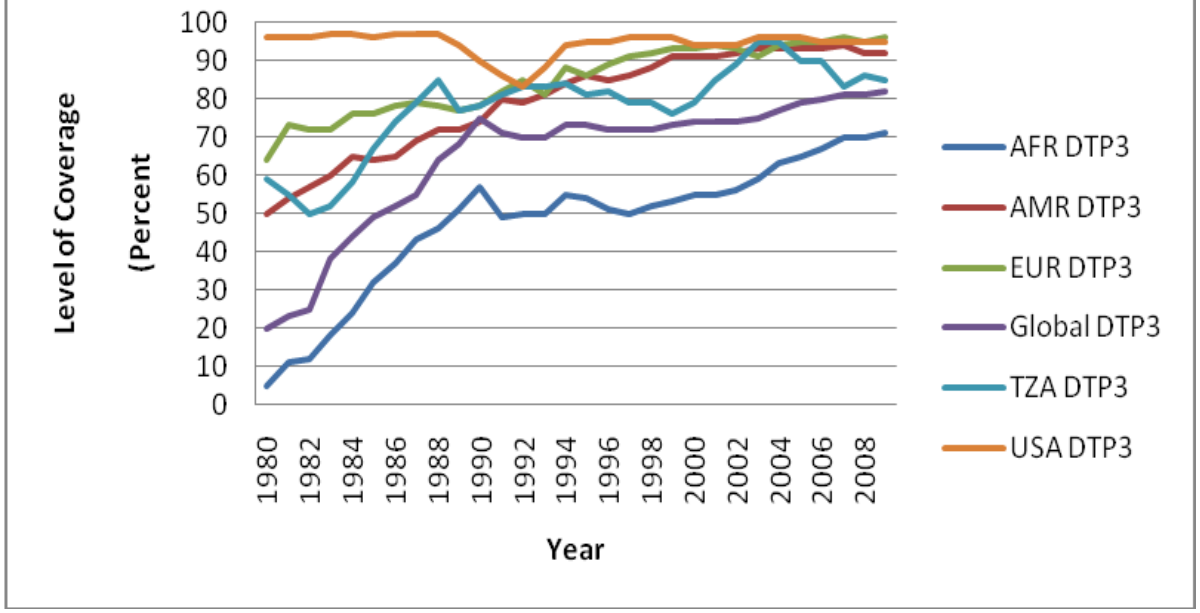
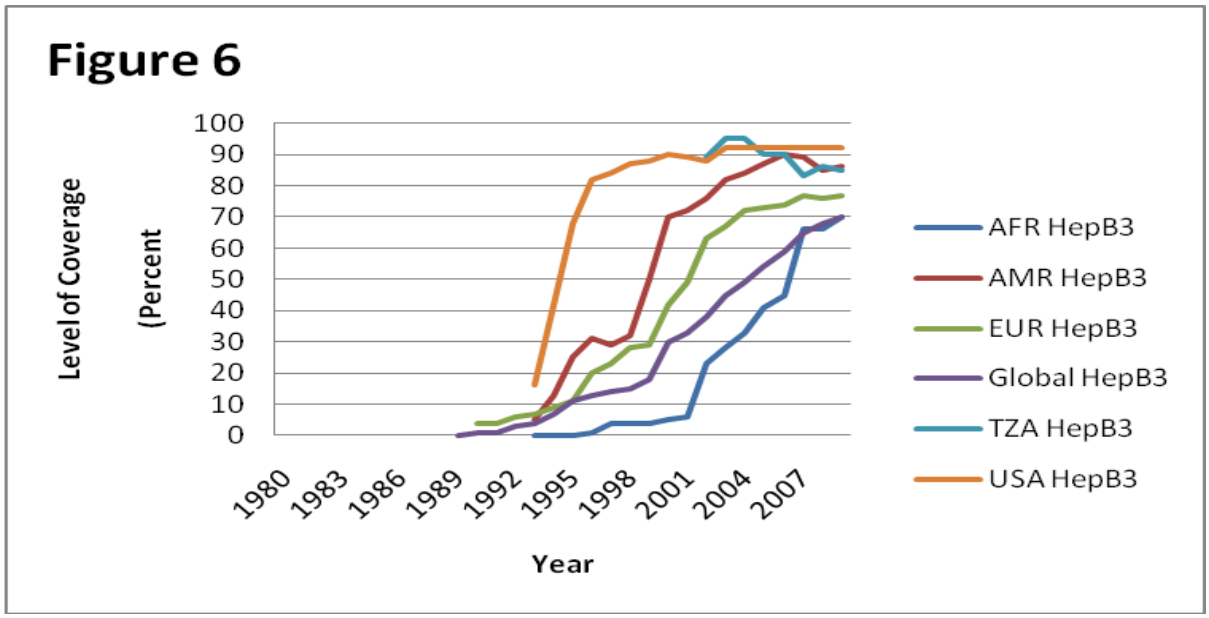


