Norms within Networks: Opinion Leader and Peer Network Influences on Mothers/Caregivers' Childhood Immunization Decisions in Rural Northern Nigeria

Allison B. Goldberg

Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
Under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2014

© 2013
Allison B. Goldberg
All rights reserved

ABSTRACT

Norms within Networks: Opinion Leader and Peer Network Influences on Mothers/Caregivers' Childhood Immunization Decisions in Rural Northern Nigeria

Allison B. Goldberg

Background & Significance

Why do some mothers/caregivers immunize their children while others don't? What role do social norms within networks play in the inequitable uptake of childhood immunizations in northern Nigeria? A large body of research has been devoted to investigating the determinants of immunization acceptance in developing countries. Up to this point, however, most of this research has focused on individual-level explanations – such as maternal age, maternal education, household wealth, maternal knowledge about the benefits of immunizations, and previous health-seeking experiences – to account for variance in immunization use. Scant attention has been paid to the ways that social factors influence this outcome.

This dissertation aims to fill this critical gap in the literature by investigating the impact of social network characteristics and norms on immunization use among a sample of mothers/caregivers in rural, northern Nigeria. More specifically, this study uses a formal social network analysis to examine how the structure of mothers/caregivers' relationships with opinion leaders and peers impact their decisions to immunize their children. This research makes a unique contribution to the literature by putting the social networks of mothers/caregivers at the center of its analyses, and examining how social relationships impact immunization decisions in a setting with some of the worst childhood immunization coverage rates in the world.

Research Aims

This study draws on theories of social networks and social norms in order to explain the variance in childhood immunization coverage rates among a sample of mothers/caregivers in Zamfara State, northern Nigeria. The aims of this research are to 1) test whether injunctive and descriptive norms towards immunizations are linked to mothers/caregivers' immunization decisions; 2) examine whether the theorized constructs of *social control* and *social learning* underlie injunctive norms and descriptive norms around immunizations; 3) assess the degree to which injunctive and descriptive norms influence mothers/caregivers immunization behaviors; and 4) test whether the structural properties of *closeness* and *frequency of communication about immunizations* moderate the influence of injunctive and descriptive norms on mothers/caregivers' immunization use.

Research Design & Methods

This study employed a refined ego-centric network design that uses quantitative and geographic data collected in October-November 2011, from 550 mothers and 127 of their opinion leaders living across 22 paired villages in one local government area in Zamfara State, northern Nigeria. Validity tests were conducted to assess the accuracy of the injunctive norms measures and a latent variable model was utilized to generate more valid indicators of them. Mixed effect models, adjusting for clustering at the compound and village levels, were used to test all study hypotheses. Sensitivity analyses were conducted to confirm study results.

Findings

The results indicate that injunctive and descriptive norms independently predict mothers/caregivers' immunization use in their peer networks, but not in their opinion leader networks. The results also confirm that social control underlies injunctive norms and that social

learning underlies descriptive norms. Injunctive norms are more influential than descriptive norms in mothers/caregivers' peer networks, indicating that social control is operating as a stronger force on mothers/caregivers' immunization decisions than reflective observations of their peers' immunization behaviors.

The results also show that that the influence of injunctive norms in opinion leader networks on mothers/caregivers' immunization use partly depends on whether or not they have a close relationship with their opinion leaders. Frequency of communication between mothers/caregivers and their opinion leaders and peers strengthens the influence of descriptive norms on immunization use. This indicates that both communication and observed immunization practices are necessary conditions for normative influences to operate.

Conclusion

This study provides additional evidence to support the claim that health outcomes depend not just on individuals' own beliefs and actions, but also on the normative beliefs and actions of the people around them. To improve the effectiveness of interventions aimed at improving immunization acceptance, researchers and programmers alike should treat mothers/caregivers not only as individuals, but as members of meaningful and influential interpersonal networks. By embracing this approach, we will improve our understanding of the determinants of routine immunization use in developing countries, while accelerating the impact of immunization programs on child survival outcomes in contexts, like northern Nigeria, with some of the worst immunization coverage rates in the world.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

BCG	Bacillus Calmette-Guerin
CDC	Centers for Disease Control and Prevention
DFID	Department for International Development
DHS	Demographic and Health Survey
DPT3	Diphteria-pertusis-tenatus-3
EPI	Expanded Programme for Immunizations
FMOH	Federal Ministry of Health
GPEI	Global Polio Eradication Initiative
HDSS	Health and Demographic Surveillance Site
IZ	Immunizations
NDHS	Nigeria Demographic and Health Survey
OL	Opinion Leader
OPV	Oral Polio Virus
PRRINN-MNCH	The Partnership for Partnership for Reviving Routine Immunization in Northern Nigeria, Maternal Newborn and Child Health
SMOH	State Ministry of Health
UNICEF	United Nations Children's Fund
WISH	Women Investing Savings for Health
WHO	World Health Organization

ACKNOWLEDGEMENTS

This research received support from the Earth Institute Travel Grant Program at Columbia University and the American Association of University Women (AAUW), American Fellowship for studies that improve the human condition and overcome barriers for women and girls. The author is also grateful to the Partnership for Partnership for Reviving Routine Immunization in Northern Nigeria, Maternal Newborn and Child Health (PRRINN-MNCH) Initiative – without their technical and logistical support, this dissertation would not have been possible. A special thanks to Henry Doctor, Jumare Abdulazeez, and Alabi Oluyomi of PRRINN-MNCH's Health and Demographic Surveillance Site (HDSS) who were absolutely critical to the successful design and implementation of this study. I would also like to thank my nine field workers – Salima Nasir, Sa'aduatu Umar, Maryan Isiyaku, Rabi Musa, Maryan Tanko, Maryan Salawudeen, Habiba Umar, Sharifat Abdul Azeez, and Nasiru Umar – for their perseverance in collecting large amounts of data in a limited time frame and volatile political environment. A special thanks to my dissertation sponsor, Peter Messeri, and dissertation chair, Connie Nathanson, as well as the other members of my dissertation committee – Sally Findley, Stephane Helleringer, and Macartan Humphreys – for their enthusiasm and responsiveness, ideas, thoughtful comments and critiques, and inclination to push me past my comfort zone on this project. This dissertation also greatly benefited from data entry support from Christine Saba and Michael Post, GIS support from Danny Sheehan, and statistical support from Raquel Andres.

A particular gratitude goes to my dear family and friends who have been supportive and motivating throughout this grueling process. I am particularly grateful for the support from my husband, David Post, who read countless drafts of this document and kept me sane and focused

during the writing phase. Last but not least, I am grateful to the hundreds of participants in the HDSS community who allowed this intrusion into their lives so that we may all better understand the influences of social networks on routine immunization use in northern Nigeria.

DEDICATION

In memory of my grandparents, Hyman and Frances Goldberg, who instilled in me a love of learning and taught me the value of education and where it can lead.

CHAPTER 1

SETTING THE STAGE

The introduction of vaccines to prevent deadly childhood illnesses is one of the greatest public health achievements of the 20th century. Universal immunization has led to the eradication of smallpox and has almost completely eliminated infectious diseases, like polio, from the globe. The global immunization coverage rate[1] has increased from 75% in 1990 to 83% today as result of international commitments to reduce childhood illness and death by two-thirds worldwide (Brown, Burton, Gacic-Dobo, & Karimov, 2012). Through focused efforts, immunization programs have reached 75% of children globally and have continued to prevent two million child deaths each year (World Health Organization [WHO], 2010; United Nations Children's Fund [UNICEF, 2010).

Despite remarkable progress, many children remain unvaccinated and thus unprotected against preventable diseases. Almost one-third (29%) of all deaths among children below five years of age are caused by illnesses – such as measles, pneumococcal diseases, and tetanus – that could have been prevented by a vaccine (WHO, 2010). The number of children left unprotected from vaccines increased by more than a million between 2010 and 2011, leaving more than 22 million children unvaccinated against preventable diseases worldwide (Centers for Disease Control and Prevention [CDC], 2012).

Vaccination coverage rates are even more alarming in developing countries where vaccine-preventable diseases – such as measles, poliomyelitis, tuberculosis, whooping cough, diphtheria, and tetanus – are the main cause of child illness and death (Lee, 2005). About 95% of

[1] Immunization coverage is calculated as the % of those in the target age group who received a dose of a recommended vaccine by a given age. Diphteria-pertusis-tenatus-3 (DPT3) coverage by age 12 months is assumed to be the measure of global immunization coverage and country-level immunization coverage unless specified otherwise.

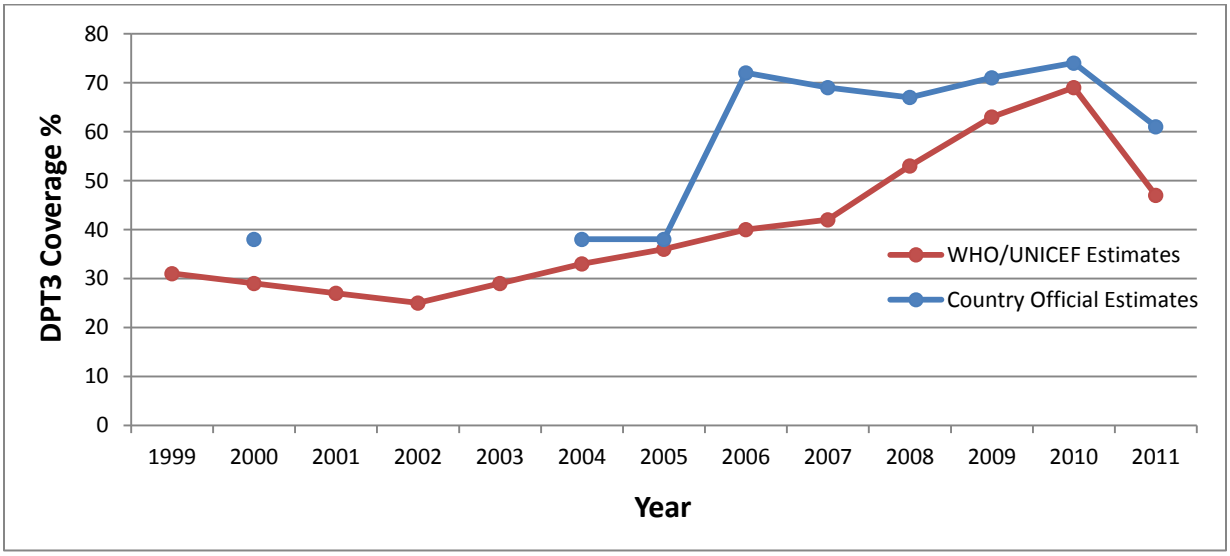
the 14 million deaths among children below five years of age occur in developing countries. Of these deaths, 70 % are due to vaccine-preventable diseases (UNICEF, 2005). While global immunization coverage rates have steadily increased from 20% in the 1980s to 83% today, coverage rates in sub-Saharan Africa have vacillated, increasing from 10% in 1980 to 76% in 1990, and then decreasing from 77% in 2005 to 71% in 2011 (Brown, Burton, Gacic-Dobo, & Karimov, 2012). The 71% immunization coverage rate in sub-Saharan Africa is particularly concerning, since it is well below the 90% coverage rate necessary to stop disease transmission (Abdulraheen, 2011).

The Case of Nigeria

According to the WHO, the persistence of vaccine-preventable diseases in Nigeria can be largely attributed to the under-utilization of available vaccines (WHO, 2005). Of all the children left unvaccinated against preventable diseases in the world, around half live in three countries: India, Indonesia and Nigeria (CDC, 2012). In Nigeria, over one million children die annually from preventable diseases, making it one of the least successful countries in the world in improving child survival (Ngowu, Larson, & Kim, 2008). In 2009, only 23% of children aged 12-23 months received all recommended vaccinations.[2] That same year, 38% of children in this age group received none of their vaccinations (Nigeria Demographic and Health Survey [NDHS], 2009). Although there was an overall increase in immunization coverage rates in the country between 1999 (31%) to 2010 (estimates range from 69 to 74%), international and country-level data both show a sharp decline in coverage rates in 2011 (estimates range from 47 to 61%; see Figure 1).

[2] Nigeria's routine immunization schedule stipulates that a child must receive the following immunizations by the time they are nine months (the ideal standard) to 12 months (the acceptable standard) of age: one dose of the bacillus calmette-guerin (BCG) vaccine; four drops of the oral polio virus (OPV) vaccine; three doses of diphtheria, pertusis, and tetanus (DPT) vaccine; three drops of the hepatitis B vaccine; one dose of the measles vaccine; one dose of the yellow fever vaccine; and two doses of vitamin A.

Figure 1. DPT3 Immunization Coverage in Nigeria, 1999-2011



Source. GAVI Alliance (2013).

In the northern region, the immunization coverage statistics are even more dismal. According to the most recent Demographic and Health Survey in Nigeria (NDHS), the immunization coverage rate in the north is seven times lower (6%) than in the south (43%; NDHS, 2009). The particularly low immunization coverage rate in this region has had grave implications on the country's child population, as clusters of under- and unvaccinated children have increased the vulnerability of the rest of the population to outbreaks of vaccine preventable diseases. As a result, Nigeria now ranks second worldwide in childhood deaths and 17th worldwide in under age five deaths (CDC, 2012).

International organizations estimate that if vaccination efforts were scaled-up and available vaccines widely accepted, an additional four million child deaths could be prevented globally each year (UNICEF, 2005; WHO, 2005). As such, understanding the factors that increase use of available immunizations – especially in countries, like Nigeria, that has some of

the highest under-vaccinations rates in the world – is critical to strengthening routine immunization services and slowing down the spread of preventable childhood diseases

The Literature

It is widely accepted by researchers that individual-level characteristics – such as maternal age, maternal education, household wealth, maternal knowledge about the benefits of immunizations, and previous health-seeking experiences (e.g., the use of antenatal care, other health services for children, and child delivery in a clinic) – are important determinants of immunization use. Indeed, these variables have been consistently shown to drive immunization use in a range of developing countries (Acharya & Cleland, 2000; Antai, 2009a, 2010; Babalola & Lawan, 2009; Bhuiya, 1995; Breiman et al., 2004; Gage, Sommerfelt, & Piani, 2007; Ibnouf, van den Borne, & Maarse, 2007; Jamil, Bhuiya, Streatfield, & Chakrabarty, 1999; Jani, De Schacht, Jani, & Bjune, 2008; Magnani et al., 1996; Oladokun, Lawovin, & Adedokun, 2009; Onyiriuka, 2005; Owais, Haif, Siddiqui, Agha, & Zaidi, 2011; Owino, Irimu, Olenja, & Meme, 2009; Oyo-Ita, Fakunle, Fajola, & Edet, 2012; Schoeps, Gabrysch, Niamba, Sle, & Becher, 2010; Siddiqi, Siddiqi, Nisar, & Khan, 2010; Tadesse, Deribew, & Woldie, 2009; Takum, Padung, Joshua, Mnickam, & Murhekar, 2011). For example, a study in Nigeria using 2003 NDHS data found that having a wealthier mother with a secular education significantly increased a child's likelihood of full immunization[3] (Antai, 2009a). A study in Bangladesh found similar results – children aged 12-23 months were more likely to be immunized if their mothers had a secular education, were older (over 29 years of age), and were in a high wealth quintile (Bhuiya, 2005).

[3] According to WHO guidelines, a child is considered to be *non-immunized* if they have received zero of the eight vaccinations in the EPI schedule. They are considered to be *partially immunized* if they have missed any one of the eight vaccinations in the EPI schedule and non-immunized. Finally, they are considered to be *fully-immunized* if they have received the full complement of eight vaccinations in the EPI schedule (World Health Organization [WHO], 2005).

The role of maternal knowledge on immunization use has also been widely explored in the literature (Acharya & Cleland, 2000; Babalola & Lawan, 2009; Eng, Naimoli, Naimoli, Parker, & Lowenthal, 1991; Jamil et al., 1999; Jani et al., 2008; Magnani et al., 1996; Owais et al., 2011; Owino et al., 2009; Schoeps et al., 2010; Siddiqi, 2010; Tadesse et al., 2009). A study investigating the lack of childhood immunization acceptance among Togolese mothers found that inadequate knowledge about the individual and community benefits of immunization negatively impacted their use of this health service (Eng et al., 1991). Also mentioned in this study were some higher-level issues regarding regular access to vaccines and adequate knowledge about when to return to health clinics for immunizations; these are indicative of the important role that a robust public health system – with a consistent supply of vaccines and a system to notify mothers when their child is due for a vaccination – plays in ensuring routine immunization use.

Other individual-level characteristics, such as household structure (Gage et al., 2007), migration status (Antai, 2010), and religious affiliation (Antai, 2009b) have also been shown to be key influencers of immunization use. For example, a recent study found that children living in nuclear or extended family households were more likely to be fully-immunized than children living in polygamous, three-generational households[4] (Gage et al., 2007). A different study found similar results: children living in nuclear or extended family households had higher odds of immunization than children living in polygamous, three generational households, and this relationship was strengthened, if the family was in a high versus low wealth quintile (Bronte-Tinkew & Dejong, 2005).

[4] A polygamous, three-generational household is a household where the head has more than one wife and includes the parents or parents-in-law of the head.

Migration status has also been shown to influence immunization use (Antai, 2010; Jani et al., 2008; Kiros & White, 2004). A quantitative study in Nigeria of children 12-23 months of age found that children of rural, non-migrant mothers had a higher likelihood of full immunization than children of rural-urban migrant mothers (Antai, 2010). The difference between migrant and non-migrant families was explained by two factors: a) migrants' loss of social support to help identify and pay for transportation services to vaccination sites; and b) disruptions in income-generating opportunities, lessening the resources available to help cover vaccination-related costs (Antai, 2010). The mechanisms linking migrant status to poor vaccination outcomes highlight the continued relevance of financial and physical barriers to immunization acceptance. This finding is consistent with other studies which show that distance to a health facility (Kadobera, Sartorius, Masanja, Mathew, & Waiswa, 2012; Larson, Mathanga, Campbell, & Wilson, 2012; Mwaniki, Kabiru, & Mbugua. 2002; Schoeps et al., 2010; Schwarz et al., 2009; Takum et al., 2011) and vaccine costs (Eng et al., 1991; Schwarz et al., 2009) can impede immunization uptake.

Religious affiliation has also been shown to have a marked impact on immunization acceptance. A quantitative study using 2003 DHS data found that children of Muslim and traditionalist mothers have three-times the risk of not being immunized than children of Christian mothers do (Antai, 2009b). According to the author, there are two explanations for this difference: a) the interpretations of specific Islamic doctrines (e.g., the Qur'an and the Hadith) lead some Muslim parents to believe that vaccinations are ineffective or a sacrilegious practice; and b) Muslims in Nigeria happen to be less educated and poorer than Christians who commonly reside in the southern region, which makes them less likely to accept childhood vaccinations. The author used the first explanation to explain why some Muslim parents do not immunize their

children against *any* preventable disease in Nigeria. The second explanation was used to explain why some Muslim parents decide to partially immunize their children. An ethnographic research study in northern Nigeria validated these claims by showing that parents' decisions to immunize their children was dependent on their interpretations and understanding of Islamic doctrines, as well as their social class and level of education (Renne, 2010).

Bridging the "Social" Gap in the Literature

As the previous section demonstrates, a large body of research has been devoted to investigating the determinants of immunization acceptance in developing countries. Up to this point, however, most of this research has accounted for variance in immunization use by focusing on individual-level explanations. While this work has made important contributions to the immunization literature, it has largely neglected to explore the role of social factors in determining immunization use.

It is widely believed that people are interconnected and that, as a result, their decisions and actions are also interconnected (Smith & Christakis, 2008). This theory of social networks, which is rooted in the classic works of anthropology in the late1960s (Levi-Straus, 1969), has been tested by researchers in a range of fields to explain a range of phenomena (Smith & Christakis, 2008). In the field of public health, social networks have been used to explain health outcomes, such as mortality (Berkman & Syme, 1979; Blazer, 1982; Cassel, 1976; Cobb, 1976; House, Robbins, & Metzner, 1982), depression (Burt, 1987; Ueno, 2005), substance use (de Belvis et al., 2008; Smith & Christakis, 2008) and the likelihood of becoming obese (Christakis & Fowler, 2007). Despite widespread recognition that people are influenced by those around them, and that this influence has had a marked impact on health, there is a still a "rudimentary

understanding of the effects of social networks on immunization decision-making" (Opel & Marcuse, 2013).

To my knowledge, only three studies have purposively explored the impact of social networks on immunization use. In the 1990s, Hershey, Asch, Thumasathit, Maszaros, and Waters (1994) hypothesized that three main factors – altruism, free-riding, and bandwagoning – influenced immunization decision-making. Of these three factors, bandwagoning (doing what most other people are doing) was found to have the greatest impact on immunization use. An international ethnographic study found a similar result (Streefland, Chowdbury, & Ramos-Jimenez, 1999). This multi-country study found a collective dimension to immunization decision-making, where parents reported vaccinating their children because "everybody else did it, and it seemed like the normal thing to do (p. 1712)" or because they felt social pressure from health workers and community leaders to follow the recommended vaccination schedule (Streefland et al., 1999).

A more recent study on the impact of social networks on immunization use (Brunson, 2013) also found evidence that immunization decisions were a collective result of individual decisions made by interdependent users. This study, conducted among a sample of parents living in King County, Washington, found the % of people in parents' networks recommending non-conformity (defined as delaying, partially vaccinating, or not vaccinating their children at all) to be the biggest predictor of immunization use (Brunson, 2013). In fact, the people in parents' networks were found to be more important than any other source of information (e.g., books, research articles, and internet) investigated in the study.

Brunson's study is important because it is the first to use a formal social network analysis to explain how specific features of social networks influence immunization use.

However, the author recognizes that in order to develop a complete understanding of the relationship between social networks and immunization use, more evidence is needed on the social network characteristics that impact this outcome (Brunson, 2013). This dissertation attempts to fill these critical gaps in the literature by investigating the impact of social network characteristics, norms, and processes on immunization use among a sample of mothers/caregivers in rural, northern Nigeria. More specifically, this study uses a formal social network analysis to examine how the structure of mothers/caregivers' relationships with opinion leaders and peers impact their decisions to immunize their children. This research therefore makes a unique contribution to the literature by putting the social networks of mothers/caregivers at the center of its analyses and examining how social relationships impact immunization decisions in a setting with some of the worst childhood immunization coverage rates in the world.

Organization of Dissertation

The remainder of this dissertation is organized as follows. In Chapter 2, I set the stage for the analysis by presenting my theoretical framework and hypotheses. Chapter 3 is a description of the methods used in this dissertation. Chapters 4 and 5 are devoted to the analysis. In Chapter 6, I describe the results of the analysis, the study's limitations, and implications of its results for future research and practice.

CHAPTER 2

THEORETICAL FRAMEWORK & HYPOTHESES

Over the past decade, there has been increased conceptual and empirical attention dedicated to examining the relationship between social networks – defined as the web of social contacts which surround an individual (Smith & Christakis, 2008) – and health. This work is based off of the seminal research conducted by Durkheim (1897) in his book *Suicide*. In his book, Durkheim studied differential rates of suicide in European countries during the 19th century and found heavily Roman Catholic and Jewish areas to have lower suicide rates[5] than Protestant areas. Durkheim's general theory was that religious society protected individuals from the growing forces of isolation and anomie (defined as the breakdown in social norms and values) in the modern world. The religious communities of Catholicism and Judaism protected its members against suicide by providing them with a "sufficiently intense collective life" (Durkheim, 1897, p. 170).

Protestantism, however, did not provide the necessary levels of social support that individuals required for overcoming the social forces that increased suicide rates in the modern landscape. While Catholicism strongly integrated members of its community through a set of beliefs and practices and Judaism provided a strong sense of solidarity to its members, Protestantism encouraged its members to engage in free inquiry and incorporated fewer rituals.

[5] According to Durkheim (1897), there are four specific types of suicide: egoist, anomic, altruistic, and fatalistic. Egoistic suicide is relevant to this dissertation since it is thought to result from a "pathological weakening of bonds" between an individual and society (Edles & Appelrouth, 2005). At the opposite end of the spectrum, is altruistic suicide, which results from over-integration, or an overload of obligations, that take prevalence over an individual's own needs (Edles & Appelrouth, 2005). Anomic suicide is thought to result from a lack of moral regulation or normlessness (anomie), while fatalistic suicide occurs as a result of oppression (Durkheim, 1897).

As a result, Protestants experienced feelings of disconnection and lack of purpose, which ultimately made them more susceptible to suicide.

Since Durkheim developed his theory on suicide, scholars have attempted to recast it within the network tradition (Pescosolido & Georgianna, 1989). Scholars have clarified that the religious "society" that Durkheim emphasized as influencing suicide rates in the early 19th century as actually being a consortium of smaller social circles or networks. According to Tilly (1984), Durkheim's reliance on the term religious "society" weakens the power of sociological explanation. This is because "society" is a "fictitious entity" that is really made up multiple social circles established through the sharing of social characteristics (Tilly, 1984, p. 27-28). Therefore, when the notion of "society" is replaced with "networks," Durkheim's idea about the relationship between religion and suicide becomes clearer and more accurate (Pescosolido & Georgianna, 1989; Wellman, 1983)

The other way that scholars have attempted to recast Durkheim's theory within the network tradition is by clarifying that religious networks are not in-and-of themselves a sufficient explanation for suicide. Indeed, these networks are operating within a larger cultural context that has the power to facilitate or inhibit acceptance, general norms, and beliefs (Pescosolido, 1986; White, Boorman, & Brieger, 1976). This context, in turn, constrains networks and influences whether or not they offer solace to members. Pescosolido and Georgianna (1989) argue that by combining network conceptualizations with a strong cultural analysis of norms and beliefs, it is possible to gain a more complete understanding of the relationship between network structures, suicide, and other human behaviors.

Scholars have attempted to use this new theoretical scheme to empirically test the influence of networks on a range of human behaviors and outcomes. In the health field,

researchers have consistently showed that a lack of social networks predict mortality from almost every cause of death (Berkman & Syme, 1979; Blazer, 1982; Cassel, 1976; Cobb, 1976; House et al., 1982). More recently, researchers have shown that social networks influence decisions around cigarette smoking (Berkman, Glass, Brissette, & Seeman, 2000; Wasserman & Faust, 1994; Wellman & Berkowitz, 1988) contraception use (Montgomery & Casterline, 1996), and substance use (Smith & Christakis, 2008). For the most part, these studies have reinforced Durkheim's theory that networks provide access to social support and other intangible resources that help to block the deleterious effects of social isolation on health (Pescosolido & Georgianna, 1989).

Even though most research on networks have emphasized the salubrious effects of social networks, some research has shown that social networks have a deleterious effect on health. This includes hindering smokers and drinkers' attempts to stop using these substances (Smith & Christakis, 2008) and preventing close friends and family from engaging in healthy eating behaviors (Fleury, 1993, Kelsey, Earp, & Kirkley, 1997; Sallis, Grossman, Pinski, Patterson, & Nader, 1987). This research has also found social networks to increase rates of depression. Falci and McNeely (2009) found that adolescents with very large friendship networks reported higher levels of depressive symptoms than those with below average sized-networks. These findings coincide with the theoretical notion that over-integration can lead to an increase in mental health problems (Pescosolido & Levy, 2002). In essence, the amount of effort that individuals are required to exert in order to maintain a large social network can outweigh the benefits of support received from it (Haines, Beggs, & Hurlbert, 2008).

While social networks researchers have also begun investigating the relationship between social networks and immunization behaviors, this research has mostly studied social network

dynamics from an epidemiological, rather than behavioral perspective (Bauch & Earn, 2004; Perisic & Bauch, 2009a, 2009b). The epidemiological perspective is important, but it has not considered how the contextual aspects of social relations might serve to channel the spread of disease. In fact, only one study to date has formally examined the linkage between social networks and immunization use from a behavioral perspective (Brunson, 2013). However, this study was conducted among populations living in the US, generating results that do not necessarily apply to developing countries. This study also did not explicitly consider the structure of norms within social networks and the critical influence that these norms have on group member behaviors (Pescosolido & Georgianna, 1989). This dissertation therefore contributes to the burgeoning social networks literature by being the first to use a behavioral perspective to formally assess the relationship between social networks, social norms, and immunization use in a developing country.

This dissertation uses social networks theory in combination with related theories on social capital, opinion leadership, social norms, and social influence to develop a refined social networks model to account for the variance in immunization use in northern Nigeria. This chapter provides a review of these theories and situates the study hypotheses within the context of this larger literature and the major religious and cultural norms governing social interactions in northern Nigeria.

Social Networks Theory

Social networks theory purports that decisions and actions are a product of people's relationships. Rather than treating actors and their actions as independent, autonomous units, researchers guided by this approach view individuals as interdependent, or reliant upon one another to make decisions (Wasserman & Faust, 1994). According to Coleman, "individuals do

not act randomly with respect to one another. They form attachments to certain persons, they group together, [and] they establish institutions (1990, p. 31)." Researchers with this view believe that it is misguided to draw conclusions on the basis of individual attributes, characteristics, values or other features alone (Wellman, 1988). Instead, they believe that it is important to examine the structure, or patterns of relationships within which people are embedded, since these relationships and the interactions within them ultimately determine the differential flow of information, influence on actions, and social capital (Coleman, 1990; Wasserman & Faust, 1994; Wellman, 1988). While studies investigating individual attributes reveal information about the production of human capital – individual-level knowledge, abilities, and experiences, – analyses of relationships and interactions between individuals provide insights into the production of social capital (Kim & Cannella, 2008).

Social Networks & Social Capital

There is solid evidence of a linkage between the structure of networks – such as who interacts with whom and how frequently people interact – and social capital (Burt, 2000). Bourdieu (1980), who was the first the draw the explicit connection between social capital and social networks, defined social capital as "the aggregate of actual or potential resources which are linked to the possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (p. 248). Even though definitions of social capital has evolved over time, social networks researchers continue to recognize that social capital is embedded in the structure of relations between individuals (Coleman, 1990) and that these relationships foster a range of resources – including social support, self-esteem, identity, perceptions of control (Brown & Harris, 1978; Cohen & Syme, 1985), norms of reciprocity, trust (Coleman, 1990; Putnam, 1995), cooperation, and perceptions of safety (Jacobs, 1960) – that can

be leveraged for purposive action (Lin, 1999). According to scholars, social capital is "the resource that actors derive from specific social structures" (Baker, 1990, p. 619) and the "friends, colleagues, and more general contact through which opportunities to use financial capital, human capital, and other types of capital arise" (Burt 1992, p. 9).[6]

Because of the embedded nature of social capital in the structure of social networks, scholars claim that social capital can be measured by key social networks characteristics. For example, the location of individuals – measured by density, size, and strength (Borgatti, Jones, & Everett, 1998) – has been used to assess social capital within a network. Whether network location is a measure *of* social capital or a *precursor to* social capital, however, has been disputed. According to Lin, "if it is assumed that social capital attempts to capture valued resources in social relations, network locations should be treated as exogenous variables rather than endogenous variables of social capital itself" (Lin, 1999, p. 39). For the purposes of this dissertation, social capital is assumed to be more than mere social relations and networks, but the resources evoked from them (Brown & Harris, 1978; Cohen & Syme, 1985; Lin, 1999). This is consistent with a growing consensus in the literature that social capital is the benefits secured by individuals by virtue of their membership in social networks and the interactions that occur between members (Portes, 1998).

[6] Even though the literature on social capital strongly emphasizes the positive consequences of structural relations–the economic and non-economic assets that come with sociability–it can also have less desirable outcomes (Portes, 1998). There are at least four negatives consequences that can result from strong structural ties: the exclusion of others; excess claims on group members; restrictions on individual freedoms; and downward leveling norms. In more concrete terms, strong social ties can bring about greater control over wayward behavior, provide privileged access to resources, restrict individual freedoms, and bar outsiders from gaining access to the same resources, ultimately leading people to experience group solidarity that is cemented by adversity and opposition (Portes, 1998, p. 21). Although important, exploring the negative consequences of social capital is not within the scope of this dissertation.

Social Networks Influencers

Opinion Leaders

Opinion leaders are one group of individuals that have been studied as key sources of influence in social network research. Lazarsfeld, Berelson, and Gaudet (1944) first introduced the concept of opinion leaders more than 60 years ago in their seminal work, *The People's Choice*. In this work, the authors analyzed voter decision-making during the 1940 presidential campaign in the United States. Contrary to common belief, they found voter decisions to be more greatly influenced by face-to-face encounters with people they considered as influential (coined opinion leaders) than campaign advertisements used in mass media (Lazarsfeld et al., 1944).

In a later publication, Katz and Lazarsfeld (1955) elaborated this concept in the *two-step flow model of mass communication*. In contrast to the *hypodermic needle model* (or magic bullet theory), which considered mass media effects to be direct and wholly accepted by receivers (Davis & Baron, 1981), the two-step model stressed the role of human agency in the flow of information. The authors theorized that people were not alone in their community, but instead integrated in one or more groups in which they had relationships with other members. Within each of these groups or communities were opinion leaders, or "special people that acted as catalysts," receiving and transferring media messages, and in the process, exerting a certain power of influence over others.

Rogers (1995, 2003) advanced the most recent and widely cited developments in the *two-step model of mass communication* by explaining how, and at what rate, learning flowed between opinion leaders and other individuals in a community. In his theory, coined *diffusion of innovations*, Rogers argued that communication messages flowed from a source, via mass media channels, to opinion leaders, who in turn passed them on to followers (Rogers, 1995, 2003). He

clarified, however, that as new innovations (e.g., new ideas, technologies) were introduced into a population, opinion leaders, who were innovators and early adopters given their willingness to take a risk as a result of their positions of influence, tried out these new innovations. As word spread about who used the new innovation and their experience with it in the community, more people used it until the local population was saturated. Rogers (1995) argued that this learning process followed a symmetric S-shape adoption curve, indicating an initial slow rate of adoption, followed by a rapid rate, and then a slow rate of adoption again, as the new innovation matured, the population became saturated, and other innovations were introduced into the environment.

Rogers recognized the critical role that opinion leaders played in the spread of innovations within a social system. With pre-existing lines of communication within local communities – which were strengthened in contexts where people lived in close proximity to one another – opinion leaders informally influenced attitudes and behaviors with relative frequency (Rogers, 1995). This work, on the role of opinion leaders in the spread of innovations, sparked interest among researchers to determine more specifically who these influential people were and what made them different from members of the average population.

Early studies investigating the defining characteristics of opinion leaders found them to have a higher level of perceived knowledge and competence, to be more sociable, to have a higher socioeconomic status, and to have more contact with relevant information supplied from outside of their immediate circle (Katz & Lazarsfeld, 1955; Nisbet, 2005; Weimann, Tustin, Vuren, & Foubert, 2007). They also found opinion leaders to be at every level of the social system, too often hold formal positions of leadership, and to be aware of the fact that they were sources of information and influence (Weimann, 1994).

In the last two decades, research on opinion leadership has shifted away from characterizing opinion leaders by individual attributes to defining them based on their level of social embeddedness. In other words, opinion leaders are now being defined by various social network attributes, including the degree to which they actually occupy a position of centrality in a network (Nisbet, 2005; Weimann et al., 2007). This shift in the field was partly driven by research emphasizing the influence of social networks on outcomes like political and social engagement (Granovetter, 1973; Huckfeldt & Sprague, 1995; Knoke, 1990a, 1990b).

To date, the influence of opinion leaders has been examined across a range of fields, from fashion, to consumer decisions, politics, and health. Opinion leaders with a high degree of network centrality have been shown to have far-reaching influence, from shaping public opinion, to changing political behavior, and persuading people to adopt new innovations, like farming technology and cell phones (Chamala & Shah, 1996; Keller & Berry, 2003). In the area of health, opinion leaders have been found to influence people's behaviors, and as a result, improve care delivered to patients (e.g., cancer pain management; Elliot et al., 1997), rheumatoid arthritis care (Stross & Bole, 1980), reduce HIV risk practices (Kelly et al., 1991) and increase the uptake of family planning methods (Rogers & Kincaid, 1981). Studies have also shown that opinion leaders can have a negative effect on health behavior, such as increasing the likelihood of alcohol (Terre, Drabman, Meydrech, & Hsu, 1992) and tobacco (Alexander, Piazza, Mekos, & Valente, 2001) use. This research, which has important implications for our understanding of the linkage between opinion leaders and health, has never investigated the combined effect of a range of opinion leaders on immunization use and the role that their normative beliefs and behaviors regarding immunizations play in facilitating the adoption of this health service.

In this dissertation, religious leaders, political leaders, and traditional medicine providers will be characterized as opinion leaders. They meet the criteria used to define opinion leaders in the literature and are therefore assumed to exert influence on a range of decisions, including those related to the uptake of health innovations, like immunizations. Indeed, these leaders are viewed as highly competent and are highly respected for upholding the moral precepts of Islam (all three groups of leaders),[7] for providing personalized, culturally appropriate, and holistic care (traditional medicine providers; Abubakar, Musa, Ahmed, & Hussaini, 2007), and for maintaining order in dense communities as a result of their formal positions of authority (political and religious leaders; Elaigwu & Gladima, 2003).

In addition to meeting the criteria used to characterize opinion leaders, the leaders in this study have proven their power to influence immunization behaviors in northern Nigeria. Islamic religious and political leader public protests against immunization programs in 2003[8] are believed to have largely contributed to the rapid decline in routine immunization uptake during that time (Yahya, 2007). Traditional medicine providers are used by a majority of Nigerians, between 80 to 85% of the population (WHO, 2002), and have been cited as providing a medicinal alternative to immunizations to prevent and treat child illnesses in the northern region (Renne, 2010).

[7] In 1999, the Sharia legal system (Islamic jurisprudence) was instituted at the state level of government in 12 northern states, including Zamfara State. In Zamfara, the application of the Sharia system transcends personal law, all aspects of civil law, and criminal law. Islam therefore cannot be disentangled from the larger political system in Zamfara State (Elaigwu & Gladima, 2003).

[8] Resistance to immunization programs in northern Nigeria culminated in 2003, when religious and political leaders in Kano, Kaduna, and Zamfara states boycotted federally sponsored polio immunization campaigns in fear that polio vaccines were deliberately contaminated with anti-fertility agents and the HIV virus (Kaufman & Feldbaum, 2009). The 16 month suspension of polio campaigns led to polio spreading into 20 countries, causing 80 % of the world's polio cases during the stoppage. Concerns about polio vaccine safety led many parents to believe that their fear of the perceived risks of vaccinating their children outweighed the benefits of vaccination. As a result, fear regarding the safety of the polio vaccine spilled over to other childhood vaccines, leading to the spread of other preventable, childhood diseases in Nigeria and surrounding countries (Yahya, 2007).

Resistance to immunization programs in Nigeria can be traced back to the 1990s when Nigeria's national immunization program, the Expanded Programme for Immunizations (EPI; a national priority in the 1980s where the government established primary health care centers throughout the country offering free immunizations to children less than two years of age) fell apart. In the late 1990s, the responsibility for primary health care serviced was transferred to the local governments as part of the structural adjustment program (SAP) initiated by the International Monetary Fund (IMF). The SAP required the national government to cut spending on social services (Renne, 2006) and states to purchase their own vaccines (Umar, 1989). The lack of vaccine support from the national government to local governments lead to a drastic decline in vaccine availability, the eventual break down of the program of primary health care centers, and confusion among Nigerians about the intentions of their government to improve their health and well-being (Renne, 1996). A 1994 research study on family planning and population policies in northern Nigeria showed that the Nigerian government's implementation of the SAP led people to specifically question whether the government was acting according to their welfare or instead, the interests of the West (Renne, 1996).

Rising levels of distrust in the Nigerian government as a result of the SAP also lead people to question vaccine safety. In the northern Nigerian region in particular, the predominantly Muslim population questioned whether the Nigerian government had originally developed the EPI in order to gain approval from the West by stopping Nigerians from having children. By the 1990s, rumors were spreading that the EPI was a Western ploy to sterilize children for the purposes of population control (Renne, 1996). In 1993, the collapse of the EPI and rising suspicions about vaccine safety eventually contributed to a 20% drop in immunization coverage rates among children under age two (Renne, 2006).

Even though the government worked with UNICEF in the mid-1990s to revitalize the immunization program and reduce suspicions about vaccines, reservations about vaccines continued into the early 2000s. Suspicions about vaccines were exacerbated by historical events, most notably the controversial 1996 Trovan meningitis drug trial that left 11 children dead and many mute, deaf, and brain dead in Kano, Nigeria (Lenzer, 2007) and the 2003 state boycotts against the polio vaccine described above.

Even though there is a long history of resistance to immunization programs in northern Nigeria, over the last decade, there has been a steadfast effort by Nigeria's national government and the global health community to engage opinion leaders to positively change people's attitudes and behaviors around immunizations. For example, major religious and political leaders in Nigeria who previously questioned the safety of immunizations, are now speaking out in support of them (Kaufman & Feldbaum, 2009). Global actors, like the WHO and UNICEF, are now working closely with local leaders to devise community-specific strategies to increase immunization use, marking a shift from a completely vertical approach to immunization programming to a more collaborative, community-based one (The Partnership for Reviving Routine Immunisation in Northern Nigeria, Maternal, Newborn, and Child Health Programme [PRRINN-MNCH], 2010).

These efforts to re-invigorate support and demand for childhood immunizations are happening in Bungudu, the site of this dissertation. PRRINN-MNCH has engaged local leaders to advocate for immunizations during meetings and sermons and to participate in health campaigns (PRRINN-MNCH, 2010). For example, PRRINN-MNCH has worked closely with local leaders in Bungudu since 2006 to devise messages that can generate social approval for childhood immunizations, ultimately making it easier for mothers/caregivers to make

arrangements to take their infants to a health facility to get immunized (PRRINN-MNCH, 2010). In 2008, PRRINN-MNCH started a series a community savings groups, called Women Investing Savings for Health (WISH) groups, giving women a forum for mobilizing savings to access needed health services, including childhood immunizations. This program remains one of the primary activities implemented by PRRINN-MNCH to increase childhood immunization use in Bungudu (PRRINN-MNCH, 2010).

Overall, given their formal positions of authority and their rich history of influence on the demand for immunizations in northern Nigeria, I argue that religious, political, and traditional medical providers continue to have a central role in northern Nigeria's social system and the power to continue exerting influence on the immunization behaviors of the populations investigated in this dissertation.

Peers

Peers are a second group of individuals that have been identified as key sources of influence in the social networks literature. Social network studies examining health have customarily focused on ties between family and friends due to the hypothesis that these relationships are a primary medium through which social capital – mostly in the form of social support, including the provision of information, emotional relief, material aid, and self-reliance (Bozo, Toksabay, & Kurum, 2009) – is transferred (Haines et al., 2008). Indeed, it is believed that friends and family members are especially likely to promote the transfer of social capital due to cultural norms, which encourage "altruism towards intimates" and the sharing of resources among kin and close non-kin (Wellman & Wortley, 1990, p. 559).

Research studying the effects of peers on health has mostly examined the impact of adolescent social networks on behavioral outcomes in developed countries. This research has

shown that peers influence adolescents' odds of smoking initiation, continuation, and cessation (Burt & Peterson, 1998; Chen, Arzu, & Triandis, 2007; Kaplan et al., 2001) as well as their use of alcohol (Andrews, Tildesley, Hops, & Li, 2002; Urberg, Degirmencioglu, & Pilgrim, 1997). This literature has also provided evidence of a protective effect of peers on risky behaviors such as engaging in violence (Prinstein, Boergers, & Spirito, 2001) and ceasing to exercise (Voorhees et al., 2005).

The much more limited research on the relationship between peers and health in developing countries has also provided support for the claim that peers play a critical role on health. A qualitative study of Togolese mothers across nine villages revealed that mothers were more likely to immunize their child if their peers encouraged it (Eng et al., 1991). The HIV/AIDS literature also shows that peers serve as a source of support for HIV-affected individuals (Murray, 2010; Skovdal, 2012), a protective factor in helping HIV-affected children build resilience (Cluver, Bowes, & Gardner, 2010; Wild, Flisher, & Roberson, 2011), and a source of advice and encouragement for adopting healthy attitudes and behaviors (Wright, Lubben, & Mkandawire, 2007).

This recent exploration into the effects of peers on health has not come without complexity, however. The fundamental claim in the social networks literature is that characteristics of peers affect individual outcomes. However, because, for the most part, individuals choose their peers and the groups that they belong to, individuals' social behavior may be incorrectly attributed to their social interaction, rather than peer choice (Manski 1993). In other words, individuals "may select their contexts on the basis of their own preferences, making the direction of causation difficult to determine" (Blalock, 1984, p. 369). To address the concern of establishing correct causal direction, researchers, like Blalock (1984), stress the

importance of giving theoretical consideration to how individuals choose peers, devising empirical strategies to account for the measured factors impacting peer and network selection, and interpreting results with caution, especially when using non-experimental data (Blalock, 1984).

For the purposes of this dissertation, I define *peers* as any woman living in the respondent's compound. Although peers are often defined as friends who are not biologically related to the respondent, peers in this study comprise female kin in order to adequately account for the traditional and religious norms governing place of residence. In the predominantly Hausa Muslim region of northern Nigeria, residence is determined by marriage. Once married, Hausa Muslim women are expected to move into their husband's compound (which comprises his other wives,[9] if he has any, direct relatives, and in some cases, close friends). This means that women in this context do not choose where they live and whom they live with.

Once relocated, a majority of these women live a life of seclusion (*kulle* in Hausa, which literally translates into "to lock"),[10] prohibited from leaving their compound without permission from their husband or a designated male kin if the husband is unavailable (Callaway, 1987). Although less than a century ago, seclusion was a highly specific religious practice[11] observed

[9] Polygamy is widely practiced in northern Nigeria. Islamic law permits men to marry up to four wives, as verse 4:3 of the Qu'ran states, "marry women of your choice, two or three or four…" (Erulkar & Bello, 2007). The number of wives a man has is highly correlated to his wealth. As a result, poorer men tend to have one or two wives, while richer men tend to have three or four wives (Hayase & Liaw, 1997).

[10] Seclusion is practiced in three ways in northern Nigeria: as *kullen tsari,* (which translates as "seclusion lock"), which is the most common form of seclusion, restricting the movement of married women to occasional, escorted participation in important events and ceremonies*; as kullen dinga* (which translates as "lock keep on doing"), which forbids any outside movement at all and is usually restricted to the wives of prominent politicians or religious leaders; and *kullen zuchi* (which translates as "lock of the heart"), which allows free movement of women who are entrusted to practice proper morality on their own (Reynolds, 1992). This last form of seclusion is practiced by women who are part of the educated elite. In this dissertation, when I refer to seclusion, I mean those practices (kullen tsari and kullen dinga) which restrict women's movement outside of the compound, since none of the women in this study are a part of the educated elite (see the descriptive analysis of the study sample in Chapter 4 for empirical evidence supporting this claim).

[11] Most proponents of *kulle* refer to Islamic law for legitimization. They turn to verses, such as Sura IV of the Qur'an, which states, "men have authority over women because Allah has made the one superior to others, and because they spend their wealth to maintain them. Good women are obedient. The guard their unseet parts because Allah has guarded them (Qur'an 4:34) and

only among the wives of important figures such as Islamic religious leaders and chiefs, today it is nearly ubiquitous (Chumley, 2007). According to recent estimates, 95% of married women in northern Nigeria live in some form of seclusion (Chumley, 2007).

As a result of these religious norms, women in northern Nigeria live most of their lives within the confines of their household and surrounding compound, largely restricted from movement, outside of important occasions such as naming ceremonies, funerals, and weddings (Reynolds, 1992). These restrictions on movement put a natural constraint on women's choices about friendships and the pool of individuals that they interact with on a daily basis. Indeed, the constraints inculcated by traditional and Islamic law make peer networks in this study largely exogenous to social behaviors. However, since women still have the freedom to select "whom" they interact with among the limited pool of women in their compounds, these laws are not completely sufficient for making a causal determination. For this reason, I follow Blalock's (1984) recommendation to also address measured selection factors (see Chapter 3 for information on how I address selection bias) and interpret the study results with caution.

Social Network Norms

As indicated above, opinion leaders and peers have the power to influence a range of health behaviors. Opinion leaders and peers are particularly influential in personal networks, where they are often the primary sources of health information and normative influences (Latkin, Forman, Knowlton, & Sherman, 2003; Latkin, Sherman, & Knowlton, 2003). As such, the relationships and interactions that occur within personal networks are critical for transmitting knowledge about illnesses and diseases and for signaling what is perceived to be socially

---

verse 33:33, which reads, "stay in your homes and do not display your finery as women used to do in the days of ignorance." The ambiguity of such verses has lead to the different interpretation of *kulle* explicated in footnote 10 above.

acceptable and "normal" behavior (Bond, Valente, & Kendall, 1999; Friedman et al., 2001; Latkin & Knowlton, 2000; Youm & Laumann, 2002).

According to sociologists and social psychologists, there are two types of normative influences that impact behavior: *injunctive norms* and *descriptive norms* (Cialdini et al., 1990). *Injunctive norms* are perceptions of what valued others believe to be appropriate conduct. In other words, they are the perceptions of what behaviors are typically approved or disapproved of in a particular network. According to Cialdini (2007), injunctive norms are based on the morals and values of individuals' personal networks and their surrounding community.

Descriptive norms, on the other hand, are perceptions of how people typically behave in a given situation, regardless of whether their behavior is considered appropriate by others (Cialdini et al., 1990). This type of norm focuses on the perceptions of other people's behaviors, which are ascertained through observations of what other people do (Cialdini et al., 1990; Reno, Cialdini, & Kallgren, 1993). Cialdini and colleagues (1990) proposed that by conveying the idea of what is normal, descriptive norms inspire other people to engage in specific behaviors.

Injunctive and descriptive norms have been long recognized to influence human behavior (Latané & Darley, 1970; Sherif, 1936). For example, the prominent theories of *reasoned action* (Fishbein & Ajzen, 1975) and *planned behavior* (Ajzen, 1991) assert that injunctive and descriptive norms predict outcomes like voting (Gerber & Rogers, 2009), electricity usage (Schultz et al., 2007), and littering (Reno et al., 1993). In the area of health, these norms have been shown to influence outcomes, such as substance use (Buttross & Kastner, 2003; Neighbors, Lee, Lewis, Fossos, & Larimer, 2007; Simons, Neal, & Gaher, 2006), exercise (Okun et al., 2003; Sorensen et al., 2007), healthy eating (Eisenberg, Neumark-Sztainer, Story, & Perry, 2005), condom use (Buhi & Goodson, 2007; Barrington et al., 2009), sunscreen use (Mahler,

Kulik, Butler, Gerrard, & Gibbons, 2008), and most relevant to this study, immunization use (Allen et al., 2009; Paulussen, Hoekstra, Lanting, Buijs, & Hirasing, 2005).

There are two main studies that have investigated the influence of injunctive and descriptive norms on immunization use. One of these studies focused on the role of norms on parents' decision to immunize their children against influenza in the Netherlands (Paulussen et al., 2005), while the other explored women's decision to use the HPV vaccine in the United States (Allen et al., 2009). Even though both studies found injunctive and descriptive norms to influence immunization use, in both cases, descriptive norms had a stronger influence on immunization use than injunctive norms. This is interesting because research on the strength of the influence of injunctive norms versus descriptive norms on health has been mixed (see Manning, 2009, for a meta-analysis comparing the influence of descriptive to injunctive norms). It is surmised that descriptive norms have a stronger relationship with health behaviors than injunctive norms when the perception of what other people *do* is more salient than perceptions of what people *want you to do* (Manning, 2009). When this is the case, descriptive norms operate as a heuristic for behavior change (Cialdini & Goldstein, 2004).

To my knowledge, no study has used a social networks framework to examine the effect of injunctive and descriptive norms on childhood immunization behaviors, especially in a developing country setting. Conducting this type of research among diverse populations and settings is important given that normative influences are by nature context specific – dependent on unique religious and cultural norms that also exist within a society (Chen, Wasti, & Triandis, 2007; Pescosolido & Georgianna, 1989).

In this study, I examine the structure of injunctive and descriptive norms around immunizations within Nigerian mothers/caregivers' social networks and test whether these

norms are linked to mothers/caregivers' decisions to use this health service. I test the influence of injunctive and descriptive norms separately given consistent empirical support that injunctive and descriptive norms are distinct constructs (Cialdini et al., 1990; Deutsch & Gerard, 1955; Reno et al., 1993; White, Terry, & Hogg, 1994) that should be measured accordingly (Cialdini & Trost, 1998; Donald & Cooper, 2001; Rivas & Sheeran, 2003). As recommended by other researchers (Pescosolido and Goergianna, 1989), I also disaggregate these tests by opinion leaders and peers in order to assess the differential effect of these norms by network type.

Hypotheses

The Influence of Injunctive & Descriptive Norms

I hypothesize that *injunctive norms* influence immunization use. More specifically, I hypothesize that mothers/caregivers who perceive that a majority of their social network partners *approve of* immunizations will be more likely to engage in immunization use. Because opinion leaders are, by nature, influential and have been found to be particularly influential on immunization behaviors in the past, I expect mothers/caregivers who believe that most of their opinion leaders support this health service will want to follow their behavioral expectations and engage in this behavior (Cialdini, 2007).

I expect the same relationship to occur between mothers/caregivers and peers. Because mothers/caregivers want to gain some approval, or informal sanctions, from their peers, mothers/caregivers' who perceive that most of the peers in their network support immunizations will also immunize their own child. In other words, the favorable social evaluations that mothers/caregivers expect to result from engaging in a behavior that is viewed as appropriate by most of their peers will motivate them to show compliance to their peers' beliefs about the value of immunizations by immunizing their children.

Hypothesis 1A: Mothers/caregivers who perceive that a majority of the opinion leaders in their network support immunizations will have a higher likelihood of immunizing their child.

Hypothesis 1B: Mothers/caregivers who perceive that a majority of the peers in their network support immunizations will have a higher likelihood of immunizing their child.

I also hypothesize that *descriptive norms* influence immunization use. More specifically, I hypothesize that mothers/caregivers who observe a majority of their social network partners immunize their children will ultimately immunize their own children. Again, because opinion leaders are, by nature, influential and have been shown to influence immunization behaviors in the past, I expect their use of this health service to have a strong, positive influence on mothers/caregivers' immunization decisions. According to descriptive norms theory (Cialdini, 2007), the motivation behind the influence of this norm lies in the perceived benefit of the observed behavior. This suggests that by observing their leaders use immunizations, the mothers/caregivers determine it to be a safe and beneficial practice, and as a result, decide to engage in it themselves.

I hypothesize that the same relationship that exists between descriptive norms and immunization use among opinion leader networks also exists in the mothers/caregivers' peer networks. I expect mothers/caregivers who observed a majority of their peers immunize their children to immunize their own child. By watching most of their peers immunize their child, mothers/caregivers realize the benefits of immunizations and decide to also engage in this health practice.

Hypothesis 2A: Mothers/caregivers who observe a majority of their opinion leaders in their network immunize their child will have a higher likelihood of immunizing their own child.

Hypothesis 2B: Mothers/caregivers who observe a majority of their peers in their network immunize their child will have a higher likelihood of immunizing their own child.

Factors Underlying the Influence of Injunctive & Descriptive Norms

After testing whether injunctive and descriptive norms influence immunization behaviors, I empirically test whether the theorized factors underlying the influence of injunctive norms and descriptive norms in the literature are, in fact, present. As alluded to above, *injunctive norms* are guided by *social control* – social pressure to conform to what is deemed appropriate behavior (Montgomery & Casterline, 1996), while *descriptive norms* are guided by *social learning* – what is considered to be normal behavior based on the observed experiences of others (Armantier, 2004; Foster & Rosenzweig, 1995; Kohler, Behrman, & Watkins, 2001). Although social control and social learning may seem similar in form, their emphasis is different. *Social control* emphasizes the harmonization of one's own beliefs with prevailing beliefs for the purpose of avoiding conflict (Montgomery & Casterline, 1996). To engage in active social control, individuals require aggregate-level knowledge about people's beliefs about an innovation. Knowledge about specific individuals' experiences with an innovation is only important if the individuals are considered "significant others" (Feder & Savastano, 2006; Hogset & Barrett, 2010). Social control is therefore different from social learning because it emphasizes the role of power in normative influences on behavior.

Social learning, on the other hand, involves an active information search by rationale individuals who look to others whom they identify with, observe them, and modify their own behaviors accordingly (Hogset & Barrett, 2010). To engage in active social learning, individuals require precise knowledge about specific individuals' experiences with the innovation in question (Hogset & Barrett, 2010). This individually-precise process of information exchange

eventually generates a "social multiplier effect," where individuals' imitate the behaviors of others, making the behavior widespread. This multiplier effect is similar to the effect that Rogers (1995) describes in his S-shaped adoption curve to explain innovation diffusion.