Figure 6



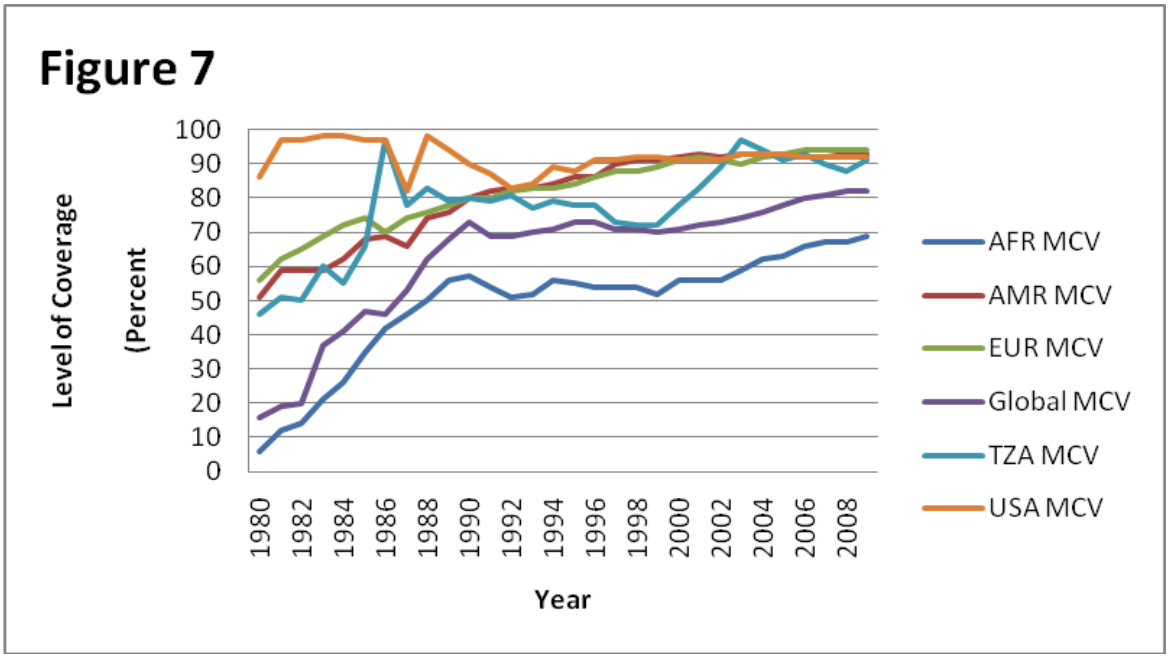


Figure 7
Level of Coverage (Percent
100
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year
AFR MCV
AMR MCV
EUR MCV
Global MCV
TZA MCV
USA MCV

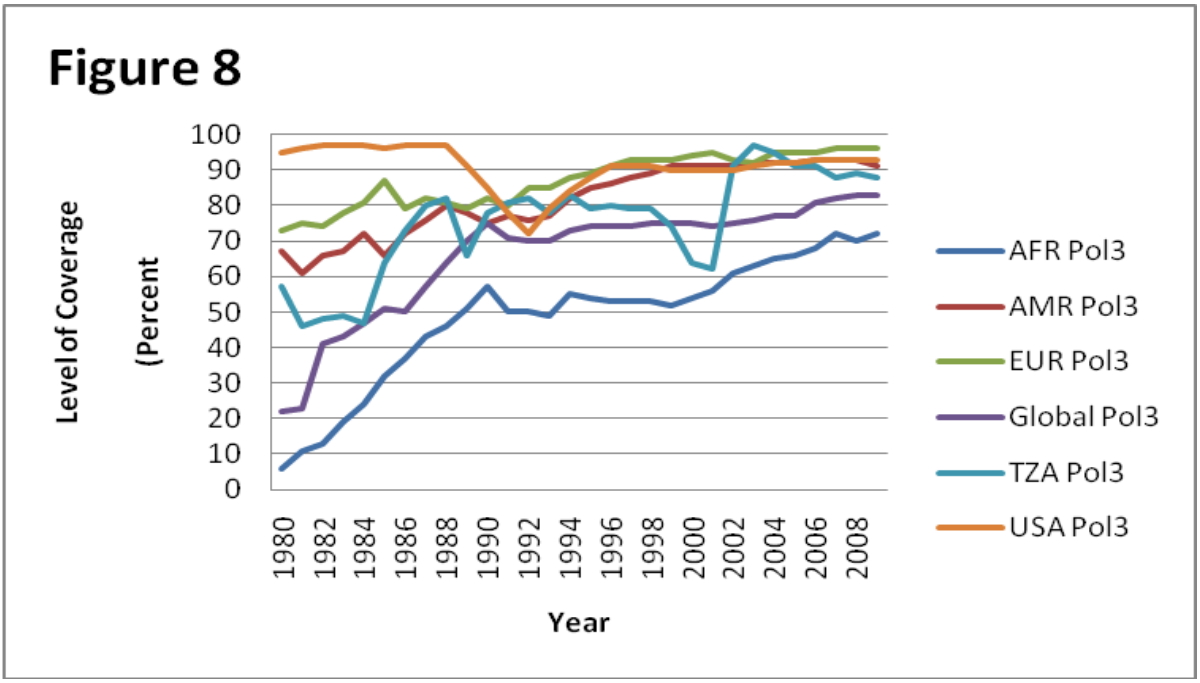


Figure 8
Level of Coverage (Percent
100
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year
AFR Pol3
AMR Pol3
EUR Pol3
Global Pol3
TZA Pol3
USA Pol3