Interest in studying whether social control or social learning is guiding health behavior change has grown rapidly in recent years (Bandiera & Rasul, 2006; Behrman, Kohler, & Watkins, 2002; Conley & Udry 2001, 2007; Miguel & Kremer, 2004; Moser & Barrett, 2006; Munshi, 2004; Mwakubo, Obare, Omini, & Mohammed, 2004). In the field of public health, these constructs have been explored and shown to guide the influence of a range of behaviors – such as cigarette smoking (Christakis & Fowler, 2008) alcohol consumption (Rosenquist, Murabito, Fowler, & Christakis, 2010) and happiness (Fowler & Christakis, 2008). In most cases, social learning has been shown to dominate (Conley & Udry 2001, 2007). However, in developing countries, the results of this research have been much more mixed (Avogo & Agadjanian, 2008; Bongaarts & Watkins, 1996; Kohler et al., 2001; Miguel & Kremer, 2004; Montgomery & Casterline, 1996; Rutenberg &Watkins, 1997). For example, a Ghana-based study, found social learning to be the dominant mechanism through which social networks influenced men, who subsequently influenced their wives, to use family planning (Avogo & Agadjanian, 2008; Behrman et al., 2002). A Kenya-based study, however, found social control to be a primary mechanism through which social networks affected women's use of contraception (Kohler et al., 2001).

In this dissertation, I examine whether the theorized constructs of social control and social learning underlie injunctive norms and descriptive norms around immunizations in mothers/caregivers' peer networks. Peers, rather than opinion leaders, are the focus of this analysis since the underlying factors guiding normative influence on mothers/caregivers'

immunization decisions is less clear among peers. Research has shown that Muslim Hausa women find a sense of status and meaning in their lives via their connections with other women. In northern Nigeria, women "form a society within a society" and are said to have more in common with each other than they do with their own husbands (Ojanuga & Johnson, 1992). It is with these other women that women are believed to share a common lot and the agonies of daily life.

However, when it comes to decision-making within the compound, research among this population shows that a hierarchy of power also exists. According to Islamic custom, husbands are responsible for determining what their wives can and cannot do (Ojanuga & Johnson, 1992).[12] However, once a husband permits his wives[13] to immunize their children, for example, they have the freedom to decide whether or not to engage in this accepted activity (Umar, personal communication, April 5, 2013). At that point, senior female kin (e.g., mothers-in-law, senior co-wives) can influence what activities women in their compound engage in, including those related to their own health and the health of their child (Ojanuga & Johnson, 1992).

Given the unique relationship that exists between women within compounds – that they can serve as friends and confidants as well as authority figures – it seems likely that social learning and social control are both guiding peer influences in northern Nigeria. This

[12] The extent to which husbands have authority over their wives' decision in northern Nigeria is evident in the literature. A recent study in northern Nigeria found that, regardless of level of education, Muslim Hausa women believe that they should not work, because it is their husband's duty to provide for them (Department for International Development [DFID], 2005). In the area of health, three different studies found Muslim Hausa women to make reproductive decisions (e.g., which health care practitioner they visited) based on what their husbands said that they could and could not do (Ojanuga & Johnson, 1992; Isiugo-Abanihe, 1994; African Population and Health Research Center [APHRC], 2009). For example, a secondary analysis of demographic and health survey (DHS) data from 2003 revealed that husbands made the vast majority of decisions related to their wives' healthcare (90%) and large household purchases (90%; Erulkar & Bello, 2007).

[13] According to Islamic law, husbands are required to treat all of his wives equally. Indeed, a man is only permitted to marry more than one wife if he has proven his ability and willingness to do justice between them. The Qu'ran states, "marry women of your choice, two or three or four, but if you fear that you shall not be able to deal justly with them, then only one…" (Qu'ran verse 4:3). In practice, this means that husbands cannot show any spousal preference. Husbands must share their time and resources between their wives equally. Non-provision of amenities or conjugal desertion constitutes cruelty and ill-treatment and are therefore grounds for divorce (DFID, 2005).

dissertation will test whether this is the case by assessing whether social control and social learning underlie its theorized norms – that social control underlies the influence of injunctive norms and social learning underlies the influence of descriptive norms. If this is the case, then I can more confidently make statements about the degree to which these processes are guiding immunization behaviors among the study population – whether mothers/caregivers are immunizing their children because of social control, social learning, or both.

Comparing the Influence of Injunctive & Descriptive Norms

After ascertaining which types of norms influence immunization use and confirming that social control and social learning underlie these norms, I plan to assess the degree to which injunctive and descriptive norms influence mothers/caregivers behaviors. Even though I expect injunctive and descriptive norms to both positively influence mother/caregivers' immunization decisions (see Hypotheses 1A-1B and 2A-2B), I expect them to have different levels of influence in opinion leader networks versus peer networks.

In opinion leader networks, I expect injunctive norms to have a stronger influence on mothers/caregivers' immunization decisions than descriptive norms. Because statements of approval regarding immunizations might be more salient in opinion leader networks than observations of immunization use, and because these statements are stronger when they come from authority figures than peers or general members of the community (Cialdini et al., 1990), I expect injunctive norms in this type of network to exert a stronger influence on mothers/caregivers' immunization decision-making. I also believe this to be the case given that the primary factor underlying the influence of injunctive norms is the desire for social approval. Because opinion leaders are authority figures, mothers/caregivers might feel a greater sense of

urgency to do what they believe to be appropriate, than what they learn from them to be beneficial, because they are eager to get into their leaders' good graces.

Hypothesis 3A: Injunctive norms around immunizations in opinion leader networks will exert a stronger influence on mothers/caregivers' immunization use than descriptive norms.

In peer networks, however, I expect descriptive norms to have a stronger influence on mothers/caregivers' immunization decisions than injunctive norms. Because mothers/caregivers share a compound with their peers, they often travel together to clinics to seek out healthcare services (Babalola & Fatusi, 2009). As a result, they have more opportunities to observe their peers immunize their children. I also expect these observations of immunization use to be more salient then their statements of approval given the informality of these relationships (Cialdini et al., 1990). Even though a hierarchy exists between some women in the same compound (see description in section above), overall these relationship are more personal and much less formal than their relationships with opinion leaders. For this reason, I expect mothers/caregivers to feel less pressure to conform to what their peers consider to be appropriate than to new knowledge about the personal benefits of this behavior acquired by watching a majority of them immunize their children.

Hypothesis 3B: Descriptive norms around immunizations in peer networks will exert a stronger influence on mothers/caregivers' immunization use than injunctive norms.

Moderators of Normative Influences

Closeness & frequency of communication. A range of demographic and contextual factors have been shown to influence the strength of the relationship between norms and people's actions. For example, studies have shown age (Henry et al., 2000; Huesmann & Guerra, 1997),

wealth, and social status (Berger, Rosenholtz, & Zelditch, 1980; Lockwood, Jordan, & Kunda, 2002; Pool, Wood, & Leck, 1998; Wood, Pool, Leck, & Purvis, 1996) to influence the strength of the correlation between norms and health behaviors, including alcohol consumption, smoking, and aggressive behavior in school. Contextual factors, such as social support (Cullum, O'Grady, Sandoval, Armel, & Tennen, 2013) and religious values (Neighbors, Brown, Dibello, Rodriguez, & Foster, 2013) have also been shown to moderate the influence of norms on health. Two network specific factors that might also moderate the influence of norms on health are: the degree of closeness between individuals in a network and the frequency of communication between individuals about the behavior of interest in a network. An overview of these characteristics and how they may operate to strengthen the influence of norms on immunization behaviors is below.

Closeness is defined as an "emotional connection that allows for sharing of personal feelings, accompanied by expectations of understanding, affirmation, and demonstrations of support" (Sinclair & Dowdy, 2005, p. 193). This concept has been described as the foundation of strong relationships (Goleman, 1997; Wood, 1984), providing a sense of purpose and belonging (Ornish, 1998), the opportunity for self-disclosure (Perlman & Fehr, 1987), and motivation and self-esteem (Cornwell, Schumm, Laumann, & Graber, 1999). Overall, the strong feelings that emanate from close relationships are expected to facilitate shared behaviors among individuals within a network (Rowley, 1997).

In recent years, the concept of closeness has received much attention in the social psychology and public health literatures as a major factor contributing to both psychological and physical well-being (Fiori, Antonucci, & Cortina, 2006; Ornish, 1998; Wellman & Wortley, 1990;). Indeed, closeness has been shown to effect physical health in a variety of longitudinal

studies (Graves, Thomas, & Mead, 1991; Russek & Schwartz, 1997), including the incidence of various chronic illnesses (Orth-Gomer, Rosengren & Wilhelmsen, 1993; Seeman & Syme, 1987). A review of research on closeness has showed that individuals with no confidant have a three-to-five times greater risk of premature death and disease from all causes, including heart disease, strokes, cancer, and auto-immune infections (Ornish, 1998). Compared to no closeness, the presence of one strong relationship can dramatically shifts one's health status in a positive direction (Ornish, 1998).

Research has also shown that closeness impacts health behaviors. For example, better quality relationships have been associated with a range of health-promoting behaviors (Padula & Sullivan, 2006), such as increasing fruit and vegetable consumption, exercising, (Emmons et al., 2007), and smoking cessation (Chouinard & Robichaud-Ekstrand, 2007). Although closeness has been mostly demonstrated as being beneficial to health, some studies demonstrate that being in a close relationship with an individual who engages in unhealthy habits, such as heavy drinking, smoking, or overeating, can lead to poor lifestyle choices (Franks et al., 2006).

Today, researchers have applied a range of methodologies to study the relationship between closeness and health (Prager, 1995). For example, the Quality of Relationships Inventory (QRI; Pierce, 1994) and the Personal Assessment of Intimacy in Relationships (PAIR) instruments (Schaefer & Olsen, 1981) have been used to measure the quality of close relationships and to assess differences in levels of closeness. Ego-centric social networks scholars have measured closeness using much simpler methods, such as asking focal persons to rate the closeness of their relationships on a likert scale (Zea, Reisen, Poppen, Echeverry, & Bianchi, 2004) or, as done in large-scale surveys like the General Social Survey (GSS) and the

National Social Life, Health, and Aging Project (NHAP), to directly report how closely connected they feel to specific people within their network.

This latter approach relies on the more standard definition of closeness, "the emotional connection that two people in a network achieve" (Cornwell et al., 2009, p. i51). Using this definition, closeness captures the "strength of ties" in a network (Granovetter, 1973, p. 1360), an indication that "thick trust" has developed and that expressive or instrumental action is possible (Lin, 1999, p. 33). According to scholars, social networks help to build this trust among members. Social trust increases as people get to know each other, learn who is trustworthy, and go through experiences together. This "thick trust" that develops tends to exist in small, face-to-face communities, such as those in rural peripheries (Coleman, 1990) like the one investigated in this dissertation.

In this dissertation, I use the standard definition of closeness to test whether it moderates the influence of norms on immunization behaviors. According to some researchers, individuals may be more likely to follow norms if they come from people that they are close to than norms that come from more distant or unspecified sources (Melnyk, Herpen, & Trijp, 2010). This is because the thought of specific persons that they are close to may activate information about their relationship with them and about expected relational outcomes (e.g., disappointment or praise), which may makes it more difficult for them to disobey a norm. In contrast, more distant others, especially when these are unspecified, may have less control and influence. I therefore predict that both injunctive and descriptive norms generated from social network contacts that are close to a majority of mothers/caregivers will have a stronger influence on their immunization behaviors than norms from opinion leaders and peers that are considered to be more distant.

I expect this relationship to emerge in both the opinion leader and peer network analyses. Even though I also anticipate mothers/caregivers and peers to have a closer and more informal relationship than mothers/caregivers and opinion leaders, I expect that when they do have a closer relationship with a majority of their opinion leaders, they will be more inclined to follow their normative beliefs and practices.

Hypothesis 4A: Closeness strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 4B: Closeness strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.

Communication frequency is another characteristic that has the potential to influence the strength of the relationship between norms and immunization use. Whereas *closeness* looks to the strength of relationships between network members, *communication frequency* looks to the amount of communication between individuals in a network in order to account for health outcomes. Communication frequency is considered an important social network characteristic since it is assumed that "the more communication there is between network partners, the more influential the relationship is" (Wellman & Wortley, 1990, p. 560). Indeed, frequent communication between individuals has been shown to help facilitate the process of influence, fostering a sense of shared values, increasing mutual awareness of needs and resources, mitigating feelings of loneliness, encouraging reciprocal rounds of support, and facilitating the delivery of aid on important matters (Galaskiewics, 1985; Homans, 1961; Lin, Woelfel, & Light, 1985; Munch, McPherson, & Smith-Lovin, 1997; Wellman & Wortley, 1990).

In the public health field, communication frequency has been shown to impact a range of health outcomes (Seeman & Berkman, 1988; Terhell, van Groenou, & van Tilburg, 2007), from influencing stress levels (Brummett et al., 2001) and experiences with troubled sleep (Ailshire &

Burgard, 2012) to improving cognitive function (Giles, Anstey, Walker, & Luszcz, 2012) and overall adult health (Cornwell et al., 2009). Communication frequency has also been shown to impact specific health behaviors, such as increasing harmful substance use (de Belvis et al., 2008) and a general openness to dietary change (Kelsey et al., 1997).

This network characteristic has been shown to have a particularly strong influence when it is around the behavior of interest. In fact, communication between social network contacts about health topics has been proposed to be a primary way in which social networks augment normative perceptions and subsequently influences behavior (Hogg & Reid, 2006; Rimal & Real, 2003). Indeed, in the health field, more conversations about health topics reflect what Noar, Carlyle and Cole (2006) refer to as "warm up" discussions that create the opportunity for more persuasive encouragement as well as pressure to use different services (p. 368). Studies have reported both positive and negative associations between communication about health topics and health behaviors (El-Bassel, Gilbert, Wu, & Chang, 2006; Kang, Deren, Andia, Colon, & Robles, 2005; Latkin et al., 2003). This highlights the need for research that takes communication and the context of people's beliefs and practices regarding the health topic of interest into account.

In this dissertation, I test whether the frequency of communication about immunizations moderates the influence of norms on immunization use. I hypothesize that frequent communication about immunizations augments the influence of both injunctive and descriptive norms on immunization use. I expect mothers/caregivers with more frequent communication with a majority of their peers and opinion leaders about immunization to be more likely to respond to this intensive exposure by aligning more closely with the attitudes and behaviors of the majority of their network partners. Because individuals have a tendency to favor information that is delivered by influential others (Rogers, 1983), and the opinion leaders and peers in this

study fit this criterion, I expect this relationship to emerge in both the opinion leader and peer network analyses. Even though I also anticipate that communication about immunizations to be much more limited between mothers/caregivers and opinion leaders than between mothers/caregivers and peers (given that that women in this context live in a state of seclusion and will therefore only interact with their leaders during special events (e.g., weddings or ceremonies) or predetermined intervals (e.g., to study the Qu'ran, seek care, or pray), I expect that when they do have more communication with a majority of these influential individuals about immunizations, they will be more inclined to follow their normative beliefs and practices.

Hypothesis 5A: Frequency of communication about immunizations strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 5B: Frequency of communication about immunizations strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.

Summary

In this chapter, I presented a robust theoretical model to guide the hypotheses linking social network norms to immunization use in northern Nigeria. In the next chapter, I describe the methods that I use to test these hypotheses.

CHAPTER 3

RESEARCH DESIGN & METHODOLOGY

Social networks researchers use a formal research methodology referred to as social network analysis in order to study social networks. These analyses are conducted from ego-centric or socio-centric perspectives (Smith & Christakis, 2008). The critical difference between these perspectives is that ego-centric networks are traced by gathering data from a set of focal individuals (egos), while socio-centric networks gather data from egos and their social contacts (alters; Luke & Harris, 2007). A complete socio-centric network design is considered the "gold standard" in social network analysis because data collected from egos and alters can be used to validate information about them and to make generalizations about an entire interacting network. However, socio-centric network studies do have disadvantages, namely that getting a complete list of all members of a network is difficult.

This study uses a refined ego-centric network design to study immunization behaviors among a sample of mothers/caregivers in northern Nigeria. Ego-centric networks have been defined as "personal core networks" (Marsden, 1987, p. 123), consisting of persons with whom a respondent has "discussed important matters" (Brut, 1984, p. 314). In this study, ego-centric networks are defined as personal core networks consisting of persons with whom mothers/caregivers may have discussed childhood immunizations.

The case-control sample design and the link-tracing method are used in this study to assess the relationship between opinion leaders and peers on childhood immunization use. The case-control sample design and the ego-centric method are used to select egos for the study. The link-tracing approach is used to gather socio-centric type data, that is, relevant information from

a sample of alters. This study takes opportunistic advantage of the small number of alters nominated by each ego to overcome the primary disadvantage of a full socio-centric design (its data demands) and to benefit from one of its main strengths (its ability to validate the more complete information provided by egos about their network influences). This study also takes advantage of the unique capacity of social network analytics to examine the structure of norms in networks and the influences of these norms on behavior (Friedman et al., 1997; Morris, Zavisca, & Dean, 1995; Rothenberg et al., 1998). Overall, these refinements in the ego-centric model in combination with the advanced analytics used to assess the relationships between mothers/caregivers and their peers and opinion leaders will allow me to generate more precise answers about the linkage between social networks and immunization use in northern Nigeria.

The Health & Demographic Surveillance System in Bungudu

This study draws on primary and secondary data collected as a supplement to the Health and Demographic Surveillance System (HDSS) implemented for the Bungudu Local Government Area (LGA), Zamfara State, Nigeria. The HDSS was established in Bungudu in 2009 by PRRINN-MNCH – an immunization program funded by DFID and the Norwegian Government and supported by the Zamfara State Ministry of Health (SMOH). The HDSS was designed as a longitudinal health and population registration system to monitor the health and demographic dynamics of Bungudu's 125,149 residents and to support studies aimed at assessing wider progress and impact of strengthening health systems (Doctor, Bairagi, Findley, Helleringer, & Tukur, 2011). The HDSS is a member of the prestigious International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) – an international platform of sentinel sites that provides health and demographic data to enable developing

countries to set health priorities and policies (INDEPTH, 2012). My dissertation is the first and only study that PRRINN-MNCH has agreed to support in this HDSS.

Justification for HDSS Site Selection

Three reasons make the Bungudu HDSS a strategic research site for this dissertation. First, the population living in the HDSS is largely homogenous. Ninety-six percent of the population identifies as Hausa and 99.8% of the same population identify as Muslim (Olatunji, Doctor, Oluwatoni, & Jumare, 2011). Almost the entire population then shares a common sense of identity, history, customs and behavioral rules (e.g., in marriage, clothing, diet, taboos; Antai, 2009a). The six districts that make up the HDSS are also similar – they share a common government, all are rural with poor road infrastructure, and have limited access to the public health system. This homogeneity limits possible confounding factors that might be introduced if I were comparing social networks in villages that differed greatly in their culture and social structure.

Second, the population is relatively sedentary. People in Bungudu maintain strong roots in their communities with most people living in their respective communities for at least ten years (Doctor, Findley, & Jumare, 2011). Some population members leave their community temporarily for labor purposes and men are much more likely to leave than women given the traditional and Islamic laws restricting their movement (see Chapter 2 for more information about the laws restricting women's movement). Since women in this context live most of their lives within the confines of their household and surrounding compound, it is relatively easy to track their stable social network influencers.

Third, in Bungudu, there is pronounced variation in immunization coverage rates at the individual and village levels. Most children in the HDSS have not been immunized (76.6%).

Twenty percent of children in the HDSS have been fully immunized (Doctor, Findley et al., 2011). The variation in immunization coverage also holds at the community-level. Three-quarters of the communities in the HDSS have immunization coverage rates between 0 and 25%, yet 12% of the communities have immunization coverage rates greater than 75 % (Doctor, Findley et al., 2011). Interestingly, many of the communities with immunization coverage rates greater than 75% do not have strong immunization programs implemented by PRRINN-MNCH,[14] leading to the conclusion that exposure to immunization programs cannot account for all of the community-level disparities in immunization coverage. The unexplained variation in immunization coverage in the HDSS makes Bungudu a fertile ground for research on the social factors that may be contributing to immunization differences.

Target Population

The target population for this study is women between 14 and 49 years of age who have maternal responsibilities for one or more children between 9 and 18 months. Women between 14 and 17 years of age are included because many women in this age range have begun childbearing (given birth or are currently pregnant with their first child). Recent research shows that 14.5% of women between 14 and 17 years of age in Nigeria have begun the childbearing process (NDHS, 2009).

Women between 45 to 49 years of age are also included. In northern Nigeria, when a mother dies, children are taken care of by female relatives (e.g., step-mother, grandmother). These other relatives could be outside of the reproductive age range (over 44 years of age).

[14] The WISH program is a program of community savings groups started by PRRINN-MNCH to give women a forum for mobilizing savings to access needed health services (e.g., ANC services, childhood immunizations). WISH Groups have been implemented in 27 of the 99 HDSS clusters since 2008. It is one of the primary activities being implemented by PRRINN-MNCH to increase the use of childhood immunizations in the HDSS (PRRINN-MNCH, 2010).

Excluding them would therefore result in a lack of information about a group of women who are making immunization decisions for young children.

Women caring for children between 9 and 18 months of age were selected because the routine immunization schedule in Nigeria stipulates that a child must receive all routine immunization by the time they are 9 months (the ideal standard) to 12 months (the acceptable standard) of age (see Table 1). In order to address the issue of maternal recall, women with a child that was a maximum of 18 months of age were included. This gave a window of 6 months for the woman to remember her child's immunization history, which is considered reasonable by survey research design standards (Fowler, 2009).

Table 1

Routine Immunization Schedule in Nigeria

Immunization	**# of Doses**	**Schedule**	**Vaccination Site**
Bacillus Calmette-Guerin (BCG)	1	At birth	Upper Left Arm
Oral Polio Vaccine (OPV)	4	At birth and 6, 10, and 14 wks	Mouth
Diphtheria, Pertusisis, and Tetanus (DPT)	3	At 6, 10, and 14 wks	Outer part of thigh
Hepatitis B	3	At birth and 6 and 14 wks	Outer part of thigh
Measles	1	At 9 mo (12 mo is acceptable)	Upper Left Arm
Yellow Fever	1	At 9 mo	Upper Right Arm
Vitamin A	2	At 9 and 15 mo	Mouth

Source. Federal Ministry of Health (FMOH), Nigeria (2006).

The other target population is opinion leaders – religious leaders (imams and malams), political leaders (village chiefs and district heads), and traditional medicine providers – directly mentioned by the mothers/caregivers as influencers of childhood immunization decisions.

Sampling Procedures

The study sample was selected from the HDSS using a two-stage process (see Figure 2). First, a case-control design was used to select villages for study inclusion. Out of the 95 villages included in the original sampling frame,[15] 38 of the villages met the study's eligibility criteria: a) immunization information collected on a minimum of 15 children and b) either a 0 or 50% or higher immunization coverage rate.[16] After these villages were selected, they were matched based on their similarity in geographic location[17] and compound size.[18] Within each strata, a total of 11 villages with 50% or higher vaccination coverage (termed "high immunization villages") were paired with 11 villages with 0% immunization coverage (termed "low immunization villages") for a final village sample of 22.

Individual-level data was collected using the ego-centric and link-tracing methods. To form the mother/caregiver sample in each village, I applied the ego-centric approach by disseminating a questionnaire to *all* women in the *HDSS longitudinal health and population registration system* who met the study's eligibility criteria. A total of 550 of the 872 eligible women (63%) were interviewed (see Table 2). The link-tracing method was then used to interview *all* the opinion leaders whom the women respondents identified as being influencers of their immunization decisions. A total of 127 of the 167 opinion leaders were successfully interviewed (76%).

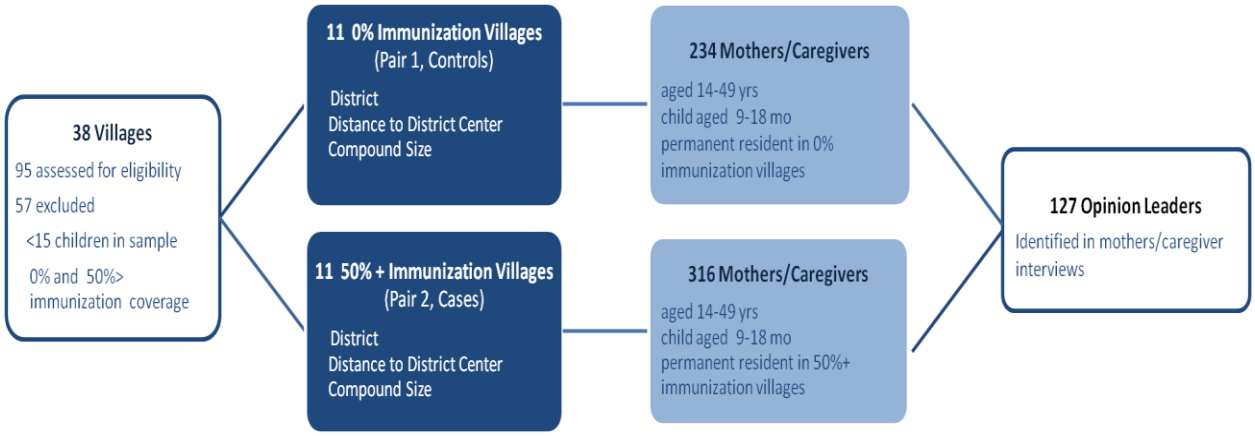
[15] Data from the HDSS pilot census from April to July 2011 was used as the sampling frame. For more details about these data, see (Doctor, Findley et al., 2011).

[16] The immunization coverage rates were estimated using a sample of children living in each village, which means that I used a sampling estimate, rather than an absolute estimate, of immunization coverage.

[17] *Geographic location* was measured as 1) residing in the same district and 2) as the degree of closeness to the district center. *Close* was defined as being within a 45-minute drive from the district center, which is the center of activity in the district. The district center is where the government offices and health facility (if exists) tend to be located.

[18] *Compound size* was measured on a 0 to 1 scale, with 0 indicating that the village had less than 18.71 individuals per compound (which is the mean value for all villages in the sampling frame) and 1 indicating that the village had more than an average of 18.71 individuals per compound.

Figure 2. Study Flow Diagram



The non-response rate among the women in the study was 18% (see Table 2). The non-response rate across the two pairs (16.1% in low immunization villages versus 20.7% in 50+ % immunization villages) was not statistically significant ($z = .7184$, $p > .05$), reducing my concern that attrition bias was a threat to the validity of the study. The non-response rate among the women can be mainly attributed to difficulty in locating a particular house because of unclear address labeling (56%). The remaining 44% can be explained by the women's unavailability – being too busy to participate, on extended family travel, or having moved outside of the community altogether (42%) – as well as their refusal to participate (2%).

Eighteen % of the women no longer met the study's eligibility criteria. Among ineligible women, 57% had children that no longer met the age requirement of the study and 42% had children that died since the time the household was last updated in the HDSS registration system (between April and October 2011). The remaining 1% of women could not be interviewed because of their unfortunate death.

The non-response rate among the opinion leaders was higher than among the women – 24% (see Table 2). When disaggregated by primary occupation,[19] the non-response rate was: 16% among religious leaders, 27% among political leaders, and 63% among traditional medicine providers. These differences can mostly be explained by traditional medicine providers' lack of availability to participate in the study. Eleven (69%) of the traditional medicine providers were not interviewed because they were either unavailable to meet – on travel or busy – or not at their residence during the scheduled visit and re-visits. The remaining five (31%) traditional medicine providers were not interviewed because of cultural reasons – the female providers refused to interview with a male field worker without their husband present. When logistically possible, a female field worker interviewed the traditional medicine providers, but this was often difficult to implement given the human resource constraints of the project.

Table 2

Sampling and Participation Rates

Immunization	Targeted Sample (N)	Total Interviewed (N)	Respondent Participation Rate (%)
Mothers/Caregivers	870	550	82
Opinion Leaders	167	127	76
Religious Leaders	112	94	84
Political Leaders	36	26	73
Traditional Healers	19	7	37

[19] Opinion leaders can hold more than one position (e.g., be a religious leader and a political chief) in their community. For the purposes of this analysis, the opinion leaders were placed into the category (religious, political, or medical) that each leader indicated as his/her primary occupation.

Data Collection & Instrumentation

Nine field workers (eight females and one male) were hired to do data collection. These field workers participated in an intensive, three-day training, which included a pilot testing of the study protocol and survey instruments in a community not selected for inclusion (see Appendix A for more details about the field worker training and pilot testing).

The field workers administered three instruments from October to November 2011 (see Appendix A for details about the data collection procedures). These instruments were adapted from surveys used in the *Malawi Longitudinal Study of Families and Health Project* (MLSFH) to measure the role of social networks in changing demographic attitudes and behaviors (University of Pennsylvania, 2006).

The first instrument was a 45-minute interview including 108 questions for mothers/caregivers about their perceptions of childhood immunizations, their experiences with childhood immunizations, and their child's immunization history. Questions about the mothers/caregivers' relationships with their husbands, peers, traditional medicine providers, village chiefs, and religious leaders were also included in order to measure the impact of these networks on immunization use (Appendix F-G).

The second instrument was a short, 20-minute interview with opinion leaders about their perceptions of immunizations. Opinion leaders were posed the same questions as mothers about their perceptions of immunizations so that leaders' self-reported attitudes about immunizations could be compared to mothers' perceptions of their views and to test the validity of the assumption that there is already a very high level of support for immunizations among opinion leaders in the northern region of Nigeria (Appendix B-E).

The third instrument was a geographic information systems (GIS) data documentation form (Appendix H). Geographic location data were collected using GPS devices for each respondent and the 10 health facilities in Bungudu that routinely provided child immunization services. The form captured data on the general location of the health facility (district and village) and its 14-digit GPS coordinates.

Compensation

Following HDSS protocol, respondents were not offered or provided compensation for participating in the study.

Confidentiality of Data

The Zamfara State Ministry of Health (SMOH) Operations Research Advisory Committee (ORAC) and the Columbia University IRB and Ethnics Committee granted ethical clearance for this study (Appendix I). District heads and village chiefs were asked for entry into communities prior to data collection. Field workers obtained verbal informed consent from respondents prior to their interviews. All data was stored on a computer with restricted access and shared with study personnel only.

Measures

Dependent Variable: DPT Vaccine Use

The dependent variable is a *mother/caregiver's use of routine immunizations.* This variable is measured as the uptake of one or more doses of the DPT vaccine. DPT vaccine uptake is strategically used as the dependent variable for two reasons. First, DPT, which confers immunity against diphtheria, pertusis or whooping cough, and tetanus, is the only vaccine in Nigeria's routine immunization schedule that is solely administered in health facilities. All other immunizations are periodically provided house-to-house and in community venues (e.g., the

village chief's house) that are part of highly publicized health campaigns, such as those sponsored by the Global Polio Eradication Initiative (GPEI, 2010). By delivering immunizations house-to-house and at convenient locations, women are more likely to "passively accept" (e.g., comply because of convenience) rather than "actively accept" immunizations (e.g., comply because they actively demand vaccines as a result of knowing their perceived benefits (Nichter, 1995; Streefland et al., 1999, p. 1709). This is no different in Bungudu where GPEI campaigns operate every month (GPEI, 2010), yet access to the DPT vaccine requires spousal permission, time to travel to a health clinic, and a vested interest in routine immunizations. Uptake of the DPT vaccine as the predicted variable captures an important element of "active acceptance" for routine immunizations that other immunizations do not.

Second, the uptake of the DPT vaccine is used because it is a standardized indicator of performance around routine immunizations and the best indicator of access to basic health services in developing countries (UNICEF, 2010). The receipt of all three doses of the DPT vaccine is traditionally used to estimate coverage. This measure was revised to include the receipt of one to three doses of the vaccine since the population of women in this study face significant barriers to accessing it (e.g., living in a state of seclusion in a rural setting with access to only ten health clinics that provide routine immunization services; Abdulazeez, personal communication, November 12, 2012). The uptake of even one dose of the DPT vaccine therefore shows an "active acceptance" for routine immunizations that other immunizations do not.

The DPT data used in this study was collected using two methods – vaccination cards provided by respondents and maternal recall when vaccination cards were missing (see approach in Appendix G). Using both methodologies to measure immunization completeness is an accepted and commonly-used practice in settings where vaccination card retention is low

(Langsten & Hill, 1998; Olatunji et al., 2011; Abdel Salam & Sokal, 2004; MEASURE Demographic Health Surveys (DHS) and ICF Macro, 2010), which is the case in rural Nigeria generally (an estimated 50% card retention; Odusanya, Alufohai, Meurice, & Ahonkhai, 2008) and Bungudu specifically (9% card retention). I used DHS's approach to collecting immunization data since it has been extensively validated to collect quality immunization information with little systematic bias (Murray et al., 2003). A diagram indicating the different parts of the body where immunizations are administered was also used during interviews to help mothers/caregivers' recall the immunizations that their child received. To help reduce social desirability bias and ensure free and frank answers to immunization questions, interviewers were trained to develop a good rapport with the mothers/caregivers and to reiterate that their responses would remain confidential (Nederhof, 1985). In the end, a positive response to DPT use, when using the vaccination cards or self-reports, was coded as a positive outcome in the dependent variable.

Using this measure, 22.4% of the women in the sample immunized their child at least once against DPT. As expected, the coverage rate was much lower for children in low immunization villages (15.6%) than children in high immunization villages (27.5%). However, this difference was not larger because 1) immunization coverage was estimated using a sampling unit of 0 rather an absolute unit of 0 (see "Sampling Procedures" section above) and 2) the survey instrument used to measure immunization coverage among children in the sampling frame relied on general, rather than immunization specific questions about immunization use. This more general line of questioning could have upwardly biased DPT coverage among children

in the sampling frame. With more question specificity, this study captures a lower, yet arguably more accurate estimate of DPT coverage.[20]

Predictors: Social Network Norms

This dissertation draws on definitions of injunctive and descriptive norms used to examine immunization behaviors in other settings (Allen et al., 2009; Paulussen et al., 2005). In this study, injunctive norms are defined as mothers/caregivers' perceptions of their opinion leaders and peers' attitudes towards immunizations, while descriptive norms are mothers/caregivers' observations of their opinion leaders and peers' vaccination behaviors.

Injunctive norms. Injunctive norms around immunizations were measured as the *distribution of opinion leaders and peers' perceived attitudes towards immunizations within the mothers/caregivers' network.* This construct was measured as the range of opinion leaders and peers' perceived attitudes towards immunizations in the mothers/caregivers' network divided by the total number of opinion leaders and peers in their network. What is unique about this variable is that it captures the degree to which supportive, ambivalent, and dissonant attitudes towards immunizations are dispersed within each network. The numerator of this variable was assessed by asking mothers/caregivers' whether each of their opinion leaders and peers approved or disapproved of immunizations. This variable, originally measured on a six-point scale ranging from strongly disapproves to strongly approves, was transformed into a three-category variable with "0" representing *Disapproves of Immunizations* (defined as strongly disapproves and disapproves of immunizations), "1" representing *Ambivalence towards Immunizations* (defined as accepts, but has fears, worries, and concerns about immunizations, and not sure), and "2" representing *Approves of Immunizations* (defined as strongly approves/approves of

[20] The DPT vaccine shortage in 2011 and the early part of 2012 is not a viable explanation for the minor difference in immunization coverage found among mothers/caregivers in this dissertation since the DPT vaccine shortage in 2011 did not start until *after* the study period (GAVI Alliance, 2012).

immunizations). The range of opinion leaders and peers' perceived attitudes towards immunizations was then calculated.

The denominator of this variable was measured as the total number of opinion leaders and peers in the mothers/caregivers' networks. The denominator ranged on a 0-4-point scale for opinion leaders and on a 0-3-point scale for peers since a maximum of four opinion leaders and three peers could be nominated by mothers/caregivers' during their interviews. To be consistent with the theoretical conceptualization of injunctive norms, mothers/caregivers with no opinion leaders or peers in their network (a total of 20 women had no opinion leaders and 160 women had no peers) were excluded from this measure. It was assumed that mothers/caregivers without opinion leaders or peers could not develop perceptions of their normative beliefs towards this health service.

Using the numerator and denominator described above, I created a variable capturing the total distribution of opinion leaders and peers' perceived attitudes towards immunizations in the mothers/caregivers' networks. This variable was measured on an increasing 0-6 scale with the following coding structure: "0" indicates *All network members are perceived to disapprove of immunizations*; "1" indicates *Most network members are perceived to be ambivalent towards immunizations and a minority of the network is perceived to disapprove of immunizations*; "2" indicates *All network members are perceived to be ambivalent towards immunizations*; "3" indicates *Most network members are perceived to be ambivalent towards immunizations and a minority of the network is perceived to approve of immunizations*; "4" indicates *Network members are perceived to be equally divided as ambivalent and supportive of immunizations*; "5" *Most network members are perceived to approve of immunizations*; and, finally, "6" indicates *All network members are perceived to approve of immunizations*. This variable was

measured separately for opinion leader and peer networks. I collapsed the categories of these variables in different ways in the descriptive and main analyses. A description and justification for the variable conversions accompanies the analyses in Chapters 4 and 5.

Descriptive norms. Descriptive norms around immunizations were assessed as the percentage of opinion leaders and peers within the mothers/caregivers' network that were observed to immunize their child. This construct was measured as the number of opinion leaders and peers observed to immunize their child in the mothers/caregivers' network divided by the total number of opinion leaders and peers in their network. The numerator of this variable was assessed by asking mothers/caregivers how they knew that each of their opinion leaders and peers approved or disapproved of immunizations. Mothers/caregivers who reported that they did not observe their opinion leaders or peers immunize their own child earned a score of "0." Mothers/caregivers who reported that they knew their opinion leaders and peers' attitudes towards immunizations as a result of observing them immunize their own child earned a score of "1." The total number of opinion leaders and peers in the mothers/caregivers' network that were observed to immunize their own child was then calculated. Similar to the injunctive norms measure, the denominator of this variable was measured as the total number of opinion leaders and peers in the mothers/caregivers' networks.

Using the numerator and denominator described above, I created a variable capturing the percentage of opinion leaders and peers in the mothers/caregivers' networks that were observed to immunize their own child. This variable was coded on an increasing 0-1 scale, with "0" indicating a network where *None of the opinion leaders or peers were observed to immunize their child* and "1" indicating a network where *All of the opinion leaders or peers were observed to immunize their child*. Unlike the injunctive norms measures, mothers/caregivers with no

opinion leaders or peers in their network were automatically assigned a score of "0." This is based on the assumption that it is not possible to observe people within a network immunize their children if a network does not exist in the first place. The final variable was measured separately for opinion leader and peer networks.

Similar to the variables measuring injunctive norms, I collapsed the categories of this variable in the descriptive and main analyses. A description and justification for the variable conversions accompanies the analysis in Chapters 4 and 5.

Underlying Factors: Social Learning versus Social Control

Peer network density. Peer network density is the only measure unique to the peer analysis. This variable is important because it ascertains whether the theorized factors of social learning and social control are underlying the influence of injunctive and descriptive norms on behavior (Kohler et al., 2001; Montgomery & Casterline, 1996). *Peer network density* was assessed by asking mothers/caregivers whether each of their peers knew each other. A matrix listing all network contacts was used to identify these connections. This variable was measured as the number of perceived connections between the mothers/caregivers' peers divided by the total number of possible connections between them. Only one tie (based on two peer nominations) or three ties (based on three peer nominations) were possible since a maximum of three peers could be nominated during interviews. Mothers/caregivers with 0 to 1 peers automatically received a density score of "0" since no connections were possible with such a limited number of network partners. This variable was transformed into a dichotomous variable, with "0" representing *Not all Peers were Connected* and "1" representing *All Peers were Connected*. This variable was dichotomized because network densities between 0% and 100 %

were relatively rare – only 10% of mothers/caregivers reported having network densities within this range.

Moderators: Closeness & Frequency of Communication

Closeness. Closeness is traditionally measured by asking respondents to classify their network partners as acquaintances, just friends, or confidants (Granovetter, 1973). Given the differences in relationship formality between mothers/caregivers, their opinion leaders, and peers, I revised this traditional measure so that it had more face validity. To more accurately capture closeness between mothers/caregivers and opinion leaders, I asked mothers/caregivers if they ever turned to each of their opinion leaders for guidance or help in the face of a difficulty, such as a family conflict, feud, or health emergency. This question was measured on a 0 to 1 scale, with "0" representing *No* and "1" representing *Yes*. A response of "No" and "Yes" was assumed to signify *Not Close* and *Close*, respectively.

Closeness between mothers/caregivers and opinion leaders was ultimately measured as the total number of opinion leaders in the mothers/caregivers' network that they were close to divided by the total number of opinion leaders in the mothers/caregivers' network. The denominator (the total number of opinion leaders in the mothers/caregivers' networks) was on a 0-4-point scale since a maximum of four opinion leaders could be nominated by mothers/caregivers' during their interviews. The final variables was coded on an increasing 0-1 scale, with "0" indicating that the mothers/caregivers were close to *None of the Opinion Leaders in their Network* and "1" indicating that they were close to *All of the Opinion Leaders in their Network*. Mothers/caregivers with no opinion leaders in their network were automatically assigned a score of "0" because it is impossible to be close to someone that does not exist.

Closeness in peer networks, however, was assessed using the traditional approach indicated above (Granovetter, 1973). Following this approach, peers categorized as *Acquaintances* or *Just Friends* were coded as a "0" and peers categorized as *Confidants* were coded as a "1." The total number of peers in the mothers/caregivers' network that they were close to was then calculated.

The denominator of this variable was measured as the total number of peers in the mothers/caregivers' networks. The denominator ranged on a 0-3-point scale since a maximum of three peers could be nominated by mothers/caregivers' during their interview. Mothers/caregivers with no peers in their network were automatically assigned a score of "0" since they could not be close to someone that does not exist. This new variable was coded the same way as the *closeness to opinion leader networks variable*, on an increasing 0-1 scale, with "0" indicating that the mothers/caregivers were close to *None of the Peers in their Network* and "1" indicating that they were close to *All of the Peers in their Network*. I collapsed the categories of these variables in the descriptive and main analyses. A description and justification for the variable conversions accompanies the analysis in Chapters 4 and 5.

Frequency of communication. Frequency of communication about immunizations in opinion leader/peer networks was measured as the number of opinion leaders and peers in the mothers/caregivers' network that they had frequent communication with about immunizations divided by the total number of opinion leaders in their network. The numerator of this variable was measured by asking mothers/caregivers how often they communicated with their opinion leaders and peers about immunizations. This variable, originally measured on a three-point scale, ranging from never, once, twice, to three times or more, was transformed into a dichotomous variable with "0" representing *Infrequent Communication about Immunizations*

(defined as less than three times) and "1" representing *Frequent Communication about Immunizations* (defined as three times or more). I used the "three times or more" category on the scale to signify *frequent communication about immunizations* since, in the health communications field, this is the number of times a message needs to be heard in order to have impact (Schooler, Chaffee, Flora, & Roser, 1998). The total number of opinion leaders and peers in the mothers/caregivers' network that they frequently communicated with about immunizations was then calculated.

The denominator of this variable was measured as the total number of opinion leaders and peers in the mothers/caregivers' networks. Mothers/caregivers with no opinion leaders or peers in their network were automatically assigned a score of "0." This is because mothers/caregivers cannot communicate with individuals in their network if a network does not exist. This new variables were coded on an increasing 0-1 scale, with "0" indicating mothers/caregivers frequently communicated about immunizations with *None of the Opinion Leaders or Peers in their Network*" and "1" indicating that they frequently communicated about immunizations with *All of the Peers or Opinion Leaders in their Network*.

This variable was measured separately for opinion leader and peer networks. I collapsed the categories of these variables in the descriptive and main analyses. A description and justification for the variable conversions accompanies the analysis in Chapters 4 and 5.

Confounders: Individual & Relational Factors

Variables that theoretically impact social network selection (i.e., factors that might lead mothers/caregivers to choose a particular group of friends and leaders) and immunization use (Adeyinka, Oladimeji, Adeyinka, & Aimakhu, 2009; Antai 2009a, 2009b, 2010; Babalola, 2009, 2011; Bhuiya, 1995; Eng et al., 1991; Lee, 2005; Ngowu et al., 2008; Streefland & Chowdhury,

1999) were also included. These variables comprise measures of socio-demographic characteristics, previous health-seeking behavior and physical access, immunization exposure and coverage, and key social network partner characteristics. The socio-demographic variables were measured using data collected as part of a 2011 census in Bungudu. The other confounders were measured using data from the mothers/caregiver and opinion leader surveys and the GIS form. Table 3 lists all of the confounding variables, along with the coding structure, that were considered for inclusion.

Table 3

Constructs & Measurements

Construct	Measurement	N	Range	Mean	Std. Dev.
Dependent Variable					
Immunization Use	Immunized child at least once against DPT	525	0,1	.226	.419
Main Predictor Variables					
Injunctive norms around IZ in opinion leader network*	% with a majority of opinion leader network perceived to support immunizations	510	0,1	.249	.432
Injunctive norms around IZ in peer network*	% with a majority of peer network perceived to support immunizations	356	0,1	.724	.447
Descriptive norms around IZ in opinion leader network	% with a majority of opinion leader network observed to immunize their own child	537	0,1	.344	.475
Descriptive norms around IZ in peer network	% with a majority of peer network observed to immunize their own child	537	0,1	.450	.498
Moderators & Mediators					
Perceived density of peer network	Less than all peers versus all peers are perceived to know each other	537	0,1	.473	.499
Frequency of communication about IZ in opinion leader network	% of opinion leader network that communicated with mother/caregiver about immunizations frequently (> 3 times)	537	0,1	.117	.322
Frequency of communication about IZ in peer network	% of peer network that communicated with mother/caregiver about immunizations frequently (> 3 times)	537	0,1	.167	.373
Closeness in opinion leader network	% with a majority of opinion leader network that is close to mother/caregiver	525	0,1	.213	.410
Closeness in peer network	% with a majority of peer network that is close to mother/caregiver	537	0,1	.271	.445

*Mothers/caregivers with 0 peers (N = 160) or opinion leaders (N = 20) were excluded from this analysis.

** These variables are missing data because no information was provided for one, or all, of the units used in their calculation.

Table 4

Measurement of Confounders

Confounding Variables	Measuring & Coding Structure
Socio-Demographic Characteristics	Maternal Age: 1 = 14-17 yrs, 2 = 18-24 yrs, 3 = 25-34 yrs, 4 = 35> yrs Marital Status: 1 = married, 2 = widowed Relationship to Child: 1 = mother, 2 = other caregiver Household Wealth[a]: Composite index: 1 = poorest; 2 = middle; 3 = richest Education Level: 0 = never attended; 1 = primary; 2 = secondary; 3 = Quranic school only Wife Status: 1 = 1st wife, 2 = 2nd wife, 3 = 3rd wife, 4 = 4th wife Religion: 1 = Muslim, 2 = Christian Ethnic Group: 1 = Hausa; 2 = Kanuri; 3 = Fulani
Health-Seeking Behavior and Physical Access	Previous experience seeking other care for child: 0 = never, 1 = ever Distance to health facility providing IZ services[b]: 0 = <5 kilometers, 1 = 5-10 kilometers, 2 = >10 kilometers
Immunization Exposure and Coverage	Previous Media Exposure about IZ: 0 = never, 1 = in 1 or more months, 2 = within the last month Number of Health Professionals Talked to about IZ: numeric, ranging from 0-5
Social Network Partner Characteristics	Perceived Husband Support for IZ: 0 = disapproves of IZ; 1 = ambivalent towards IZ; 2 = approves of IZ Degree centrality[c] numeric, total number of nominations of a specific leader; total number of nominations of each category of peer

[a]Household wealth was estimated using an index adapted from the DHS wealth index – the mostly commonly used measure of socio-economic position in developing countries (Rutstein & Johnson, 2004; Filmer & Pritchett, 2001). This index includes 14 asset indicators: ownership of durable assets (clock/watch, car, refrigerator, bicycle, stereo/radio, television, motorcycle); ownership of farming assets (work animals and land); and the housing quality (dwelling made out of high quality materials, uses high quality cooking fuel, and access to good toilet facilities, safe water, a waste disposal system, and electricity). These variables were each measured on a 0-1 scale and combined with equal weight to create a 14-point scale. Women in households with 0-4, 5-9, and 10+ assets were categorized in the lowest, middle, and highest wealth quintiles in their communities.

[b] Straight-line (geodesic) distances in meters were calculated using the ArcGIS 10. These data were exported into Stata 10.0 and converted into kilometers. The distance data was then categorized into the three categories often used to predict basic health service use in rural areas in developing countries (Kadobera et al., 2012; Larson et al., 2012; Mwaniki et al., 2002).

[c] Degree centrality is the extent to which an individual/or group of individuals is positioned near the center of a network. The number of times a specific social network contact is mentioned is the simplest way to identify the most central individuals in a network (Scott, 2000). I used this approach to measure the degree centrality of opinion leaders. However, I was not able to use this approach to measure the degree centrality of peers. Because mothers/caregivers were required to nominate peers within their own compounds, peers were limited in terms of the total number of nominations that they could receive. In fact, only 104 of the 805 peers in the sample (12%) were nominated more than once. Of these 104 peers that were nominated more than once, 84 of them (80%) were nominated twice. For this reason, I conducted an alternative analysis that captured the centrality of each type of peer group in the sample.

Statistical Analysis

Validating Measures of Injunctive Norms

Before testing the study hypotheses, I assessed the accuracy of the mothers/caregivers' reports regarding their opinion leaders and peers' attitudes towards immunizations. Depending on these results, I improved the measures to make them more valid indicators of injunctive norms towards immunizations. I decided to assess the validity of the measures of injunctive norms rather than descriptive norms because the former has been shown to be inferred to a greater extent than the latter. For example, a meta-analysis conducted by Borsari and Carey's (2003) on the role of injunctive and descriptive norms on a range of health outcomes found that more people misperceived injunctive norms than descriptive norms. This trend was indicated by much larger self-other discrepancies (SODs; i.e., a measure of how well people accurately predict the preferences of others) for injunctive norms than descriptive norms in the studies (Borsari & Carey, 2003). This finding is noteworthy, given that the meta-analysis rendered 102 separate tests of SODs for descriptive and injunctive norms with over 53,000 participants

The authors hypothesized that people are better able to report on descriptive norms than injunctive norms because the former requires individuals to directly observe the behavior of interest, while the other does not (Ajzen & Fishbein, 2005). Direct observations of a behavior lead to more accurate and stable cognitions than general perceptions of how people view it. The sense of certainty that goes along with direct observations ultimately leads people to provide more accurate reports of their behaviors than their attitudes (Ajzen & Fishbein, 2005; Doll & Ajzen, 1992).

I also feel more confident that the descriptive norm reports are more accurate than the injunctive norm reports because of how data on descriptive norms was collected. The questions

capturing the information used to measure descriptive norms – whether their opinion leader or peer immunized their child – were specified in a way that would help to overcome bias in reporting. Instead of asking mothers/caregiver if their peers and opinion leaders ever immunized their child, the mothers/caregivers were asked to name the ways in which they observed their opinion leaders and peers express their attitudes towards immunizations. Immunizing their child was one way that opinion leaders and peers could express support for this health service. I specified the survey question in this more indirect way so that respondents felt less impelled to over-state their social contacts' use of childhood immunization services.

For these reasons, I assume that the data collected on descriptive norms are accurate, while the data collected on injunctive norms need to be validated. Assessments of the validity of injunctive norms around immunizations for opinion leaders and peers are below. An overview of these tests and their results, and the strategy for improving these measures, if deemed necessary, is included.

Perceived opinion leader support for immunizations. To assess the accuracy of opinion leader reports, I first assessed the level of agreement between the mothers/caregivers' reports and the opinion leaders' own reports about their attitudes towards immunizations. I used the *observed percentage of agreement* instead of the *kappa statistic* to measure the level of agreement between these reports since statements of immunization disapproval were rare (only 4% of mothers/caregivers and < 1% of opinion leaders reported that opinion leaders disapproved of immunizations). When observations for an event are rare, low kappa values do not necessarily reflect the rate of agreement that exists between observers (Viera & Garrett, 2005). For this reason, the *observed percentage of agreement* is instead used to capture this information.

This issue is empirically indicated by a relatively high *observed percentage of agreement* and a low *kappa* score.

In this study, the *overall percentage of agreement* between the mothers/caregivers' reports and the opinion leaders' reports regarding their attitudes towards immunizations was relatively high (74.76%) and the kappa score was very low (.02). Even though the *observed percentage of agreement* between the mothers/caregivers reports and the opinion leaders' own reports was relatively high (74.76%), it is still below the 85% benchmark used to indicate confidence in reporting (Jager, 2005; Laumann, Marsden, & Presndky, 1983; Viera & Garrett, 2005).

There are three primary reasons that the mothers/caregivers' reports may differ from opinion leader reports regarding their attitudes towards immunizations. First, mothers/caregivers might have *limited access to information* about their opinion leaders' views towards immunizations. This might be a result of having infrequent contact or information exchanges with their opinion leaders about immunizations (Jager, 2005). The second reason that mothers/caregiver reports and opinion leader reports may differ is *projection bias*. Projection bias is when an individual incorrectly attributes his or her own beliefs or behaviors to her social contacts, artificially increasing the observed correlation between the behaviors of social contacts and an overestimation of their influence (Ross, Greene, & House, 1976).

The third reason that mother/caregiver reports and opinion leader reports may differ is *social desirability bias*. Social desirability bias is the tendency of respondents to answer questions in a manner that will be viewed favorably by others (King & Bruner, 1999). This response bias occurs mainly for questions that deal with personally or socially sensitive content (Crowne & Marlowe, 1964). Given normative pressure on opinion leaders to support this health

service in northern Nigeria, it is possible that social desirability bias influenced both the mother/caregivers' and opinion leaders' reports.

As described in Chapter 2, the Nigerian government and international community have made a concerted to improve immunization coverage rates in northern Nigeria over the last decade (PRRINN-MNCH, 2010). One way that these actors have tried to increase immunization use is by engaging local opinion leaders in their immunizations activities. For example, opinion leaders have been invited to immunization-related advocacy meetings and sensitivity workshops and included in social mobilization teams to convince people to immunize their children (GPEI, 2010; PRRINN-MNCH 2010). By getting local leaders to buy-into the public health benefits of immunizations and participate in campaigns, the government and international community hope to increase demand for this health service.

It is possible that the pressure faced by opinion leaders to support immunizations led them to over-state their support for immunizations during their interviews. This is especially plausible given village chiefs' political motives to express support for immunizations (e.g., they sometimes get financial incentives for getting their community involved in immunization activities; Doctor, personal communication, June 29, 2013) and the fact that the use of immunizations fundamentally conflicts with some religious leaders' beliefs (e.g., the belief that Allah alone is the source of all illness and cure; Renne, 2010) and traditional healers' medicinal alternatives (e.g., herbal medicines and spirit worship; Renne, 2010) for preventing childhood death and disease. This normative pressure that opinion leaders face to support immunizations may have trickled down to mothers/caregivers, leading them to also over-state their opinion leaders' level of support towards this health service.

To test the plausibility of the first explanation for the incongruence in reporting – that mothers/caregivers did not have *access to sufficient information* to accurately report on their opinion leaders' attitudes towards immunizations – I first assessed the level of direct contact and communication that mothers/caregivers had with their opinion leaders about immunizations. The analysis shows that 53% (288 of the 537 women) of the mothers/caregivers had frequent contact (defined as interacting a few times a week or daily) with at least one of their opinion leaders and that 47% of them (254 of 537 women) communicated frequently (defined as more than three times) with at least one of their opinion leaders about immunizations. With just around half of the mothers/caregivers in the sample in frequent contact and communication with an opinion leader about immunizations, I cannot assume that they had sufficient information to generate accurate reports about their attitudes towards immunizations.

I therefore conducted a second analysis in order to compare opinion leaders' reports on how they wielded their support for immunizations to mothers/caregivers' reports on this same topic. If mothers/caregivers accurately reported on their opinion leaders' involvement in immunization activities, and they were able to do this regardless of their level of contact and communication with their opinion leaders about immunizations, then I could conclude that they had enough information to accurately report on their opinion leaders' attitudes towards this health service. The formal analysis resulted in a very high level of observed agreement between the two reports on how opinion leaders wielded their support for immunizations (90.81%). This level of agreement is notable given that the survey questions capturing this information were open-ended, requiring opinion leaders to name the range of immunization activities that they participated in and mothers/caregivers to recall their opinion leaders' involvement in these activities.

The level of agreement between these reports was also not statistically different across mothers/caregivers with infrequent contact (88% agreement) versus frequent contact (92% agreement) with their opinion leaders (two-sample test of proportions, $p = .260$) and mothers/caregivers with infrequent communication (90% agreement) versus infrequent communication (94% agreement) with their opinion leaders about immunizations (two-sample test of proportions, $p = .269$). I therefore concluded that mothers/caregivers had sufficient information to make claims about their opinion leaders' views towards immunizations and that their incongruence in reporting is thus, most likely due to other forms of bias.

To test the plausibility of the second explanation for incongruent reporting, *projection bias*, I conducted a statistical test commonly used by researchers to test for this type of bias (Hogset & Barrett, 2010). This test was a comparison of the correlation between the mothers/caregivers' own attitudes towards immunizations and their perceptions of their opinion leaders' attitudes towards immunizations, to the mothers/caregivers' own attitudes towards immunizations and their opinion leaders' actual attitudes towards immunizations. Even though the aforementioned correlations were relatively low, the former correlation was still weaker (22%) than the latter correlation (39%), signaling that it is unlikely that projection bias influenced this injunctive norms measure.

Since the incongruence in mother/caregiver and opinion leader reporting about opinion leader attitudes towards immunizations does not seem to be due *insufficient access to information* or *projection bias*, it seemed plausible that social desirability bias is threatening the validity of these reports. To address this bias and obtain a more reliable estimate of injunctive norms towards immunizations within the mothers/caregivers' opinion leader networks, I used a latent variable approach. The latent variable approach assumes that reports from multiple

informants are more reliable than reports from a single informant because it captures a range of true score variance, systematic variance unique to the perspective of the rater, and error variance (Cook & Goldstein, 1993; Moskowitz & Schwarz, 1982; Schwarz, Barton-Henry, & Pruzinsky, 1985). Therefore, by aggregating reports from multiple informants, the systematic variance due to the shared perceptions of the informants will cumulate, but the random effects of the errors in measurement will not (Cook & Goldstein, 1993). This ultimately improves the ratio of true score variance to error variance (the reliability) for aggregated reports as compared to single rater reports. Different from other models, the latent variable model is recommended for studies with this type of data because it is also able to provide statistical controls for rater effects (Cook & Goldstein, 1993).

Since I believe that the opinion leader reports on their attitudes towards immunizations are influenced by bias and I have multiple reports of a majority of the opinion leaders' views towards immunizations,[21] I use the latent variable approach to obtain a more reliable estimate of their injunctive norms towards immunizations. To operationalize this approach, I used a mixed linear model with a random intercept. The equation for estimating this model is below.

$$\mathbf{Y_{ij}=\alpha+\beta_1X_{1ij}+\ldots+\beta_8X_{8ij}+\quad+}$$

[21] Even though more than three-quarters of the opinion leaders in the sample were rated by multiple mothers/caregivers (79% of the 149 opinion leaders were rated by more than 1 mothers/caregiver), 21% of them (N = 30) were rated by only one mother/caregiver. This means that a more reliable estimate of opinion leaders' attitudes towards immunization could not be generated for 21% of the sample. This is a study limitation that is described in greater length at the end of Chapter 6.

In this model, Y_{ij} is the opinion about immunizations of leader j as perceived by woman i, with women i clustered in leader j. X_1 to X_8 are the covariates.[22] is the random intercept varying over leaders (level 2) and is the woman rating (or woman-leader) specific error term.

Once I ran this latent variable model, I used a random effects post-estimation procedure in order to retrieve predicted errors for each opinion leader in the sample. I used the *e(sample)* procedure to make sure that predicted values were generated for all the opinion leaders and that mothers/caregivers who were dropped from the model, because of missing values for some of the regressors (a total of 39 mothers/caregivers), were re-included in the sample. Next, I used the summary procedure to make sure that the predicted values imputed for each opinion leader in the sample was the same for each of their observations. The results showed that all of the leaders in the sample earned the same predicted value.

After cross-checking the predicted values generated from the random effects procedure, I used the percentile distribution of these errors (20/40/60/80) to generate the new categories of the opinion leader injunctive norms variable. A table comparing the distributions of the original variable generated from mothers/caregivers' reports about each of their opinion leaders' views towards immunizations and the new variable generated from the latent variable approach is below (Table 5). The new variable, which is used in all proceeding analyses, was reconstructed in the same way as the peer injunctive norms variable described in the "Measures" section above.

[22] The woman-level covariates in the model are: number of years lived in village, age, education level, household wealth, size of uncensored network, frequency of contact with leader, closeness to leader, and degree centrality of leader.

Table 5

Comparison of the Distributions of the Original & New Variable Measuring Opinion Leader Attitudes towards Immunizations

Response Categories	*N*[a] (%) Original Measure	*N*[a] (%) New Measure
Unsupportive	17 (1.3)	418 (40.2)
Ambivalent	338 (26.8)	260 (25.0)
Supportive	907 (71.9)	362 (34.8)
Missing[b]	8	230

[a] The total number of mother/caregiver-opinion leader observations (pairs) in the sample is 1,270. *N* is based on the range of 0 to 4 opinion leaders that each mother/caregiver in the sample nominated in their network.
[b] The missing observations for the new variable comprise of opinion leaders that were dropped from the analysis because they had missing values for too many of the regressors in the latent variable model. As indicated in the text, I used a strategy to re-include those opinion leaders who were dropped from the analysis. However, only 39 observations were recovered through this procedure. The observations that could not be recovered through this procedure had missing values for two or more of the variables in the model.

After generating the new measure of opinion leaders' perceived support for immunizations, I conducted a sensitivity analysis to assess whether this new measure was a good surrogate of opinion leaders' actual support for immunizations. Since opinion leaders' reports about their attitudes towards immunizations are influenced by social desirability bias (as described in the earlier part of this section), I used their reports on the range of immunization activities that they participated in as a proxy of their level of support for this health service. As explained previously, this measure is reliable, since it was very, highly correlated with mothers/caregivers own reports about their leaders' involvement in immunization activities. For this reason, I felt comfortable using this measure as an indicator of opinion leaders' actual support for immunizations.

For the purposes of this analysis, I recoded the variable measuring the range of immunization activities that leaders reported participating in on an increasing 0-1 scale, with "0" representing *No Participation in Immunization Activities* or *Disapproval of Immunizations* and "1" representing *Participation in Three or More Immunization Activities* or *Approval of Immunizations*. If the new variable measuring opinion leaders' perceived attitudes towards

immunizations is a better measure, in other words, a good surrogate of their actual attitudes towards immunizations, I expected there to be a statistically significant relationship between the two variables. The sensitivity analysis results provided support for this claim by showing a statistically significant relationship between the new variable measuring opinion leaders' perceived attitudes towards immunizations and opinion leaders' actual attitudes towards immunizations (chi-square test, $p = .034$).

Perceived peer support for immunizations. To evaluate the accuracy of peer reports, I first assessed the level of agreement between the mothers/caregivers' reports and the peers' own reports about their attitudes towards immunizations. I used the same methodological approach used in the opinion leader analysis to make this comparison. Different from the opinion leader analysis, however, I did not collect data directly from peers about their attitudes towards immunizations. I therefore had to deduce peers' self-reported views towards immunizations from the 118 mothers/caregivers in the study that were also nominated as peers. In the end, the *overall % of agreement* between the mothers/caregivers' reports and the peers' own reports regarding immunizations was a high 97.92%. This *percentage of agreement* is well above the 85% benchmark used to indicate confidence in reporting (Jager, 2005; Laumann et al., 1983; Viera & Garrett, 2005). I, therefore, feel confident that the mothers/caregivers' reports about their peers' attitudes towards immunizations are accurate.

As indicated in the opinion leader analysis, having access to sufficient information about people's views is a critical part of being able to provide accurate reports about them. To qualify that mothers/caregivers had sufficient information to accurately report on their peers' attitudes towards immunizations and that the high level of agreement between the mothers/caregivers' reports and peers' own reports about immunizations is not am empirical fallacy, I assessed the

level of contact and communication about immunizations between mothers/caregivers and their peers. The results show that 67% (361 of the 537 women) of mothers/caregivers had frequent contact (defined as interacting a few times a week or daily) with at least one of their peers and that 64% of them (341 of the 537 women) communicated frequently (defined as more than three times) with at least one of their peers about immunizations. With nearly two-thirds of the mothers/caregivers in the sample reporting that they have frequent contact and communication with a peer about immunizations, I feel more comfortable using data from the mothers/caregivers' reports to measure their injunctive norms towards immunizations.

To ensure that this is the case, I conducted a test to rule out that *projection bias* was also present in this study. I tested whether projection bias in particular was present, given that this type of bias is the primary threat to accurate reporting of peer attitudes and behaviors in ego-centric network studies (Hogset & Barrett, 2010). In ego-centric network studies, projection bias occurs when an individual incorrectly attributes his or her own beliefs about a topic to his or her peers. If the peers' beliefs differ, the observed correlation between the attitudes of the peers is biased. This leads to an overestimation of peer influence in analyses (Ross, Green, & House, 1976).

To determine whether or not *projection bias* influenced mothers/caregivers' reported opinions about their peers' attitudes towards immunizations, I conducted the same, accepted statistical tests used in the opinion leader analysis (Hogset & Barrett, 2010). I compared the correlation between mothers/caregivers own attitudes towards immunizations and their perception of their peers' attitudes towards immunizations to the mothers/caregivers own attitudes towards immunizations and the peers' actual attitudes towards immunizations. The former correlation was much weaker (32%) than the latter correlation (87%), which signals that

projection bias was not influencing this measure. In this study, I, therefore, follow suit with the practice of experienced social networks scholars (e.g., Bandiera & Rasul, 2006; Behrman et al., 2002) and use mothers/caregivers' reports about their peers' attitudes towards immunizations as a measure of injunctive norms.

Testing Study Hypotheses

The following steps were taken to analyze the study data. First, bivariable selection (BVS) analysis was used to select the variables, listed in Table 4, to include as confounders in the analyses. Those variables that emerged as statistically significant predictors of DPT use at the .10 level were included. These variables were: relationship to child; distance to a health facility providing immunization services; previous experience seeking care for child; number of health professionals talked to about immunizations; previous media exposure about immunizations; husband's perceived views towards immunizations. The more conservative, .10 *p* was used as the BVS cut-off so that I did not reject any potentially important variables, properly controlled for confounding (Sun, Shook, & Kay, 1996), and accounted for measured selection effects.[23]

Next, logistic regression models with robust standard errors (SE) and multi-level models were run, using the *logit* and *xtlogit* functions, to test the study hypotheses. The benefit of using the multi-level modeling approach is that it assumes a hierarchical or clustered data structure. With this analysis strategy, it is therefore possible to utilize sampling units at different levels in order to model inferences at the individual level (Goldstein, 1999). The multi-level models in

[23]A fundamental challenge in estimating social network effects is that individuals tend to select peers who are similar to themselves. The threat in this study is that IZ users may choose peers based on their IZ status and that non-IZ users may choose peers based on their non-IZ status. When relationships are determined because of common IZ behaviors, the IZ behaviors of peers will be correlated, but this correlation will reflect peer selection rather than peer influence.

this study were run as one-level hierarchical mixed effect models, adjusting for clustering at the compound[24] and village levels.[25]

When running the logistic and multi-level models, all predictors and confounders were simultaneously added, unless otherwise specified in the equations below. A log likelihood ratio test, using the *lrtest* function, was then used to compare the fit of the logistic and mixed-effects models. In all cases, the mixed-effects models were a better fit than the logistic models ($p < .05$), given the multi-level structure of the data. For this reason, I only present the results of the mixed-effects models in this dissertation. Unstandardized regression coefficients with corresponding confidence intervals were used to interpret all results, unless otherwise specified. Stata version 12 was used to conduct all modeling (StataCorp; College Station, TX, USA).

Equations

Testing the influence of injunctive & descriptive norms on immunization use. The equations for testing the hypotheses on the positive effects of injunctive and descriptive norms on mothers/caregivers routine immunization use are below.

Injunctive norms hypotheses.

Hypothesis 1A: Mothers/caregivers who perceive that a majority of the opinion leaders in their network support immunizations will have a higher likelihood of immunizing their child.

Hypothesis 1B: Mothers/caregivers who perceive that a majority of the peers in their network support immunizations will have a higher likelihood of immunizing their child.

[24] A random effect at the compound-level accounts for the fact that all peers live in the same compound as the main respondents and that their networks of leaders may also be the same given that they share a family and a home.

[25] Fixed effects at the village level were included to reduce heterogeneity across the 22 paired villages in this study.

Descriptive norms hypotheses.

Hypothesis 2A: Mothers/caregivers who observe a majority of their opinion leaders in their network immunize their child will have a higher likelihood of immunizing their own child.

Hypothesis 2B: Mothers/caregivers who observe a majority of their peers in their network immunize their child will have a higher likelihood of immunizing their own child.

The model used to estimate Hypotheses 1A-2B was:

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \quad)} \qquad (1)$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and j representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents the measures of injunctive norms or descriptive norms. is the random intercept varying over compounds (level 2). The only difference between this model specification and the model specification for the mixed effects model is that the random intercept varying over compounds was not included. This equation was modeled four times in order to estimate the independent influence of injunctive norms and descriptive norms in mothers/caregivers' opinion leader networks versus peer networks.

Confirming the underlying factors behind the influence of injunctive & descriptive norms. The following standardized model developed by Montgomery and Casterline (1996) was

used to confirm that social control underlies the influence of injunctive norms and social learning underlies the influence of descriptive norms on mothers/caregivers' immunization use:

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij} + \delta_1 (S_{18} * S_{19}) \quad)} \qquad (2)$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with *i* representing the individual and *j* representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents the measures of injunctive norms or descriptive norms. S_{19} is the density of the peer network. S_{18}*S_{19} is an interaction term of the variables measuring injunctive norms or descriptive norms and density. is the random intercept varying over compounds (level 2). This equation was estimated two times in order to test whether social control underlies injunctive norms and social learning underlies descriptive norms respectively.

According to Montgomery and Casterline (1996), if social control underlies injunctive norms around immunization use, a mother's routine immunization use would be influenced weakly by the distribution of peer support for immunizations (the measure of injunctive norms) in sparse networks, but strongly in dense networks that are exerting normative pressure. From an empirical point of view, this means that the coefficient for S_{18} will be insignificant, the coefficient for S_{19} will be significant, and δ_1 will emerge as a strong, positive factor, signaling that normative pressure is underlying the influence of injunctive norms on the mothers/caregivers' decisions to immunize.

If social learning underlies descriptive norms around immunization use, the percentage of observed immunization users (the measure of descriptive norms) in the mothers/caregivers' peer network would exert a positive influence on the mothers' use of DPT. Density would have a minor, possibly negative effect because dense networks are expected to provide redundant information. From an empirical point of view, this means that if the coefficient for S_{18} is positive and significant, the coefficient for S_{19} is insignificant, and the coefficient for δ_1 is insignificant or negative, then social learning is the main factor underlying the influence of descriptive norms on immunization use.

Comparing the influence of injunctive & descriptive norms on immunization use. In order to hypotheses 3A and 3B, which compare the influence of injunctive norms to descriptive norms on immunization use, I estimated the following equation:

Hypothesis 3A: Injunctive norms around immunizations in opinion leader networks will exert a stronger influence on mothers/caregivers' immunization use than descriptive norms.

Hypothesis 3B: Descriptive norms around immunizations in peer networks will exert a stronger influence on mothers/caregivers' immunization use than injunctive norms.

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij} ... + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij} + \quad)} \qquad (3)$$

Similar to the model used to test hypotheses 1A-2B, Pr $[Y_{ij} = 1]$ is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and *j* representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} is the measure of injunctive norms and S_{19} is the measure of descriptive norms. S_{18} and S_{19} were transformed into

standardized regression coefficients to make their units comparable. is the random intercept varying over compounds (level 2). This equation was modeled twice in order to compare the influence of injunctive norms and descriptive norms regarding immunizations in the mothers/caregivers' opinion leader networks versus peer networks.

Testing moderators of the effect of injunctive & descriptive norms on immunization use.

Hypothesis 4A: Closeness strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 4B: Closeness strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 5A: Frequency of communication about immunizations strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 5B: Frequency of communication about immunizations strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.

The models assessing whether social control underlies the influence of injunctive norms and if social learning underlies the influence of descriptive norms on mothers/caregivers' immunization use (equation 2 above) were used to test Hypothesis 4A-5B, with two specification changes. First, the covariate ($S_{19)}$, measuring density was transformed into the measure of closeness or frequency of communication about immunizations within the mothers/caregivers' networks. Second, S_{18}*****S_{19} was transformed into an interaction term of the variables measuring injunctive norms or descriptive norms and the variable measuring closeness or frequency of communication about immunizations. Also different from equation 2, this equation was estimated eight times – four times to test whether closeness strengthens the influence of

descriptive norms and injunctive norms in mothers/caregivers' opinion leader networks and peer networks respectively and four times to test whether frequency of communication about immunizations has a similar effect across the different social network norms and network types.

CHAPTER 4

DESCRIPTION OF SAMPLE & NETWORK

In this chapter, I describe the mothers/caregivers, opinion leaders, and peers in the study and contextualize how the mothers/caregivers compare to other women in northern Nigeria. I then compare the mothers/caregivers and peers across key socio-demographic characteristics, social network properties, norms, and matched villages. Comparing mothers/caregivers across matched villages allowed me to establish the efficacy of sampling procedure – that the mothers/caregivers in the study were comparable on characteristics other than immunization use. By comparing mothers/caregivers on key social network properties and norms by matched villages, I was able to provide a social network-based explanation for why some villages have higher immunization coverage rates than others. Overall, the results from this descriptive analysis informed procedures used in the main analysis and recommendations for increasing routine immunization use in northern Nigeria.

Description of Sample

Mothers/Caregivers

More than three-quarters of the 550 women interviewed for this study are between 18 years and 34 years of age. Nearly all of the women in the study are the biological mother of the child described in their interview. A small proportion of the women (3%) are caregivers, primarily responsible for the child during the mother's temporary or permanent absence. Almost all of the women are married. This is not surprising since marriage at an early age (when girls

reach menarche, usually around the age of 14) is common practice[26] (Ojanuga & Johnson, 1992; United States Agency for International Development [USAID], 2010) and out-of-wedlock births are considered a criminal offense in Muslim Hausa Nigeria (DFID, 2005; Ojanuga & Johnson, 1992).

A majority of the women in the study do not have a secular education. Ninety-six percent of the women attended Qu'ranic School, where they learned the Arabic alphabet and how to read and copy Qu'ranic texts for daily prayer. Only 2.5% attended primary and secondary school combined, and none of them earned a higher education. The secular education rate among the women is much lower than the estimates derived from other studies in the region. A recent study shows that 12% of women living in northwest Nigeria attained a primary or secondary education (Erulkar & Bello, 2007). The extremely low secular education rate among study participants, which might be a result of their rural status (NDHS, 2008), is important given that this factor has been associated with low childhood vaccination use in Nigeria (Antai, 2009a; Odusanya et al., 2008).

Nearly 100% of the mothers/caregivers in the study are in the lowest (44%) and middle (55%) wealth quintiles.[27] This is to be expected since poverty is highly correlated with place of residence in developing countries. That is, wealthier groups tend to concentrate in urban areas, while poorer groups tend to concentrate in rural areas (MEASURE Evaluation Population and Reproductive Health [PRH], 2011; USAID, 2011). This trend is important since in Nigeria, children from wealthier households are 13 times more likely to be vaccinated than children from

[26] By Islamic custom, marriages are arranged through contracts between families. In 2003, an estimated 54% of girls aged 15-24 were married by age 15 and 81% were married by age 18 in northwestern Nigeria. In rural areas in this region, two-thirds of girls were married by age 15 (Erulkar & Bello, 2007).

[27] The difference between mothers/caregivers in the middle quintile versus lowest quintile is that they own certain farming assets (cattle, sheep, goat, and poultry), durable assets (watches, bicycles, radios, motorcycles, and refrigerators, and car) and have a more sustainable source of light ($p < .05$).

poorer households (DHS, 2009). However, this trend does not hold up in the study (being in any of the wealth quintiles does not significantly predict DPT use (p = .84) because of the minimal variation in the mothers/caregivers' wealth status, which is a result of the matched sampling procedure used to control for socio-demographic differences among the study respondents.

Almost all of the mothers/caregivers in the study are their husband's first or second wife (96%). This is to be expected given that the number of wives a man has is correlated to his wealth (Hayase & Liaw, 1997). Since almost all of the mothers/caregivers are from poorer households (as described above), it is expected that they would be part of a family unit where they are their husband's only wife or second wife. This assumption was confirmed with data collected in the HDSS – 52% of the mothers/caregivers' husband's reported having one wife and 42% of them reported having two wives (N = 452).

Mothers/caregivers in low versus high immunization villages. A total of 234 of the mothers/caregivers live in low immunization villages and 316 live in high immunization villages. As expected from the matched sampling procedure, women across village groupings share similar characteristics (see Table 6). The women only differed in two ways. A higher percentage of mothers/caregivers in the high immunization villages reported that they support immunizations than mothers/caregivers in the low immunization villages (p = .00). This result is consistent with the theory tested in this dissertation that attitudes towards immunizations in a network are an important part of decision-making around this health service. Distance to a health facility that provides childhood immunization services was also different across village groupings. A higher proportion of mothers/caregivers in the low immunization villages live closer (<5 kilometers away) to a health facility that offers immunizations services then mothers/caregivers in high immunization villages (p = .00). This is the case even though their

utilization of this health service was much lower (16% versus 34 % DPT use, $p = .00$), suggesting that living closer to a health facility does not necessarily translate into greater immunization use.

Social Network Partners

Opinion leaders. The mothers/caregivers nominated a total of 208 opinion leaders. Because mothers/caregivers sometimes nominated the same leader, there are 167 different opinion leaders in the sample. Interviews were collected from 127 of these leaders, who fall into four categories – traditional healers (traditional medical providers), malams (Muslim Qu'ranic school teachers), imams (Muslim religious leader), and political chiefs (see Figure 3 for a venn diagram of the opinion leaders). A majority of the opinion leaders are religious in affiliation – 29 (23%) are imams, 20 (16%) are malams, and 44 (35%) occupy both positions. One opinion leader had religious and political influence, since he held positions as an imam, malam, and political chief.

The second largest group of sampled opinion leaders was political chiefs (20%). An overwhelming majority of sampled opinion leaders (92%) exerted influence at the village level. The remaining 8% had influence extending to the district-level. These leaders are elected District Heads, appointed Chief Imams, and appointed Deputy Chief Imams.

Table 6

Descriptive Statistics for Mothers/Caregivers

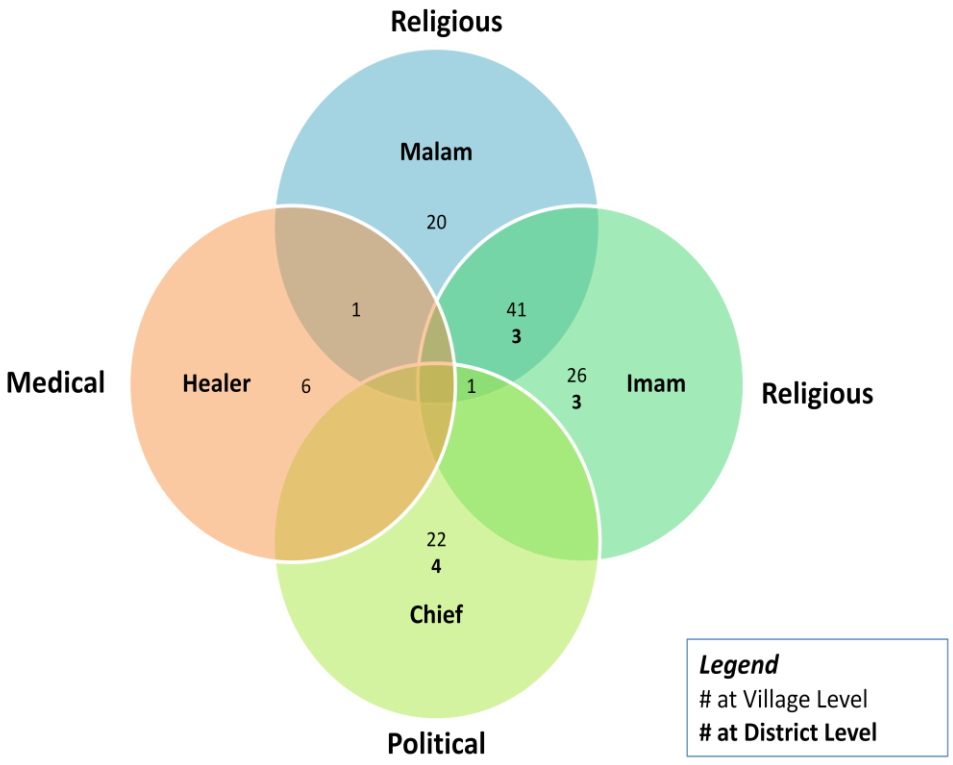
Characteristic	Low Immunization Villages		High Immunization Villages		*p* Value
	n	%	*n*	%	
Age					
14-17	22	9.40	24	7.67	
18-24	78	33.33	113	36.10	
25-34	103	44.02	130	41.53	0.761
35<	31	13.25	46	14.70	
Missing	0		0	0	
Marital Status					
Married	232	99.15	315	99.68	
Widowed	2	0.85	1	0.32	0.397
Missing	0	0	0	0	
Relationship to Child					
Mother	228	97.44	303	96.19	
Other Caregiver	6	2.56	12	3.18	0.418
Missing	0	0	1	0	
Household Wealth					
Lowest	100	42.74	150	47.47	
Middle	132	56.41	164	51.90	0.532
Highest	2	0.85	2	0.63	
Missing	0	0	0	0	
Religion					
Muslim	234	100	315	99.68	
Christian	0	0	1	0.32	0.389
Missing	0	0	0	0	
Ethnic Group					
Hausa	231	98.72	308	97.47	
Kanuri	0	0	1	0.32	0.495
Fulani	3	1.28	7	2.22	
Missing	0	0	0	0	
Education Level					
No School	2	0.88	4	1.31	
Primary School	4	1.76	5	1.64	
Secondary School	1	0.44	3	0.98	0.862
Qu'ranic School	220	96.92	293	96.07	
Missing	7	0	11	0	
Wife Status					
1st Wife	166	72.49	232	76.05	
2nd Wife	55	23.81	61	20.15	
3rd Wife	7	3.17	12	3.80	0.498
4th Wife	1	0.53	0	0	
Missing	5	0	11	0	
Distance to Health Facility					
<5 Kilometers	219	93.59	197	62.34	
5-10 Kilometers	13	5.56	72	22.78	.0000*
>10 Kilometers	2	0.85	47	14.87	
Missing	0	0	0	0	
Support for Immunizations					
Supports IZ	32	13.93	86	27.76	.001*
Missing	8		4	0	

Note. Chi-square tests were conducted to determine statistically significant differences between mothers/ caregivers in low versus high immunization villages.

*$p < .001$ between mothers/caregivers in low versus high immunization villages on the specified variable.

The smallest number of opinion leaders was from the traditional healer category (5.5% of the leaders). As described in Chapter 3, the sample of traditional healers is in part small because the field worker responsible for collecting these data found it difficult to locate them.

Figure 3. Venn Diagram of Opinion Leaders (*n* = 127)



Opinion leaders primarily wield their influence on mothers/caregivers' immunization behaviors in five ways: by immunizing their own child in public (84.8%), advocating for routine immunization before health campaigns (24.5%), dispelling myths about immunizations (17.8%), encouraging women to take their child to a clinic (16.1%), and speaking out about immunizations at meetings or sermons (15.7%). These same channels of influence were

mentioned by the mothers/caregivers during their interviews, giving me confidence in the validity of responses. In fact, the level of agreement between the opinion leaders' reports and the mothers/caregivers' reports on how opinion leaders wield their influence on immunizations was a high 90.8%[28] (see the section on validating measures of injunctive norms in Chapter 3 for a more in-depth discussion of this finding and its relevance to this dissertation). This is notable, given that the survey question capturing this information was open-ended, requiring opinion leaders to name the range of immunization activities that they participated in and mothers/caregivers to recall their leaders' involvement in these activities.

Peers. The mothers/caregivers nominated a total of 964 peers. Because the women sometime nominated the same peer, there were 805 different women in the sample (see Table 7). The socio-demographic profile of the peers was very similar to the mothers/caregivers that were interviewed. A majority of the peers are married (94%), Hausa (98%), Muslim (99.8%), have no formal education (96.5% earned their education from Qu'ranic school), and are between 18 years and 34 years of age (58%). The peers and women are also similar in respect to their co-wife and wealth status – three-quarters of them are their husband's first wife and nearly all of them fall into the lowest and middle wealth quintiles.

Peers in this study wield influence on mothers/caregivers' immunization use through more direct channels than opinion leaders. Mothers/caregivers' report that their peers primarily influence their immunization use by immunizing their own child (87.7%). The remaining mothers/caregivers' report that their peers influence their immunization use by verbally encouraging them to engage in this behavior (12.3%). Whether peers ultimately influence mothers/caregivers as a result of their perceived attitudes towards immunizations (injunctive

[28] Only those mothers/caregivers who reported that they know their leaders' views regarding immunizations were included in this analysis.

norms) or observed engagement in the use of this health service (descriptive norms) is empirically tested in the next Chapter.

Table 7

Comparison of Descriptive Statistics for Peers & Mothers/Caregivers

Measure	% Mothers/Caregivers	% Peers
Relationship To Mother/Caregiver		
Co-Wife		39.27
Friend		7.67
Sister-in-Law		20.83
Mother-in-Law		17.31
Other Female Relative		14.92
Age		
14-17	8.41	8.40
18-24	34.92	23.70
25-34	42.60	34.32
35<	14.08	33.58
Marital Status		
Never Married	0	3.21
Married	99.45	94.08
Widowed	0.55	1.24
Separated/Divorced	0	1.48
Wife Status		
1st Wife	74.56	72.57
2nd Wife	21.68	24.41
3rd Wife	3.54	2.89
4th Wife	0.22	.13
Household Wealth		
Lowest	45.45	40.25
Middle	53.82	59.01
Highest	0.73	0.75
Religion		
Muslim	99.68	99.88
Christian	0.32	0.12
Ethnic Group		
Hausa	98	97.7
Kanuri	0.18	0.37
Fulani	1.82	1.98
Education Level		
No School	1.13	0.25
Primary School	1.69	1.73
Secondary School	0.75	0.86
Qu'ranic School	96.43	97.16
N	550	964 (805)

Description of Social Networks

The mothers/caregivers' in the study have between 0 and 60 social network partners that they report *ever* communicating with about immunizations. This is an average of 8.3 and a median of 6 partners in their uncensored networks, which is slightly lower than the size of other networks centered around health behaviors in African countries (Gerland, 2004). The mean size of the mothers/caregivers' censored, or personal opinion leader and peer networks is 2.3 out of four and 1.75 out of three respectively. The median of the mothers/caregivers' censored opinion leader and peer networks is two.

Within their censored networks, a much higher percentage of mothers/caregivers perceive that most or all their peers (65%) versus most or all of their opinion leaders (24%) support immunizations. A higher % of mothers/caregivers also reported that they observed all of their peers versus all of their opinion leaders immunize their own children. Twenty-four percent of mothers/caregivers reported that they observed all of their peers immunize their children, while 16% of them observed all of their opinion leaders immunize their children. This finding is expected given that mothers/caregivers' share a compound with their peers and, therefore, have more opportunities to observe their behaviors.

The degree of closeness between mothers/caregivers, opinion leaders, and peers also varied. The mothers/caregivers feel closer to a higher percentage of their peers (27% are close to a majority of their peers) than their opinion leaders (21% are close to a majority of their opinion leaders). This finding is also expected given that mothers/caregivers share a compound with their peers and these relationships are much more informal (see Description of Sample above). The degree of closeness between the mothers/caregivers and their opinion leaders may be low because of strict formalities governing these interactions. Mothers/caregivers may engage in

conversations with their male opinion leaders (and all unrelated males) if they are granted permission from their husband, or a designated male relative in their absence, to do so. This Islamic practice, of secluding women from unrelated men, might explain why the mothers/caregivers frequently discussed (defined as three times or more) childhood immunizations with a smaller percentage of their opinion leaders (11%) than peers (16%) and also had less frequent contact (frequent contact is defined as interacting a few times a week or daily) with their leaders (28% have frequent contact with a majority of their leaders) than their peers (67% have frequent contact with a majority of their peers).

The mothers/caregivers also have rather dense peer networks, with nearly 50% of their peers connected to each other. High density is to be expected, given that all of the mothers/caregivers' peers share the same compound. These findings are consistent with other ego-centric network studies exploring kin relationships (Scott, 2000) and populations living in rural sub-Saharan Africa, as people in these areas tend to concentrate in small, relatively dense villages that provide communal life (Gerland, 2004). In terms of degree centrality,[29] there were four opinion leaders and three groups of peers that had the most nominations. The most central political chief was nominated by 82 mothers/caregivers, representing 66% of all chief nominations in his district. The most central imam earned 47 nominations (26% of all imam nominations in his district) and the most central malam earned 29 nominations (47% of all malam nominations in his district). The most central traditional healer earned a total of 13 nominations (7% of all traditional healer nominations in his district), which is significant given that this was the smallest category of opinion leaders in the study. These totals are substantial

[29] The simplest measure of degree centrality is a count of the total number of ties an actor has to other members of the network (Brass & Burkhardt, 1992). I also created a weighted measure of centrality by dividing the actual number of nominations for each opinion leader by the total number of mothers/caregivers in the district where their opinion leader leads. This measure adjusts for the fact that some districts have more mothers/caregivers that are eligible to nominate opinion leaders than others.

given that the average number of nominations dedicated to each group of leaders in the sample was much less – political chiefs earned an average of 16.5 nominations; imams earned an average of 6.6 nominations; malams earned an average of 5.7 nominations; and traditional healers earned an average of 4.4 nominations.

What is interesting about the four, most central opinion leaders in the study is that they all occupied their positions of authority for more than 10 years. They all reported being supportive of immunizations, yet only two of them – the political chief and malam – actively engaged in immunization activities, such as encouraging women to immunize their children and speaking out during meetings about the value of immunizations. However, mothers/caregivers with central opinion leaders in their networks were not more likely to immunize their child (p = .33). Mothers/caregivers with the actively supportive political chief and imam in their networks were also not more likely to use the DPT vaccine (p = .44).

This trend also appeared in the analysis of the most common type of peer groups in the study.[30] More than three-quarters of the 964 nominated peers fit into three categories: co-wives (39.32%), mothers-in-law (17.32%), and sisters-in-law (20.85%).[31] However, mothers/caregivers with these more common type of peers were not more likely to immunize their child (chi-square test results, p = .57). Centrality is regarded as a strong marker of importance and influence in a network, capturing the relative power of individuals to exchange and disperse information to many others quickly (Rowley, 1997). However, in this study, the centrality of specific opinion leaders and types of peers did not predict immunization use. These

[30] I was not able to formally capture the degree centrality of peers in study. Because mothers/caregivers were required to nominate peers within their compound, peers were limited in terms of the total number of nominations that they could receive. For this reason, I conducted an alternative analysis that captured the centrality of specific types of peers on immunization use.

[31] There were eight categories of peers: friends, co-wives, sisters-in-law, mothers-in-law, and "other female relatives." The "other female relative" category included: cousins, step-parents, mothers, daughters, and daughters-in-law and represented less than 3% of all peer nominations.

results are consistent with the theory underlying my study hypotheses, which suggests that network-based norms are the primary source of influence on behavior (Cialdini et al., 1990).

Social Network Characteristics & Norms in Low versus High Immunization Villages

Mothers/caregivers across village groupings differed on many of the social network properties and norms explored in this study (see Table 8). Mothers/caregivers' in high immunization villages have larger uncensored networks (ranging from 0-60 and a mean of 8.6 individuals versus a range of 0-33 and a mean of 7.8 individuals, $p = .00$) and censored networks with opinion leaders (2.4 versus 2.1 individuals, $p = .00$) and peers (1.8 versus 1.6 individuals, $p = .01$), than mothers/caregivers in low immunization villages. A higher percentage of mothers/caregivers in high immunization villages are also part of networks where most or all of their peers are perceived to support immunizations (77% versus 64%, $p = .00$) and have been observed to immunize their own children (28% versus 17% of peers were observed to immunize some of their own children; 27% versus 20% of peers were observed to immunize all of their of their own children, $p = .00$). Mothers/caregivers in high immunization villages also have denser peer networks than mothers/caregivers in low immunization villages (51% versus 41% have peers that all know each other, $p = .01$).

Not all of the opinion leaders' perceived norms towards immunizations, however, differed by village grouping. Perceived opinion leader support for immunizations (24% of mothers/caregivers in low immunization villages versus 26% in high immunization villages are part of networks where their opinion leaders are perceived to mostly support immunizations, $p = .18$) did not differ. The observed rate of immunization use among opinion leaders did, however, differ, but only across one category. Twenty-two percent of mothers/caregivers in low immunization villages versus 29 percent of mothers/caregivers in high immunization villages

observed *some* of their opinion leaders immunize their own children. However, mothers/ caregivers in high immunization villages were not more likely than mothers/caregivers in low immunization villages to observe all of their opinion leaders immunize their own children (15% in low immunization villages and 17% in high immunization villages). These findings provide preliminary support *against* my hypotheses that injunctive and descriptive norms towards immunizations in opinion leader networks have an independent influence on mothers/caregivers' immunization use.

The village immunization rate is also unrelated to the level of conversations about immunizations with opinion leaders (10% in low immunization villages versus 14% in high immunization villages have frequent communication with a majority of their opinion leaders about immunizations, $p = .16$) or peers (14% in low immunization villages versus 18% in high immunization villages have frequent communication with a majority of their peers about immunizations, $p = .20$). Mothers/caregivers across villages are not closer to their opinion leaders (23% in low immunization villages versus 20% in high immunization villages are closer to a majority of their opinion leaders, $p = .51$) and peers (28% in low immunization villages versus 27% in high immunization villages are closer to a majority of their peers, $p = .73$). Whether frequency of communication about immunizations and closeness has the power to alter the strength of the relationship between social network norms and immunization use is tested in the next chapter.

Overall, the results indicate that mothers/caregivers in high immunization villages have more robust *peer* network structures than mothers/caregivers in low immunization villages (see Chapter 2 for the theoretical discussion of this literature). As the academic literature shows, network structures have a major bearing on the social capital benefits (information, ideas, and

support) that can be secured within a network (Burt, 2000). With a higher number of connections, shared connections, and interactions between mothers/caregivers and their peers who support immunizations, mothers/caregivers in high immunization villages have heightened access to positive information about immunizations and more of a capacity to transfer this information effectively to others (Hansen, 1999). With less structural holes and constraints to access information about immunizations (Burt, 1997; Lin, 2011), mothers/caregivers in high immunization villages may also have more of an opportunity to leverage social capital from their peer networks for the purposes of promoting immunization use.

Table 8

Summary Statistics: Social Network Characteristics

	Low Immunization Villages		High Immunization Villages		
Social Network Characteristic	*n*	Statistic	*n*	Statistic	*p* Value
Network Size					
Range of total network for egos	229	0-33	309	0-60	NA
Mean network size for egos	229	7.86	309	8.64	.0099*
Mean # of opinion leader nominations (0-4) made by egos	229	2.16	309	2.40	.0002*
Mean # of peer nominations (0-3) made by egos	229	1.59	309	1.88	.0100*
Injunctive Norms towards Immunizations [a,b]					
Opinion Leaders					
% of egos in a network with opinion leaders that disapprove and/or are ambivalent towards IZ	122	55.20	185	64.01	
% egos in a network with opinion leaders that are ambivalent and supportive of IZ	46	20.81	30	10.38	.1857
% egos in a network with opinion leaders that mostly or all support IZ	53	23.98	74	25.61	
Peers					
% egos in a network with peers that disapprove and/or are ambivalent towards IZ	29	20.42	22	10.28	
% egos in a network with peers that are ambivalent and supportive of IZ	21	14.79	26	12.15	.0051*
% egos in a network with peers that mostly or all support IZ	92	64.79	166	77.57	

Social Network Characteristic	Low Immunization Villages		High Immunization Villages		*p* Value
	n	Statistic	*n*	Statistic	
Descriptive Norms towards Immunizations					
Opinion Leaders					
% of egos who observed none of their opinion leaders immunize their child	144	62.88	164	53.25	
% egos who observed some of their opinion leaders immunize their child[c]	50	21.83	90	29.22	.0446*
% egos who observed all of their opinion leaders immunize their child	35	15.28	54	17.53	
Peers					
% of egos who observed none of their peers immunize their child	144	62.88	140	45.45	
% egos who observed some of their peers immunize their child [c]	39	17.03	86	27.92	.0004*
% egos who observed all of their peers immunize their child	46	20.09	82	26.62	
Closeness					
% egos that are close to a majority of their opinion leader network	229	22.67	300	20.33	.5188
% egos that are close to a majority of their peer network	229	27.95	308	26.62	.7333
Frequency of Communication about IZ					
% egos with frequent communication about IZ with a majority of their opinion leader network	229	10.06	308	13.97	.1643
% egos with frequent communication about IZ with a majority of their peer network	229	14.41	308	18.51	.2093
% of egos with all peers connected to each other	229	41.41	309	51.77	.0182*

Note. Two-sample Wilcoxon (Mann-Whitney) rank-sum tests were conducted to determine statistically significant differences between the underlying distributions of mothers/caregivers in low versus high immunization villages. These tests were used to account for the non-normal distribution of the data. The standard errors are slightly lower than they should be given the clustering of data around the egos and opinion leaders.
[a]As indicated in Chapter 3, mothers/caregivers with 0 peers or opinion leaders were excluded from this analysis. This is why the *N* is lower in this analysis than in the others displayed in the table.
[b] I collapsed categories 0-2, 3-4, and 5-6 of the injunctive norms scale described in Chapter 3.
[c] This category includes egos who observed between 25% and 67% of their network immunize their own child.
* $p < .10$

However, this trend does not seem to apply to the opinion leader networks in this study. The opinion leader network structures are *not* more robust in the high immunization villages than low immunization villages. In comparison to mothers/caregivers in low immunization villages, mothers/caregivers in high immunization villages have a higher number of connections to opinion leaders and have observed some of them immunize their own children. However, mothers/caregivers in high immunization villages do not have more interaction with opinion leaders who are perceived to support immunizations. These results suggest that mothers/caregivers' might *not* be acquiring enough positive information about immunizations from their opinion leaders networks and using this information to decide whether or not to immunize their own children. The implications of these findings are elaborated further in Chapter 6.

Summary

In this chapter, I described the mothers/caregivers' and the characteristics of their social networks. In the next chapter, I conduct the confirmatory analyses and test the hypotheses presented in Chapter 2. The results from the next chapter provide evidence of a linkage between specific features of social networks, norms, and processes of influence on immunization behaviors.

CHAPTER 5

MAIN RESULTS

In this chapter, I conduct all confirmatory analyses and test the hypotheses outlined in Chapters 2 and 3. The results generated from these analyses provide insight into the degree to which social network norms, their underlying processes, and influencers guide immunization behaviors among mothers/caregivers in northern Nigeria. The findings have important implications for designing strategies that can effectively engage naturally-occurring social networks in order to increase routine immunization use among mothers/caregivers.

The Influence of Injunctive & Descriptive Norms on Immunization Use

In the first set of analyses, I tested whether injunctive and descriptive norms towards immunizations in opinion leader and peer networks independently predict mothers/caregivers' immunization use. Since I am ultimately interested in determining whether having *most* opinion leaders and peers in a network who supports immunizations influences mothers/caregivers' immunization use (see Chapter 2 for a review of hypotheses 1A and 1B), I dichotomized the injunctive norms variables. Mothers/caregivers who perceived that less than a majority of their network partners approved of immunizations (response categories 0-4 on the scale) earned a score of a 0, representing a *Minority of the mothers/caregivers' network was perceived to approve of immunizations*. Mothers/caregivers who perceived that a majority of their network partners approved of immunizations (response categories 5 and 6) earned a score of a 1, representing a *Majority of the mothers/caregivers' network was perceived to approve of immunizations.*

I dichotomized the descriptive norms variables in the same way given my interest in the influence of *most* opinion leaders and peers' immunization practices on mothers/caregivers' immunization use (see Chapter 2 for a review of hypotheses 2A and 2B). Mothers/caregivers who observed 50% or less of their network partners immunize their child earned a score of 0, representing a *Minority of the mothers/caregivers' network was observed to immunize their child*. Mothers/caregivers who observed more than 50% of their network partners immunize their child earned a score of 1, representing a *Majority of the mothers/caregivers' network was observed to immunize their child*.

After testing hypotheses 1A and 1B, I conducted a sensitivity analysis to investigate whether the study results were sensitive to the cut-points of these variables. I used the three-category versions of the injunctive norms (0 = *network partners disapprove and/or are ambivalent towards immunizations*, 1 = *network partners are ambivalent and supportive of immunizations*, 2 = *network partners are mostly or all supportive of immunizations*) and descriptive norms (0 = *none of the network partners were observed to immunize their child*; 1 = *some of the network partners were observed to immunize their child*; 2 = *all of the network partners were observed to immunize their child*) variables in the sensitivity analysis. The results from all of the analyses are below.

Injunctive Norms Hypotheses

> **Hypothesis 1A: Mothers/caregivers who perceive that a majority of the opinion leaders in their network support immunizations will have a higher likelihood of immunizing their child.**
>
> **Hypothesis 1B: Mothers/caregivers who perceive that a majority of the peers in their network support immunizations will have a higher likelihood of immunizing their child.**

The results from testing hypotheses 1A and 1B are presented in Table 9 below. Contrary to hypothesis 1A, perceiving that a majority of opinion leaders in a network support immunizations does not lead to a significant increase in mothers/caregivers' routine immunization use, Model 1: b = .73, CI [-.48, 1.9], p = .23. The sensitivity analysis confirms these results, b = .28, CI [-.33, .90], p = .36 (results not shown in table). Hypothesis 1B is, however, supported in this analysis – perceiving that a majority of peers support routine immunizations in a network leads to a statistically significant increase in mothers/caregivers' routine immunization use, Model 3: b= 1.69, CI [.36, 3.0], p = .01. The sensitivity analysis also confirms this finding, b = 1.25, CI [.34, 2.1], p = .00 (results not shown in table).

Descriptive Norms Hypotheses

> **Hypothesis 2A: Mothers/caregivers who observe a majority of their opinion leaders in their network immunize their child will have a higher likelihood of immunizing their own child.**
>
> **Hypothesis 2B: Mothers/caregivers who observe a majority of their peers in their network immunize their child will have a higher likelihood of immunizing their own child.**

The results from testing hypotheses 2A and 2B are also presented in Table 9. Contrary to hypothesis 2A, observing a majority of opinion leaders immunize their own children was not a statistically significant predictor of mothers/caregivers' immunization use, Model 2: b =.57, CI [-.45, 1.6], p = .27. The sensitivity analysis confirms these results, b = .34, CI [-.23, 1.0], p = .21 (results not shown in table). However, the results from testing hypothesis 2B show that observing a majority of peers in a network immunize their own children leads to a statistically significant increase in mothers/caregivers' routine immunization use, Model 4: b = .92, CI [.04, 1.7], p = .04. The sensitivity analysis also confirms this finding, b = .53, CI [.01, 1.0], p = .04 (results not shown in table).

In all four of analyses, five confounders maintained statistically significant relationships with routine immunization use: living far (>10 km) from a health facility that provides immunization services; having a previous experience visiting a healthcare facility to receive *other* care for their child; having previous exposure to media about routine immunizations in the last month; having discussions with a greater number of health professionals about routine immunizations; and having spousal support to immunize their child (see Table 9). I expected all of these confounders to have a positive relationship with routine immunization use, except the last category of the distance to a health facility variable (since living far away from a health facility has been shown to have a negative association with basic health service use in rural areas in developing countries; Kadobera et al., 2012; Larson et al., 2012; Mwaniki et al., 2002) and the first and second categories (measuring disapproval and ambivalence towards immunizations respectively) of the husband perceived support for immunizations variable (since having full spousal support for immunizations is necessary to gaining access to this health service; Ojanuga & Johnson, 1992). All of the statistically significant confounders were in their hypothesized direction.

Table 9

Regression Results from Models Testing Hypotheses 1A-2B on Social Network Norms

Social Network Norms	Model 1 *b* (CI)	Model 1 *p* value	Model 2 *b* (CI)	Model 2 *p* value	Model 3 *b* (CI)	Model 3 *p* value	Model 4 *B* (CI)	Model 4 *p* value
Opinion Leader Norms								
Majority of opinion leader network perceived to support immunizations (Injunctive Norms)	.74 (-.48–1.9)	.23						
Majority of opinion leader network observed to immunize own child (Descriptive Norms)			.57 (-.45–1.6)	.27				
Peer Network Norms								
Majority of peer network perceived to support immunizations (Injunctive Norms)					1.69 (.36–3.0)	.01***		
Majority of peer network observed to immunize own child (Descriptive Norms)							.92 (.04–1.7)	.04**
Confounders								
Relationship to Child	1.1 (-1.1–2.8)	.42	1.0 (-.93–3.1)	.29	1.4 (-2.3–5.1)	.45	1.3 (-.59–3.2)	.17
Distance to Health Facility								
<5 km	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
5-10 km	0.81 (-1.1–2.8)	.42	.97 (-.96–2.9)	.32	2.4 (-1.0–5.1)	.23	1.0 (-.79–2.8)	.27
>10 km	-1.0 (-3.6– -1.5)	.04**	-1.3 (-3.9– -1.2)	.05**	-1.5 (-4.2– -1.0)	.04**	-1.5 (-3.9– -.87)	.04**
Previous experience seeking care for child	1.4 (.42–2.4)	.00***	1.6 (.60–2.6)	.00***	2.1 (.88–3.4)	.00***	1.7 (.72–2.7)	.00***

Table 9 (cont'd)

Social Network Norms	Model 1 *b* (CI)	Model 1 *p* value	Model 2 *b* (CI)	Model 2 *p* value	Model 3 *b* (CI)	Model 3 *p* value	Model 4 *b* (CI)	Model 4 *p* value
Previous media exposure about IZ								
Never	0.0 (ref)	-	0.0 (ref)	-	0.0 (ref)	-	0.0 (ref)	-
In 1+ months	.42 (-1.2-2.0)	.61	.73 (-.95-2.4)	.39	.60 (-1.2-2.4)	.21	.78 (-.78-2.3)	.32
Within last month	1.3 (-.2-3.0)	.09*	1.6 (-.15-3.3)	.07*	1.6 (-.16-3.5)	.07*	1.5 (.02-3.1)	.04**
Number of health professionals talked to about IZ	0.79 (.27-1.3)	.00***	.76 (.25-1.2)	.00***	.73 (.17-1.3)	.01***	.67 (.20-1.1)	.00***
Husband perceived support for IZ								
Disapproves of IZ	0.0 (ref)	-	0.0 (ref)	-	0.0 (ref)	-	0.0 (ref)	-
Ambivalent towards IZ	-.56 (-3.4-2.3)	.70	-.57 (-3.4-2.3)	.69	-1.2 (-4.7-2.1)	.47	-.41 (-3.8-2.3)	.77
Approves of IZ	1.4 (.80-3.7)	.03**	1.5 (.70-3.8)	.02**	1.3 (.80-2.0)	.02**		.03**
Constant	.00***		.00***		.00***		.00***	
Log pseudo likelihood	-177.77		-181.71		-125.68		-180.26	
Wald chi2(2)	33.72		34.32		31.72		37.53	
Number of observations	499		513		355		513	
Number of groups	364		374		251		374	
Log likelihood ratio (LR) Test	.00***		.00***		.00***		.00***	

Note. All models presented in this table are mixed-effects models with a random effect at the compound-level and fixed effects at the village level.
*$p \leq .10$. ** $p \leq .05$. *** $p \leq .01$.

Confirmation of Influential Factors

The next set of analyses aimed to confirm that social control underlies the influence of injunctive norms and social learning underlies the influence of descriptive norms. The results from these analyses will allow me to make more confident statements about the degree to which social control and social learning guide the influence of social network norms on immunization behaviors and, thus, to generate a more meaningful interpretation of the main study findings.

Social control & injunctive norms. According to Montgomery and Casterline (1996), if social control underlies injunctive norms around immunization use, a mother's routine immunization use would be influenced weakly by the distribution of network support for immunizations (the measure of injunctive norms) in sparse networks, but strongly in dense networks that are exerting normative pressure. To test whether this is the case, I conducted a four steps procedure. First, I examined the independent relationship between the variables measuring injunctive norms towards immunizations (i.e., having a majority of peers perceived to support immunizations) and perceived density on routine immunization use in the mothers/caregivers' peer networks (Models 1 and 2). I then included both of these variables in the same model (Model 3) and added an interaction term to it (Model 4; see Table 10).

Results from the first step of the analysis show that having a majority of peers perceived to support immunizations in a network was a positive, statistically significant predictor of routine immunization use when it was the only, main predictor in the model, $b = 1.69$, CI [.36, .02], $p = .01$, for Model 1 and when the density variable was included, $b = 1.7$ [.37, 3.0], $p = .01$, for Model 3.

The variable measuring perceived density also had the same effect in both tests included in the first three steps of the analysis (Models 2 and 3). Having a dense network had a

statistically insignificant influence on immunization use when it was the only, main predictor in the model, b = .09, CI [-.87, 1.0], p = .85, for Model 2 and, when the injunctive norms measure was also included, b = .22, CI [-.93, 1.39], p = .70, for Model 3.

In the final step of the analysis, however, the relationship between injunctive norms, perceived density, and immunization use changed. As illustrated in Model 4 (see Table 10), the coefficients for the injunctive norms measure became statistically insignificant, b = 1.3, CI [-.366, 4.9], p = .11, the density variable became statistically significant, b = 1.2, CI [.08, 3.6], p = .02, and the interaction term between these two variables emerged as a strong, positive factor influencing immunization use, b = -1.4(.35-1.9), p = .02). According to Montgomery and Casterline (1996), these empirical results suggest that social control is underlying the influence of injunctive norms on mothers/caregivers' immunizations use. This means that the mothers/caregivers' social network structures are operating as a constraint in favor of immunizations when strong *normative support* for immunizations exists within a network.

Table 10

Regression Results Confirming that Social Control Underlies Injunctive Norms

	Model 1		Model 2		Model 3		Model 4	
	b (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Majority of peer network perceived to support IZ (Injunctive Norms)	1.69 (.36–3.02)	.01***			1.7 (.37–3.0)	.01***	1.3 (-.36–4.9)	.11
Perceived Density			.09 (-.87–1.0)	.85	.22 (-.93–1.3)	.70	1.2 (.08–3.6)	.02**
Interaction[a]							1.4 (.35–1.9)	.02**
Confounders								
Relationship to Child	1.3 (-2.2–4.9)	.45	1.1 (-.87–2.3)	.26	1.4 (-2.1–5.0)	.44	1.4 (-2.2–5.0)	.45
Distance to Health Facility								
<5 km	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
5-10 km	1.5 (-.11–3.0)	.27	1.0 (-.85–2.9)	.27	1.4 (-.13–4.9)	.26	1.5 (-.10–5.0)	.26
>10 km	-1.4 (-4.1– -.55)	.04**	-1.4 (-3.9– -.90)	.03**	-1.4 (-4.1– -.48)	.03**	-1.4 (-4.0– -.48)	.03**
Previous experience seeking care for child	2.1 (.85–3.3)	.00***	1.6 (.63–2.6)	.00***	2.1 (.84–3.3)	.00***	2.1 (.84–3.3)	.00***
Previous media exposure about IZ								
Never	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
In 1+ months	.70 (-1.0–2.4)	.43	.58 (-1.0–2.2)	.48	.71 (-1.0–2.5)	.48	.65 (-1.1–2.4)	.48
Within last month	1.5 (.01–3.3)	.04**	1.3 (.20–2.9)	.03**	1.5 (.01–3.2)	.04**	1.5 (.02–3.1)	.04**
Number of health professionals talked to about IZ	.69 (.15–1.2)	.00***	.73 (.23–1.2)	.00***	.68 (.14–1.2)	.01***	.70 (.15–1.2)	.01***
Husband perceived support for IZ								
Disapproves of IZ	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
Ambivalent towards IZ	-.40 (-4.4–2.1)	.48	-.55 (-3.4–2.3)	.70	-.39 (-4.4–2.1)	.48	-.41 (-4.9–1.9)	.39
Approves of IZ	1.1 (.82–3.0)	.03**	1.6 (.62–3.8)	.04**	1.1 (.81–3.0)	.03**	1.1 (.83–2.8)	.03**

Table 10 (cont'd)

Constant	.00***	.00***	.00***	.00***
Log pseudo likelihood	-125.68	-182.32	-125.61	-125.21
Wald chi2(2)	31.72	35.41	31.55	30.70
Number of observations	355	513	355	355
Number of groups	251	374	251	251
Log likelihood ratio (LR) Test	.00***	.00***	.00***	.00***

Note. All models presented in this table are mixed-effects models with a random effect at the compound-level and fixed effects at the village level.

[a] The interaction terms measured the probability of using routine immunizations when a majority of the peer network was perceived to support immunizations and density = 1. This is the same approach used by Montgomery and Casterline (1996) and Kohler, Behrman, and Watkins (2001) to test the social influence mechanism.

*$p \leq .10$. ** $p \leq .05$. *** $p \leq 01$.

Social learning & descriptive norms. According to Montgomery and Casterline (1996), if social learning underlies descriptive norms around immunization use, the percentage of observed immunization users (the measure of descriptive norms) in the mothers/caregivers' network would exert a positive influence on the mothers' use of DPT. Density would have a minor, possibly negative effect because dense networks are expected to provide redundant information. To determine whether or not this is the case, I applied the same four steps procedure used in the social control analysis. First, I examined the relationship between the variables measuring the descriptive norms (i.e., observing a majority of peers immunize their child) and the perceived density of the peer networks on routine immunization use (Models 1 and 2). I then included both of these variables in the model (Model 3) and added an interaction term of these variables to it (Model 4; see Table 11). Results from the first steps of the analysis show that observing a majority of peers immunize their children was a positive, statistically significant predictor of routine immunization use, b = .92, CI [.04, 1.7], p = .04, Model 1. Having a majority of peers immunize their children remained a positive, statistically significant predictor of routine immunization use when the density variable was also added to the model, b = 1.3, CI [.23, 2.3], p = .01, Model 3.

However, the variable measuring density changed in the later steps of the analysis (Models 2 and 3). Having a dense network changed from having a positive coefficient, b = .09, CI [-.87, 1.0], p = .85, Model 2, to a negative one, b = -.70, CI [-1.8, .40], p = .21, Model 3, once the descriptive norms variable was added to the model. At first glance, this change, as well as the trend that density remained statistically insignificant in Models 1 through 4, seems surprising given that the analysis in Chapter 4 shows that mothers/caregivers in high immunization villages have denser networks than mothers/caregivers in low immunization villages (64% of

mothers/caregivers in low immunization villages versus 77% of mothers/caregivers in high immunization villages, $p = .0182$. However, according to Kohler and colleagues (2001), this transformation is possible when the process of social learning is being maximized.

When social learning is being maximized, information provided by a dense network is viewed as redundant. This theoretical point is empirically expressed by a positive or negative, statistically insignificant coefficient for density. What instead matters is the content of the information provided by the individuals in the network. According to Kohler and colleagues (2001), this information can be diffused by learning about others women's experiences with immunizations.

The final analysis (Model 4) confirms that social learning underlies the influence of descriptive norms in this study. The coefficient for the variable measuring that a majority of peers were observed to immunize their own children remained positive and statistically significant, $b = 1.9$, CI [.29, 3.5], $p = .02$, the density variable stayed statistically insignificant, $b = -.08$, CI [-1.6, 1.5, $p = .92$, and the interaction term between these two variables emerged as a mute factor influencing immunization use, $b = -1.2$, CI [-.66, 3.2], $p = .29$. Based on these results, I conclude that learning about network members' experiences with immunizations, rather than normative pressures, is the primary factor explaining the relevance of *normative actions* to the adoption of this health behavior within mothers/caregivers' networks.

Table 11

Regression Results Confirming that Social Learning Underlies Descriptive Norms

	Model 1		Model 2		Model 3		Model 4	
Peer Network Characteristics	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Majority of peer network observed to immunize own child (Descriptive Norms)	.92 (.04–1.7)	.04**			1.3 (.23–2.3)	.01***	1.9 (.29–3.5)	.02***
Perceived Density			.09 (-.87–1.0)	.85	-.70 (-1.8–.40)	.21	-.08 (-1.6–1.5)	.92
Interaction[a]							-1.2 (-.66–3.2)	.29
Confounders								
Relationship to Child	1.3 (-.60–3.2)	.18	1.1 (-.87–2.3)	.26	1.1 (-.69–3.0)	.21	1.2 (-.66–3.2)	.19
Distance to Health Facility								
<5 km	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
5-10 km	1.0 (-.77–2.8)	.26	1.0 (-.85–2.9)	.27	.89 (-.86–2.6)	.21	.93 (-.89–2.7)	.31
>10 km	-1.5 (-3.9– -.90)	.03**	-1.4 (-3.9– -.90)	.03**	-1.4 (-3.8– -.85)	.03**	-1.4 (-3.8– -.94)	.04**
Previous experience seeking care for child	1.6 (.70–2.6)	.00***	1.6 (.63–2.6)	.00***	1.6 (.71–2.6)	.00***	1.7 (.73–2.7)	.00***
Previous media exposure about IZ								
Never	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
In 1+ months	.78 (-.78–2.3)	.32	.58 (-1.0–2.2)	.48	.79 (-.75–2.3)	.31	.84 (-.75–2.4)	.30
Within last month	1.5 (.00–3.1)	.04**	1.3 (.20–2.9)	.03**	1.5 (.05–3.1)	.04**	1.7 (.09–3.3)	.03**
Number of health professionals talked to about IZ	.68 (.21–1.1)	.00***	.73 (.23–1.2)	.00***	.71 (.24–1.1)	.00***	.69 (.22–1.1)	.00***
Husband perceived support for IZ								
Disapproves of IZ	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
Ambivalent towards IZ	-.49 (-3.2–2.2)	.72	-.55 (-3.4–2.3)	.70	-.47 (-3.1–2.2)	.72	-.37 (-3.1–2.3)	.78
Approves of IZ	1.3 (.77–3.5)	.03**	1.6 (.62–3.8)	.04**	1.3 (.75–3.4)	.04**	1.3 (.77–3.5)	.05**

Table 11 (cont'd)

	Model 1		Model 2		Model 3		Model 4	
Peer Network Characteristics	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Constant	.00***		.00***		.00***		.00***	
Log pseudo likelihood	-180.26		-182.32		-179.49		-178.90	
Wald chi2(2)	37.53		35.41		39.67		37.30	
Number of observations	513		513		513		513	
Number of groups	374		374		374		374	
Log likelihood ratio (LR) Test	.00***		.00***		.00***		.00***	

Note. All models presented in this table are mixed-effects models with a random effect at the compound-level and fixed effects at the village level.

[a] Measured the probability of using routine immunizations when a majority of the peer network was observed to use immunizations and density = 1. This is the same approach used by Montgomery and Casterline (1996) and Kohler, Behrman, and Watkins (2001) to test the social influence mechanism.

*$p \leq .10$. ** $p \leq .05$. *** $p \leq .01$.

Comparing the influence of injunctive & descriptive norms. In the analyses above, I established that injunctive and descriptive norms towards immunizations in peer networks independently predict immunization use, while injunctive and descriptive norms in opinion leader networks do not. I also confirmed that social control and social learning underlie the influence of injunctive and descriptive norms on this behavior. In this section, I assess the *degree* to which injunctive and descriptive norms influence mothers/caregivers behaviors in their networks. These analyses will allow me to make claims about *which* social network norms and underlying processes operate as a stronger force on mothers/caregivers' immunization decisions in northern Nigeria.

Strength of Norms in Opinion Leader Networks

> **Hypothesis 3A: Injunctive norms around immunizations in opinion leader networks will exert a stronger influence on mothers/caregivers' immunization use than descriptive norms.**

In order to test hypothesis 3A, I planned to transform the variables measuring injunctive and descriptive norms into standardized regression coefficients (so that their units were comparable), to include them in the same model, and compare their effect sizes. However, because neither injunctive norms or descriptive norms towards immunizations in the mothers/caregivers' opinion leader networks had a significant, independent influence on their immunization use (see Table 9), Model 1: injunctive norms, $b = .74$, CI [-.48, 1.9], $p = .23$; Model 2: descriptive norms, $b = .57$, CI [-.45, 1.6], $p = .27$, it was not necessary to conduct this test in order to conclude that the results refute my hypotheses. Indeed, not only do injunctive norms around immunizations in opinion leader networks appear to exert a *weak* influence on mothers/caregivers' immunization use, but neither injunctive norms nor descriptive norms appear to play a strong role at all in mothers/caregivers' immunization decisions.

Strength of Norms in Peer Networks

Hypothesis 3B: Descriptive norms around immunizations in peer networks will exert a stronger influence on mothers/caregivers' immunization use than injunctive norms.

To test hypotheses 3B, I conducted the test described in the section above to compare the influence of injunctive and descriptive norms on mothers/caregivers' immunization use. Again, this test involved transforming the variables measuring injunctive and descriptive norms in the mothers/caregivers' peer networks into standardized regression coefficients, including them in the same model, and comparing their effect sizes. Contrary to my hypothesis, the results from the analysis do *not* support my hypothesis that descriptive norms around immunization use, b = .45, CI [.02, .89], p = .04, N = 355, exert a stronger influence on mothers/caregivers' immunization use than injunctive norms, b =.75, CI [.16, 1.3,], p = .01, N = 355, in their peer networks. Instead, the results suggest that, among peers, injunctive norms are more influential, which means that social control, or normative pressure, is operating as a stronger force on mothers/caregivers' immunization decisions than their experiences of reflective observation of their peers' immunization behaviors.[32]

Testing Moderators of Normative Influences

In this section, I assess whether two network specific characteristics – closeness between mothers/caregivers and a majority of their network partners and frequency of communication between mothers/caregivers and a majority of their network partners – strengthens the influence of injunctive and descriptive norms on mothers/caregivers' immunization behaviors. For the purposes of this analysis, I conceive of closeness and frequency of communications about

[32] I originally developed individual-level hypotheses to test and compare the influence of injunctive and descriptive norms on immunization use so that I could put in competition different theories on the influence of these norms on health behavior. I attempted to put all of the variables measuring normative influence in the same model to see if their influence changed as a result of the range of network influencers (opinion leader versus peer) and social norms (injunctive versus descriptive norms) included. However, this model would not converge because of collinearity and a relatively small sample size.

immunizations as structural properties of mothers/caregivers' networks (Hill & Dunbar, 2003).[33] This approach allows me to provide insights into the influence of being embedded in close or rich communication networks on mothers/caregivers' decisions to follow normative beliefs and practices towards immunizations.

Closeness as a moderator of the influence of social network norms. First, I tested whether closeness between mothers/caregivers and a majority of their network partners strengthens the influence of social network norms. I conducted this analysis four times – twice to assess whether closeness strengthens the influence of injunctive norms in mothers/caregivers' opinion leader and peer networks (hypothesis 4A) and twice to test whether closeness strengthens the influence of descriptive norms in these same two networks (hypothesis 4B).

> **Hypothesis 4A: Closeness strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.**

> **Hypothesis 4B: Closeness strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.**

Closeness as a moderator of injunctive norms. The results from the analyses assessing whether closeness between mothers/caregivers' and a majority of their network partners strengthens the influence of injunctive norms were mixed (see Table 12). In the opinion leader analysis, the results show that being close to most of the opinion leaders in their network and perceiving that most of the opinion leaders in their network supports immunizations positively predicts mothers/caregivers' immunization use (see Table 12), Model 1: injunctive norms in opinion leader networks* closeness, b = 2.3, CI [.00, -.31], p = .05. These results, which are consistent with my hypothesis, are interesting given that injunctive norms in opinion leader

[33] There are other valid ways to conceive of closeness and frequency of communication within networks. For example, the social psychological approach considers closeness and frequency of communication to be bivalent properties of ties between egos and alters (Savitsky, Keysar, Epley, Carter, & Swanson, 2011). I conducted a moderation analysis that follows this approach. The results, which are consistent with the results presented in the main text of this dissertation, is in Appendix J.

networks do *not* have a significant influence on mothers/caregivers' immunization use when it is independently included in the model (see Table 9), Model 1: b = .73, CI [-.48, 1.9], p = .23, nor when the closeness variable is added to it, b = .66, CI [-.58, 1.9], p = .29. This same trend appeared for the closeness variable – the closeness variable does not have an influence on immunization use when it is independently included in the model, b = .54, CI [-.51, 1.6], p = .31, nor when the injunctive norms variable is added to it, b = .43, CI [-.67, 1.5], p = .43. This means that the influence of injunctive norms in opinion leader networks on mothers/caregivers' immunization use partly depends on whether or not they have a close relationship with a majority of their opinion leaders. These results are consistent with my hypothesis that closeness *strengthens* the influence of injunctive norms on mothers/caregivers' immunization use.

The results from the peer analysis are, however, not consistent with my hypothesis. The results from this analysis showed that the association between injunctive norms towards immunizations in peer networks and mothers/caregivers' immunization use is *not* dependent on whether mothers/caregivers have a close relationship with a majority of their peers (see Table 12), Model 2: injunctive norms in peer networks* closeness, b = -1.8, CI [-4.6, 1.0], p = .21. The implications of the disparate influence of closeness on injunctive norms in mothers/caregivers opinion leader and peer networks are discussed in Chapter 6.

Table 12

Regression Results from Models Testing Closeness as a Moderator of the Influence of Social Network Norms on Immunization Use (Hypotheses 4A-4B)

	Model 1		Model 2		Model 3		Model 4	
	b (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Injunctive Norms								
Opinion Leader Network								
Majority of opinion leader network is perceived to support IZ	1.4 (-.12–2.9)	.07*						
Majority of opinion leader network is close to mother/caregiver	1.5 (-.08–3.2)	.06*						
Interaction[a]	2.3 (.00–3.1)	.05**						
Peer Networks								
Majority of peer network perceived to support IZ			2.7 (.44–5.1)	.01***				
Majority of peer network is close to mother/caregiver			1.6 (-1.0–4.3)	.23				
Interaction[a]			-1.8 (-4.6–1.0)	.21				
Descriptive Norms								
Opinion Leader Network								
Majority of opinion leader network observed to immunize own child					.57 (-.60–1.7)	.33		
Majority of opinion leader network is close to mother/caregiver					.53 (-.89–1.9)	.46		
Interaction[b]					-.15 (2.3–2.0)	.89		
Peer Networks								
Majority of peer network observed to immunize own child							.92 (.10–1.9)	.04**
Majority of peer network is close to mother/caregiver							.44 (-.80–1.0)	.55
Interaction[b]							.06 (-1.7–1.9)	.94

Table 12 (cont'd)

	Model 1		Model 2		Model 3		Model 4	
	b (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Confounders								
Relationship to Child	1.0 (-1.0–3.2)	.33	1.5 (-2.1–5.2)	.21	1.0 (-.98–3.0)	.30	1.2 (-.64–3.1)	.19
Distance to Health Facility								
<5 km	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
5-10 km	.83 (-1.2–2.9)	.44	2.5 (-.96–4.9)	.28	.83 (-1.1–2.8)	.40	1.0 (-.76–2.8)	.26
>10 km	-1.59 (-3.3– -1.1)	.03**	-1.4 (-3.9– -1.1)	.04**	-1.3 (-3.7– -1.1)	.03**	-1.5 (-3.9– -.82)	.05**
Previous experience seeking care for child	1.4 (.39–2.5)	.00***	2.1 (.86–3.3)	.00***	1.5 (.47–2.5)	.00***	1.6 (.65–2.6)	.00***
Previous media exposure to IZ								
Never	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
In 1+ months	.30 (-1.4–2.0)	.73	.65 (-1.1–2.4)	.39	.59 (-1.1–2.3)	.49	.85 (-.72–2.4)	.29
Within last month	1.3 (-.40–3.1)	.08**	1.4 (-.28–3.2)	.08*	1.5 (-.13–3.2)	.08*	1.6 (.07–3.1)	.04**
Number of health professionals talked to about IZ	.81 (.27–1.3)	.00***	.67 (.13–1.2)	.01***	.80 (.28–1.3)	.01***	.69 (.23–1.1)	.00***
Husband perceived support for IZ								
Disapproves of IZ	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
Ambivalent towards IZ	-.65 (-3.6–2.3)	.67	-.30 (-2.3–2.9)	.43	-.56 (-3.4–2.3)	.70	-.54 (-3.2–2.1)	.69
Approves of IZ	1.5 (.83–3.8)	.02**	1.3 (.70–1.9)	.03**	1.4 (.83–3.7)	.02**	1.3 (.81–3.4)	.03**
Constant	00***		.00***		.00***		.00***	
Log pseudo likelihood	-174.83		-124.80		-178.22		-179.92	
Wald chi2(2)	32.30		31.32		34.46		38.91	
Number of observations	494		355		501		513	
Number of groups	361		251		365		374	
Log likelihood ratio (LR) Test	.00***		.00***		00***		.00***	

Note. All models presented in this table are mixed-effects models with a random effect at the compound-level and fixed effects at the village level.

[a] The interaction terms measured the probability of using routine immunizations when a majority of the network was perceived to support immunizations and emotional closeness = 1.

[b] The interaction terms measured the probability of using routine immunizations when a majority of the network was observed to immunize their own children and emotional closeness = 1.

*$p \leq .10$. ** $p \leq .05$. *** $p \leq .01$.

Closeness as a moderator of descriptive norms. The results from the analyses assessing whether closeness between mothers/caregivers' and a majority of their network partners strengthens the influence of descriptive norms both provide support *against* my hypotheses (see Table 12). Even though closeness strengthens the influence of injunctive norms in opinion leader networks on mothers/caregivers' immunization use, Model 1: injunctive norms in opinion leader networks*closeness, b = 2.3, CI [.00, .31], p = .05, this factor does not appear to have the same, moderating effect on descriptive norms, Model 3: descriptive norms in opinion leader networks* closeness, b = -.15, CI [2.3, 2.0], p = .89.

This same trend emerged in the peer analysis. The association between descriptive norms towards immunizations in mothers/caregivers' peer networks and mothers/caregivers' immunization use does not depend on whether the mothers/caregivers have a close relationship with a majority of their peers, Model 4: descriptive norms in peer networks* closeness, b = -.06, CI [-1.7, 1.9], p = .94. The implications of these results are discussed in Chapter 6.

Frequency of communication as a moderator of the influence of social network norms. In the final section, I test whether frequency of communication between mothers/caregivers and a majority of their network partners strengthen the influence of social network norms. I conducted this analysis four times – twice to assess whether frequency of communication about immunizations strengthens the influence of injunctive norms in mothers/caregivers' opinion leader networks and peer networks (hypothesis 5A) and twice to test whether frequency of communication about immunizations strengthens the influence of descriptive norms in these same two networks (hypothesis 4B).

Hypothesis 5A: Frequency of communication about immunizations strengthens the effect of injunctive norms about immunizations on mothers/caregivers' routine immunization use.

Hypothesis 5B: Frequency of communication about immunizations strengthens the effect of descriptive norms about immunizations on mothers/caregivers' routine immunization use.

Frequency of communication as a moderator of injunctive norms. The results from the analyses, which assess whether frequent communication between mothers/caregivers and a majority of their network partners strengthens the influence of injunctive norms, provide support *against* my hypotheses (see Table 13). In the opinion leader analysis, the results show that being in frequent communication with most of the opinion leaders in their network and perceiving that most of the opinion leaders in their network supports immunizations does not predict mothers/caregivers' immunization use, Model 1: injunctive norms in opinion leader networks*frequency of communication about immunizations, b = 2.5, CI [-.17, 5.4], p = .11. The same results appeared in the peer analysis. Indeed, the association between injunctive norms towards immunizations in mothers/caregivers' peer networks and mothers/caregivers' immunization use does not appear to depend on whether the mothers/caregivers communicate frequently about immunizations with a majority of their peers, Model 2: injunctive norms in opinion leader networks*frequency of communication about immunizations, b = 1.2, CI [-2.2, 4.8], p = .47.

Frequency of communication as a moderator of descriptive norms. The results from the analyses are consistent with the hypotheses that frequency of communication between mothers/caregivers' and a majority of their network partners strengthens the influence of descriptive norms (see Table 13). The interaction between descriptive norms in opinion leader networks and frequency of communication about immunizations is positive, Model 3; b = 2.7, CI

[.58, 3.0], p = .04. This indicates that the influence of descriptive norms is enhanced as the frequency of network communication increases. The data also explains the absence of the effect in the unmoderated model. Taking into account the absence of a descriptive norm influence in the unmoderated model (see Table 9), I further conclude that both communication and observed immunization practices are necessary conditions for opinion leader influences to operate.

The results from the peer analysis also provide support for my hypothesis. This analysis showed that the association between descriptive norms towards immunizations in peer networks and mothers/caregivers' immunization use depends on whether the mothers/caregivers have frequent conversation about immunizations with their peers, Model 4: descriptive norms in peer networks*frequency of communication about immunizations, b = 1.6, CI [-.03, 4.0], p = .06. The results also show that descriptive norms towards immunizations in the mothers/caregivers' peer networks have diminished, but are still significant when communication frequency is low, Model 4: descriptive norms, b = .63, CI [.35, 1.6], p = .02). The implications of these results are discussed in Chapter 6.

Table 13

Regression Results from Models Testing Frequent Communication as a Moderator of the Influence of Social Network Norms on Immunization Use (Hypotheses 4A-4B)

	Model 1		Model 2		Model 3		Model 4	
	b (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Injunctive Norms								
Opinion Leader Network								
Majority of network perceived to support IZ	.39 (.88–2.6)	.54						
Majority of network has frequent comm. w/ mother/caregiver about IZ	1.1 (-.03–1.0)	.30						
Interaction[a]	2.5 (-.17–5.4)	.11						
Peer Networks								
Majority of network perceived to support IZ			1.4 (.04–2.9)	.04**				
Majority of network has frequent comm. w/ mother/caregiver about IZ			.87 (-4.1–2.3)	.59				
Interaction[a]			1.2 (-2.2–4.8)	.47				
Descriptive Norms								
Opinion Leader Network								
Majority of network observed to immunize own child					.86 (-.22–1.9)	.12		
Majority of network has frequent comm. w/ mother/caregiver about IZ					1.3 (-.36–3.0)	.12		
Interaction[b]					2.7 (.58–3.0)	.04**		
Peer Networks								
Majority of network observed to immunize own child							.63 (.35–1.6)	.02**
Majority of network has frequent comm. w/ mother/caregiver about IZ							.30 (-1.9–1.3)	.71
Interaction[b]							1.6 (-.03–4.0)	.06*

Table 13 (cont'd)

	Model 1		Model 2		Model 3		Model 4	
	b (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value	*b* (CI)	*p* value
Confounders								
Relationship to Child	1.0 (-1.0–3.0)	.34	1.2 (-2.3–4.9)	.48	1.1 (-.97–3.1)	.29	1.2 (-.94–4.0)	.16
Distance to Health Facility								
<5 km	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
5-10 km	.71 (-1.2–2.7)	.48	2.4 (-.98–4.8)	.28	.92 (-1.0–2.8)	.35	.87 (-.95–2.7)	.34
>10 km	-1.0 (-3.6– -1.6)	.03**	-1.4 (-4.0– -1.1)	.04**	-1.1 (-3.7– -1.5)	.03**	-1.5 (-3.9– -.93)	.05**
Previous experience seeking care for child	1.4 (.37-2.5)	.00***	2.1 (.85–3.3)	.00***	1.7 (.65–2.8)	.00***	1.7 (.73–2.7)	.00***
Previous media exposure to IZ								
Never	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
In 1+ months	.50 (-1.1–2.1)	.55	.64 (-1.1–2.4)	.48	.72 (-.95–2.4)	.39	.76 (-.83–2.3)	.34
Within last month	1.4 (-.25–3.0)	.09	1.5 (-.19–3.3)	.08*	1.5 (-.15–3.2)	.07*	1.6 (.03–3.2)	.04**
Number of health professionals talked to about IZ	.84 (.21–1.3)	.00***	.71 (.16–1.2)	.01***	.77 (.26–1.2)	.01***	.69 (.21–1.1)	.00***
Husband perceived support for IZ								
Disapproves of IZ	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–	0.0 (ref)	–
Ambivalent towards IZ	-.75 (-3.6–2.1)	.61	-.20 (-2.5–2.9)	.43	-.61 (-3.5–2.2)	.67	-.48 (-3.2–2.3)	.73
Approves of IZ	1.3 (.93–3.6)	.04**	1.3 (.57–2.0)	.03**	1.3 (.83–3.6)	.03**	1.2 (.87–3.4)	.03**
Constant	.00***		.00***		.00***		.00***	
Log pseudo likelihood	-175.94		-125.34		-179.69		-178.79	
Wald chi2(2)	32.41		31.10		33.12		36.51	
Number of observations	499		355		513		513	
Number of groups	364		251		374		374	
Log likelihood ratio (LR) Test	.00***		.00***		.00***		.00***	

Note. All models presented in this table are mixed-effects models with a random effect at the compound-level and fixed effects at the village level.

[a] Measured the probability of using routine immunizations when a majority of the network was perceived to support immunizations and frequency of communication about immunizations = 1.

[b] Measured the probability of using routine immunizations when a majority of the network was observed to immunize their own children and emotional closeness = 1.

*$p \leq .10$. ** $p \leq .05$. *** $p \leq .01$.

CHAPTER 6

DISCUSSION

Why do some mothers/caregivers immunize their children while others don't? What role do social norms within networks play in the inequitable uptake of childhood immunizations in northern Nigeria? A large body of research has been devoted to investigating the determinants of immunization use in developing countries. Up to this point, however, most of this research has focused on individual-level explanations to account for variance in this outcome. Scant attention has been paid to the ways that social factors influence immunization decisions. Indeed, to my knowledge, only three studies have explained immunization use from a socio-behavioral perspective. Only one of these studies used formal social network analysis to explain how social network influences immunization use (Brunson, 2013). This study was conducted among a sample of parents in the United States and did not explore the impact of different types of networks and normative influences on immunizations.

To fill these gaps in the literature, I used social networks theory in combination with related theories on social capital, opinion leadership, social norms, and social influence to develop a refined social networks model using primary y data. Drawing on this data, I assessed four inter-related aims: a) whether social norms, namely injunctive and descriptive norms towards immunizations are linked to mothers/caregivers' immunization decisions; b) whether the theorized constructs of social control and social learning underlie injunctive norms and descriptive norms around immunizations; c) the degree to which injunctive and descriptive norms influence mothers/caregivers immunization behaviors; d) whether the structural properties of closeness and frequency of communication about immunizations moderate the influence of

injunctive and descriptive norms on mothers/caregivers' immunization use. What was unique about this study is that I tested these aims across two network structures that have been both theorized and shown to have a marked influence on health decisions in northern Nigeria: opinion leader networks and peer networks. A discussion of the main lessons learned from this dissertation is below.

The Influence of Social Networks Norms on Immunization Use

The results from the analyses show that injunctive norms in peer networks independently influence mothers/caregivers' immunization use. However, injunctive norms in opinion leader networks do not have an independent influence on mothers/caregivers' immunization decisions. Results from the village level analyses provide additional evidence to support these findings, as the percentage of peers that disapprove of, and are in favor of, immunizations substantively varies in the theorized direction across villages with low versus high immunization rates (i.e. higher levels of disapproval and lower levels of support in low immunization villages versus lower levels of disapproval and higher levels of support in high immunization villages), while the percentage of opinion leaders does not.

The results from the descriptive norms analyses reveal a similar trend. Descriptive norms in peer networks independently influence mothers/caregivers immunization use, but do not have the same influence in opinion leader networks. These same results appear in the village-level analyses, where the percentage of peers observed to immunize their children substantively varies in the theorized direction across low versus high immunization villages (i.e., lower levels of observed immunization use in low immunization villages and higher levels of observed immunization use in high immunization villages), but the percentage of opinion leaders does not.

A potential explanation for these results is that peer and opinion leader networks are operating as conflicting forces on mothers/caregivers' immunization behaviors. This implies that there is still strong resistance towards immunizations among opinion leaders in northern Nigeria. Even though there has been renewed support and positive engagement around immunizations among opinion leaders in this region for over a decade (see Chapter 2), the marginal differences in opinion leader support and immunization engagement indicated by mothers/caregivers in this study suggest otherwise. Indeed, latent opinion leader resistance may be operating as an impediment, rather than a catalyst, for mothers/caregivers' demand for immunizations. This is an explanation that is worth further research and investigation.

A second explanation for this discrepancy is that opinion leaders are not the important, direct influencers on mothers/caregivers' immunization behaviors as previously thought. Even though religious, political, and medical leaders in northern Nigeria have an important influence on health decision-making in this context, perhaps the combination of a strong social hierarchy – that limits interaction between authority figures and the general populous – and gender norms – that limits non-familial, male-female interaction – in northern Nigeria restrict opinion leaders' ability to have a notable, direct impact on mothers/caregivers' immunization behaviors. Indeed, the relatively small percentage of mothers/caregivers who observed any of their opinion leaders, who are almost exclusively male, immunize their own children, provides preliminary evidence to support this explanation. Investigating the degree to which opinion leaders are able to directly influence mothers/caregivers immunization decisions, outside of their husbands, is therefore important if the immunization research and programming community want to maximize the impact of immunization-related activities in northern Nigeria.

The results also confirm that social control underlies injunctive norms and that social learning underlies descriptive norms. The notion that social control and social learning are root constructs guiding normative influences on behavior has been widely theorized. However, this study empirically tested, arguably for the first time, whether this was the case among a population of women living in a developing country in the midst of making critical health decisions for their children.

Contrary to my original beliefs, however, injunctive norms were found to be more influential than descriptive norms in mothers/caregivers' peer networks. This indicates that social control is also operating as a stronger force on mothers/caregivers' immunization decisions than reflective observations of their peers' immunization behaviors. These results reflect the salience of the hierarchy of power that exists between women within northern Nigerian compounds. Indeed, as explicated in Chapter 2, women in this study live under a hierarchy of power in which their husbands and male relatives make major household decisions and selected female kin (e.g., based on age, co-wife status) influence the execution of approved decisions (Ojanuga & Johnson, 1992; Umar, personal communication, April 5, 2013). Such a hierarchy gives peers – who, in this study, are mostly co-wives, mothers-in-law and sisters-in-law – the power to exert influence on mothers/caregivers. Very often, this influence seems to take the form of pressure to engage in activities that the peers themselves consider appropriate (Montgomery & Casterline, 1996). The idea that peers have a significant hand in influencing mothers/caregivers' immunization decisions independently of their husbands – who themselves possess enormous power over immunization practices within the family (Ojanuga & Johnson, 1992) – is plausible, not only because spousal support for immunizations was controlled for in the analyses, but also due to the strength of the statistical results.

Finally, the results from the moderation tests points to key contextual factors that might augment the ability of the predominately male opinion leaders to directly influence mothers/caregivers' immunization use. The results show that mothers/caregivers' immunization use partly depends on whether mothers/caregivers are close to a majority of their opinion leaders or have frequent communication with them about immunizations. This means that direct connections – both in terms of relationship quality and contact – between opinion leaders and mothers/caregivers may be critical for mothers/caregivers to demand immunizations. The finding that frequency of communication about immunizations also strengthened the influence of norms on immunization use within mothers/caregivers' peer networks provides additional evidence to support the claim that contextual factors may be necessary conditions for normative influences to operate.

Overall, this research has important for both research and practice. In research, this study provides additional evidence to support the claim that health outcomes depend not just on individuals' own beliefs and actions, but also on the normative beliefs and actions of the people around them. This study clarifies the social network partners that exert influence over mothers/caregivers' immunization use and the specific conditions under which they are most likely to have a normative influence on immunization decisions. In practice, this study demonstrates the potential of social networks to influence immunization use. As a result, it provides support for further investigation into interventions that leverage the power of social networks to improve immunization behaviors and ways that networks may be better leveraged to make a difference on this critical health outcome. Recommendations for how these findings can be specifically used to inform future research and practice are described below.

Other Determinants of Immunization Use

I originally included six variables in my analysis that were demonstrated in the literature to influence immunization choices. Of these six variables, five were found to consistently predict mothers/caregivers' immunization decisions: their distance to a health facility, recent exposure to mass media about immunizations, the number of health professionals that mothers/caregivers communicated with about immunizations, having previous experiences in seeking care for their child at a health facility, and (as elaborated on above) having spousal support for immunizations. The results confirm the significance of more traditional sources of health information (e.g., mass media and members of the formal health system) on immunization use.

The results from the regression analyses show that living farther away (>10 km) from a health facility that provides immunization services has a negative influence on immunization use. These results are consistent with the literature that shows that distance influences individuals' use of basic health services, especially in rural, developing country settings (Kadobera et al., 2012; Larson et al., 2012; Mwaniki et al., 2002). This finding is particularly interesting, given that the results from the village-level analysis show that a higher proportion of mothers/caregivers in high immunization villages live farther away (>10) from health facilities that provide immunization services than mothers/caregivers in low immunization villages. This statistical finding points the dangers of drawing inferences about individual behavior from aggregate data (Kramer, 1983).

The results also show that having recent exposure to mass media positively influences immunization uptake. At first glance, this finding seems peculiar. Given that the study is geographically and socio-economically circumscribed, mothers/caregivers should have similar

levels of exposure to mass media messages (Rani & Lule, 2004; Singh, Rai, Alagarajan, & Singh, 2012). However, variations in mass media exposure are possible among individuals who are detached or excluded from social networks (Rani & Lule, 2004). An analysis confirms that mothers/caregivers who are excluded from peer networks (zero peers versus any peers in their network) or opinion leader networks (zero opinion leaders versus any opinion leaders in their network) have less mass media exposure than do mothers/caregivers who are part of these networks (chi-square test results, opinion leader network analysis, $p = .040$; peer network analysis, $p = .00$). I, therefore, conclude that recent mass media exposure does indeed influence immunization decisions.

The idea that exposure to mass media positively influences health behavior has been put forward by many health researchers over the last three decades (see Grilli, Ramsay, & Minozzi, 2002 for a systematic review of the literature; Brunson, 2013; Freed, Katz, & Clark, 1996; Gangarosa et al., 1998; Kennedy, Lavail, Nowak, Basket, & Landry, 2011; Lewis & Speers, 2003). Accordingly, it may be possible to use mass media, in conjunction with more direct sources of influence (e.g., opinion leaders and peers) to alter beliefs and practices around immunization use.

This study also provides preliminary evidence for the importance of the formal health system in immunization decision-making. Previous research showed that health providers positively influence immunization use by easing concerns about immunization safety, providing information about the individual and community benefits of immunizations, and ultimately giving parents the information that they need to make an informed decision about their child's health (Gellin, Maibach, & Marcuse, 2000; Jackson, Cheater, & Reid, 2008; Kennedy et al., 2011; Smith, Kennedy, Wooten, Gust, & Pickering, 2006). My study suggests that because

health providers are a source of immunization information, more contact with these individuals may positively impact[34] mothers/caregivers' immunization use. However, given the cross-sectional structure of the data, I cannot empirically establish that the influence of their health providers helped lead the mothers/caregivers in this study to seek out immunizations. Nonetheless, the strength of the association between the number of health providers that the mothers/caregivers' communicated with about immunizations and their immunization use makes this an area worth further investigation.

Previous exposure to the healthcare system also influenced immunization decisions. The results suggest that getting mothers/caregivers to health facilities to obtain any type care for their child may increase the likelihood that they will make use of this health service.[35] Given the nature of the data, I cannot readily establish that the mothers/caregivers who immunized their children were not already predisposed to seeking out other care for their children. However, because of the strength of the association between mothers/caregivers' previous exposure to other types of child health services and their immunization use, future research could productively investigate the relevance of this relationship to increasing immunization service usage.

Social Networks Characteristics in Villages with Varying Rates of Immunization Coverage

The results from this study provide preliminary support for the theory that the structural characteristics of social networks – such as who interacts with whom and how frequently people interact – effect the flow of the information, resources, and support that are made available by

[34] Research shows that having a negative experience during a health facility visit can have a deleterious effect on immunization use (Stockwell, Irigoyen, Martinez, & Findley, 2011). For this reason, larger health system factors must be taken into account in order to help ensure that mothers/caregivers return to their health facility for routine immunizations. These health systems factors are discussed in the Implications section below.

[35] The effectiveness of this strategy is contingent on mothers/caregivers' having a positive experience during their health facility visits, as elaborated in the footnote above (Stockwell et al., 2011).

social capital (Burt, 2000). Mothers/caregivers in villages with high rates of immunization coverage generally have more robust peer network characteristics than mothers/caregivers in villages with low rates of immunization coverage. For example, mothers/caregivers living in high immunization villages have more general connections with peers, more connections with peers that are both supportive of immunizations and have immunized their own children, and denser peer networks than do mothers/caregivers living in low immunization villages.

With a higher number of connections, and shared connections between mothers/ caregivers and peers who are mostly supportive of immunizations, mothers/caregivers in high immunization villages may have more of a capacity to generate the social capital needed to effectively diffuse positive[36] information about immunizations within a network. Though an empirical determination of whether social capital varies across high and low immunization villages and predicts immunization use is beyond the scope of this study, the results from the village comparisons indicate that this might be the case. For this reason, it might be worthwhile to conduct a deeper investigation into the connection between social capital and immunization use in northern Nigeria.

Limitations

The findings from this research should be interpreted in light of six limitations. First, this study used observational and cross-sectional data to test the relationship between social networks and routine immunization use. As mentioned above, by using this approach, I am limited in my ability to make strong causal claims about the relationship between social networks and immunization use. Even though I employed accepted techniques to mitigate this problem (e.g.,

[36] It is important to recognize that negative information can also more readily flow in areas with more robust social relationships and interactions. Researchers and programmers need to be cognizant of this threat so that they can devise ways to prevent the rapid spread of negative information (e.g., attitudes about immunizations) if introduced into the environment.

including a comparison group with clearly defined health outcomes; providing strong theoretical claims about the direction of influence; and including a large set of control variables in the analysis to account for possible selection effects), other approaches could be used to address this threat more fully. For example, the instrumental variable (IV) approach could be used to exploit a natural experimental component in the data (e.g., a shock, like migration or death) that alters mothers/caregivers' social networks in a meaningful way.[37] Moreover, methods such as sensitivity analyses (e.g., Rosenbaum Bounds)[38] could be used to show the vulnerability of the results to selection bias, which by nature raise confusion about causal direction.

The second limitation of this study relates to data accuracy. Most of the data in this study are based on mothers/caregivers' reporting of their child's immunization history (in the case that they do not have a health card, which is the majority) and their social network partners' characteristics and perceptions. It is important to note that the study incorporated steps to reduce the threat of misreporting (e.g., only children between 9 and 18 months of age were included in the study) and to address the issue of data accuracy (e.g., accepted tests of projection bias were conducted, comparisons between mothers/caregiver reports and peer reports were made, and the latent variable approach was used to create a new, more valid measure of opinion leader attitudes towards immunizations).

[37] I explored the possibility of using *the death of an adult in a compound* as an IV in this study. Even though I was able to gather secondary data on this variable from the HDSS, the IV proved to be invaluable for two reasons: 1) adult death was such a rare event (which was somewhat expected given that the highest mortality rate is among children under age 5) that I did not have enough power to use it in a meaningful analysis; and 2) I became concerned about the validity of my assumption that the *death of an adult in a compound* was a good instrument in the first place. Even though this variable seemed to meet part of the exclusion rule for IVs (the association between social network structure and immunization use is reasonably mediated by the IV, since the death of an adult alters the composition of individuals in a compound), it became unclear whether this measure met the IV criteria completely – that the death of an adult was correlated with the strengthening or weakening of network influence regarding immunization behaviors specifically. Even though I did not end up using an IV in this study, there is room to explore other shocks (e.g., corruption, migration) that might serve as a good instrument.

[38] Rosenbaum bounds include two parts. The first part of this sensitivity analysis makes the assumption that there is not an unobserved confounder accounting for the outcome. The second part of the analysis assesses how reasonable this assumption is by calculating Rosenbaum bounds for both the *p* value and the estimated social network effects. The resulting data would tell me if the introduction of an unobserved covariate changed the inferences made in the study (Keele, 2010).

Nevertheless, other approaches could be used to address this issue more fully. For example, predicted probability modeling could be used to go beyond making assessments of relative risk of immunization use (traditionally measured by regression coefficients and odds ratios; Pepe, Janes, Longton, Leisenring, & Newcomb, 2004) to making statements about the absolute risk of this behavior (Steyerberg et al., 2010). Overall, this new way of expressing data would allow for more absolute and precise statements about the relationship between mothers/caregivers' social network influences and immunization use.

The third limitation of this study relates to the little variation in opinion leaders' perceived attitudes towards immunizations. A majority of the mothers/caregivers reported, and arguably overstated, their opinion leaders' support for immunizations. Although I addressed this issue by using a latent variable model to estimate a more valid measure of opinion leaders' attitudes towards immunizations, this strategy was not perfect. The latent variable approach generates more valid measures by aggregating reports from multiple informants about the same individual (Cook & Goldstein, 1993; Moskowitz & Schwarz, 1982; Schwarz, Barton-Henry, & Pruzinsky, 1985). Unfortunately, I could not generate more reliable estimates for 30 of the opinion leaders (20% of the opinion leaders) in the sample because they were rated by only one mother/caregiver. For this reason, I recommend that other strategies be used during the data collection phase (e.g., having interviewers document whether anyone else was present during their interviews; Smith, 1995) – in order to reduce the incidence of over-reporting.

The fourth limitation of this study is that children who were deceased were excluded. Given that infant mortality is highly correlated with missed immunizations (WHO, 2005), it is possible that this study did not capture the social network influences of mothers/caregivers with low or erratic immunization behaviors. I am not concerned about this bias affecting the results

of this study, however, because it was designed in a way to ensure that women with no to low immunization uptake rates were well represented (via a one-to-one matching procedure). Nevertheless, this limitation points to the value of including mothers/caregivers with deceased children in future research, if deemed ethically possible.

The fifth limitation of this study is that only peers that the mothers/caregivers' ever communicated with about immunizations were included. This assumes that the mothers/caregivers were only influenced by peers that they ever had direct communication with about immunizations, which is not necessarily the case. Even though it is common practice in ego-centric network studies to ask egos' to report on people that they engage with on a particular topic of interest (in this case, immunizations) to make the research more manageable (University of Pennsylvania, 2006; Wasserman & Faust, 1994; Wellman, 1982), this approach makes the study of social networks instead a study of specific relations within a sample of networks.

The final limitation of this study relates to its generalizability. The population of women included in this study is largely homogenous. The homogeneity of the study population provided important benefits to this research, namely limiting possible confounding factors that might have been introduced if I were comparing social networks in villages that greatly differed by culture and social structure. This also means, however, that what I learned from this study might not be generalizable to women from other cultures and social strata. Although I cannot address this issue with the data at hand, this limitation points to the importance of conducting similar studies among women in diverse settings. Indeed, future studies should be conducted among other populations of women, especially those living in developing countries, where the knowledge gap on the impact of social networks on immunization use is widest.

Implications for Future Research & Practice

This study provides valuable insights for researchers and programmers who are committed to increasing childhood immunization rates and reducing child morbidity and mortality. Research and interventions that attempt to understand and address barriers to immunization use should be mindful of who influences immunization decisions and how this influence operates within networks.

Recommendations for Research

As noted, much more research that examines how social networks influence immunization use is needed. Below are four categories of research that could broaden this evidence base in a systematic and conceptually meaningful way.

Uncovering the influence of structural factors on immunization adoption. More research is needed on the factors that promote the adoption of immunizations. This dissertation provides important insights into this question by accounting for a wide range of individual factors known to influence immunization use and identifying specific aspects of social networks that impact this outcome. However, much more knowledge on the structural factors that promote or hinder immunization use is needed. For example, health system factors – such as the frequency of health provider contact and previous exposure to health facilities – appear to positively influence immunization use. Higher levels of social capital also appear to exist in villages with high immunization coverage rates.

Future research should more formally study the role of these structural influences on immunization use. This could include establishing whether these variables independently predict immunization uptake (e.g., does increased health provider access increase immunization use?) and under what conditions their effects may vary (e.g., under what circumstances does social

capital access have a positive versus negative influence on immunization decisions?). Overall, this information could be useful for identifying barriers to immunization use as well as for generating new ideas about how to overcome them in the future.

Identifying other important moderators of social network norms. Another line of research could focus on other factors that moderate the relationship between social network norms and immunization use. In this study, I empirically tested whether two network-specific factors – closeness and the frequency of communication about immunizations – moderated the influence of social network norms on immunization use. However, there are other factors that could influence whether social network norms have a greater or lesser, or positive or negative impact on this outcome. For example, one group of moderators could capture important individual and contextual characteristics that have been shown to moderate the influence of norms on health behavior in the past. Examples of these are demographic factors (e.g., age, wealth, and social status; Berger et al., 1980; Lockwood et al., 2002; Pool et al., 1998; Wood et al., 1996) and traditional norms (e.g., whether immunization decisions are enacted by just a single individual, or requires joint consultation with others, which is the case with husbands and female kin in this study; Neighbors et al., 2013). Given the homogeneity of the sample, these factors could not be empirically investigated in my study. Conducting research that delineates the role of these moderators on the relationship between social network norms and immunization use could help to generate a better understanding of the conditions under which opinion leaders and peers are most likely to have a normative impact on immunization decisions.

Examining the flow of negative information in social networks. It is important to recognize that negative information can flow just as readily in a network as positive information. Even though the purpose of this dissertation was to explore how the prevalence of *positive*

normative beliefs and practices within a network influences immunization decisions, the inverse could be analyzed with the data at hand. This research could focus on the factors that accelerate or slow the flow of *negative*, normative beliefs (e.g., voiced disapproval of immunizations) and practices (e.g., active protests of immunization campaigns) in a network. This information could aid researchers and programmers alike in devising ways to avert the rapid spread of negative information introduced into an environment.

Using other methods of inquiry. Much of the research examining the linkage between social networks and immunization behaviors has relied on observational data (Brunson, 2013). By nature of design, this type of study is limited in its ability to make causal claims about the effects of social networks on defined health outcomes. Future studies should therefore adopt different research designs in order to make stronger inferences about the effects of social networks on immunization behaviors. Examples could include a longitudinal study design with a lagged dependent variable to eliminate unmeasured selection effects (Christakis & Fowler, 2007), or a randomized experimental design where respondents are randomly assigned to settings with different groups of network partners so that a network relationship can be assessed early on (Aral & Walker, 2011)

There is also a need for more qualitative studies on this topic. Qualitative research would provide a richer understanding of the cultural factors that shape immunization adoption, the norms that shift in important ways because of the introduction of immunizations in communities, and the nature and implications of social network effects on immunization use (Streefland et al., 1999).

In summary, the body of research on this subject is far from complete. More and different types of research could provide a better understanding of the ways in which social

networks impact immunization use and thus provide new strategies for encouraging the use of this health service.

Recommendations for Practice

With widespread recognition that social networks, even when weak, have the power to influence (Granovetter, 1973), there is little doubt that interventions focusing on social networks will continue to grow in number and scope in the near future. This dissertation, in demonstrating the potential of social networks to influence immunization use, provides support for interventions that leverage the power of social networks to improve immunization behaviors. Below is a list of strategies that could be used to potentially increase routine immunization use among mothers/caregivers in settings similar to northern Nigeria.

Customizing approaches to engaging "traditional" social network influencers. The results of this study show that when mothers/caregivers perceive that a majority of opinion leaders and peers support routine immunizations, their likelihood of seeking out immunizations for their children increases. However, the results also show that the normative influence of these groups on immunization decisions is impacted by external factors. Unlike peers, opinion leaders have a greater normative influence on mothers/caregivers' immunization use if they have a close relationship with them, and if they also have frequent conversations with them about immunizations.

In contrast, peers are more likely to have a normative influence on mothers/caregivers' immunization use only if they have frequent conversations with them about immunizations. Peers were also shown to influence mothers/caregivers' immunization decisions via the processes of social control and social learning, with most of their influence generated through the

former. These variations in how normative influences occur indicate the value of customizing how different groups of actors engage in immunization-related activities.

Given the significant influence that closeness and frequent communication have on the normative influence of opinion leaders on mothers/caregivers' immunization use, I recommend that opinion leaders be engaged in immunization campaigns in two ways. First, I recommend that opinion leaders focus upon delivering messages in support of immunization to key constituents, as the closeness of their relationships influences the strength of their impact on mothers/caregivers' immunization behaviors. Second, when immunizing their children in public – a practice that opinion leaders often do in immunization campaigns (PRRINN-MNCH, 2010) – opinion leaders should consider pairing this activity with frequent messaging about the community benefits of immunizations. According to the results of this study, these strategies will increase the likelihood that mothers/caregivers will immunize their own children.

As with opinion leaders, peers should be engaged in immunization campaigns. Given the relevance of frequent communication to their normative influence on mothers/caregivers' immunization decisions, peers should be asked to deliver regular messages in support of immunizations (e.g., during house visits, clinic functions, or family meetings). In contrast to findings on opinion leaders, I was able to confirm that peers influence mothers/caregivers' immunization behaviors through both social control and social learning, with the former exerting a stronger force. This knowledge is important because it influences how campaign messages should be structured in order to have the desired impact.

Standard designs for developing campaigns around health innovations, including immunizations, assume that individuals are mainly influenced through the process of social learning; in other words, that they are active learners, absorbing specific information about the

innovation of interest (e.g., information about the community benefits of immunizations) from people in their network (Hogset & Barrett, 2010). However, this means that individuals who are mainly influenced through the process of social control (like the mothers/caregivers in this study) will be less impacted by this type of campaign. This is the case because individuals that are mainly influenced through the process of social control respond less to precise information about health innovations (e.g., information about the community benefits of immunizations), and more to the knowledge that there is consensus around it (e.g., knowledge that a majority of their peers are using immunizations; Hogset & Barrett, 2010).

Because mothers/caregivers are influenced through both social control and social learning, immunization campaigns should include messages that target both types of processes. However, these campaigns should make sure to emphasize the social-control oriented message, such as information about the attributes of the key groups of people who are using immunizations. Indeed, if campaigns are designed for actively learning groups only, then a sense of consensus may not be generated, passive learning may fail, and immunization campaigns may end up less impactful than they could have been.

Closing the gap in the two-step flow model of mass communication with "new" social network influencers. Social networks researchers have demonstrated the important role that peers and family members play in health-decision making. However, strategies need to be put in place that more adequately account for the role of these more contextually specific influencers. The results from this dissertation show that husbands and males in general, play a critical role in immunization decision-making. The results also show that opinion leaders and peers have a pronounced influence on immunization use. These findings point to value of leveraging and combining the influence of males and influential females and their close leader

networks to positively change the routine immunization behaviors of more immunization-hesitant mothers/caregivers.

The *two-step flow model of mass communication* suggests that opinion leaders mediate the influence of the mass media on the wider population (Katz & Lazarsfeld, 1955). However, based on the findings in this dissertation, males and influential female relatives should also be included in this model. Systematically incorporating males and influential females in efforts to increase immunization use may help programmers reach mothers/caregivers who are at the greatest risk of not immunizing their children.

Using a coordinated approach to designing social network interventions. The findings show that the mass media and the formal health system are important sources of influence on routine immunizations. Recent exposure to mass media about immunizations, the number of health providers that mothers/caregivers communicated with about immunizations, and previous experience visiting a health facility for other services, were all consistently important predictors of immunization use. This means that social network interventions should consider coordinating these more traditional sources of influence into their design.

For example, the mass media may help to increase the uptake of routine immunizations by being a medium for reaching people, wherever they may be, when they are ready to receive the message, and being an additional source of information that ultimately makes delivered message seem more credible. Overall, incorporating mass media into social network interventions will allow programmers to further leverage social dynamics and networks in a way that facilitates the wider spread of key messages around immunizations and encourages the use of this health service.

Continuing to integrate local health professionals into campaigns around routine immunizations may also contribute to positively changing immunization behaviors. For example, using more general strategies that focus on getting mothers/caregivers to health facilities for care may prove useful, since increasing mothers/caregivers' exposure to local providers and this type of setting might make them more comfortable with the idea of immunizing their child. Overall, mass media and health system interventions are compatible with social network interventions and can work in tandem to help strengthen activities around immunization use.

Conclusion

Despite its limitations, this dissertation confirms that health outcomes depend not just on individuals' own beliefs and actions, but also on the normative beliefs and actions of the people around them. To improve the effectiveness of interventions aimed at improving immunization acceptance, researchers and programmers alike should treat mothers/caregivers not only as individuals, but as members of meaningful and influential interpersonal networks. By embracing this approach, we will improve our understanding of the determinants of routine immunization use in developing countries while accelerating the impact of immunization programs on child survival outcomes in contexts, like northern Nigeria, with some of the worst immunization coverage rates in the world.

REFERENCES

Abdalla, I. H. (1991). Neither friend, nor foe: The Malam practitioner-Yan Bori relationship in Hausaland. In I. M. Lewis, A. Al-Safi, & S. Hurreiz (Eds.), *Women's medicine: The Zar-Bori cult in Africa and beyond*. Edinburgh, Scotland: Edinburgh University Press.

Abdel Salam, H. H., & Sokal, M. M. (2004). Accuracy of parental reporting of immunization. *Clinical Pediatrics*, *43*, 83-85.

Abdulazeez, J. (November 12, 2012). *Interview with Allison Goldberg*. Nahuche Health and Demographic Surveillance Site, PRRINN-MNCH. Nahuche, Zamfara State, Nigeria.

Abubakar, M. S., Musa, A. M., Ahmed, A., Hussaini, L. M. (2007). The perception and practice of traditional medicine in the treatment of cancers and inflammations by the Hausa and Fulani tribes of Northern Nigeria. *Journal of Ethnopharmacology*, *111*, 625-629.

Acharya, L. B., & Cleland, J. (2000). Maternal and child health services in rural Nepal: Does access or quality matter more? *Health Policy & Planning, 15*(2), 223-229.

Adeyinka, D. A., Oladimeji, O., Adeyinka, F. E., & Aimakhu, C. (2009). Uptake of childhood immunizations among mothers of under-five in southwestern Nigeria. *The Internet Journal of Epidemiology, 7*(2). Retrieved from http://archive.ispub.com/journal/the-internet-journal-of-epidemiology/volume-7-number-2/uptake-of-childhood-immunization-among-mothers-of-under-five-in-southwestern-nigeria.html#sthash.z00crcob.dpbs. doi: 10.5580/f4.

African Population and Health Research Center. (2009). *Change and continuity in reproductive norms and behavior: A Northern Nigeria study*. Report submitted to the David and Lucile Packard Foundation, Nigeria Office.

Ailshire, J. A., & Burgard, S. A. (2012). Family relationships and troubled sleep about U.S. adults: Examining the influences of contact frequency and relationship quality. *Journal of Health and Social Behavior, 53*(2), 248-262. doi: 10.1177/0022146512446642.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), *The handbook of attitudes* (pp. 173-221). Mahwah, NJ: Erlbaum.

Alexander, C., Piazza, M., Mekos, D., & Valente, T. W. (2001). Peer networks and adolescent cigarette smoking: An analysis of the national longitudinal study of adolescent health. *Journal of Adolescent Health, 29*, 22–30.

Allen, J. D., Mohllajee, A., Shelton, R. C., Othus, M. K., Fontenot, H. B., & Hanna, R. (2009). Stage of adoption of the human papillomavirus vaccine among college women. *Preventive Medicine, 48*(5), 420-425.

Andrews, J. A., Tildesley, E., Hops, H., & Li, F. (2002). The influence of peers on young adult substance use. *Health Psychology, 21*(4), 349-357.

Antai, D. (2009a). Inequitable childhood immunization uptake in Nigeria: A multilevel analysis of individual and contextual determinants. *BMC Infectious Diseases, 9,* 181.

Antai, D. (2009b). Faith and child survival: The role of religion in childhood immunization in Nigeria. *Journal of Biosocial Science, 41*(1), 57-76.

Antai, D. (2010). Migration and child immunization in Nigeria: Individual- and community-level contexts. *BMC Public Health, 10,* 116.

Armantier, O. (2004). Does observation influence learning? *Games and Economic Behavior, 46,* 221-239.

Avogo, W., & Agadjanian, V. (2008). Men's social networks and contraception in Ghana. *Journal of Biosocial Science, 40,* 413-429.

Babalola, S. (2009). Determinants of the uptake of the full dose of Diphtheria-Pertusis-Tetanus Vaccines (DPT3) in Northern Nigeria: A multi-level analysis. *Maternal Child Health Journal, 13,* 550-558.

Babalola, S. (2011). Maternal reasons for non-immunisation and partial-immunisation in northern Nigeria. *Journal of Paediatrics and Child Health, 47*(5), 276-281.

Babalola, S., & Fatusi, A. (2009). Determinants of use of maternal health services in Nigeria – looking beyond individual and household factors. *BMC Pregnancy and Childbirth, 9,* 43.

Babalola, S., & Lawan, U. (2009). Factors predicting BCG immunization status in northern Nigeria: A behavioral-ecological perspective. *Journal of Child Health Care, 13*(1), 46-62.

Baker, W. E. (1990). Market networks and corporate behavior. *American Journal of Sociology, 96,* 589-625.

Bandiera, O., & Rasul, I. (2006). Social networks and technology adoption in northern Mozambique. *Economic Journal, 116*(514), 869-902.

Barrington, C., Latkin, C., Sweat, M. D., Moreno, L., Ellen, J., & Kerrigan, D. (2009). Talking the talk, walking the walk: Social network norms, communication patterns, and condom use among the male partners of female sex workers in La Romana, Dominican Republic. *Social Science and Medicine, 68*(11), 2037-2044.

Bauch, C. T., & Earn, D. J. (2004). Vaccination and the theory of games. *Proceedings of the National Academy of Sciences of the United States of America (PNAS), 101*(36), 13391-13394.

Behrman, J., Kohler, H. P., & Watkins, S. C. (2002). Social networks and changes in contraceptive use over time: Evidence from a longitudinal study in rural Kenya. *Demography, 39*, 713-738.

Berger, J., Rosenholtz, S., & Zelditch, M. (1980). Status organizing processes. *Annual Review of Sociology, 6*, 479-508.

Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine, 51*, 843-857.

Berkman, L. F., & Syme, S. L. (1979). Social networks, host-resistance, and mortality—9-year follow-up study of Alameda County residents. *American Journal of Epidemiology*, *109*(2), 186–204.

Bhuiya, A. (1995). Factors affecting acceptance of immunization among children in rural Bangladesh. *Health Policy & Planning, 10*(3), 304-311.

Blalock, H.M. (1984). Contextual-Effects Models: Theoretical and Methodological Issues. *Annual Review of Sociology, 10*, 353-372.

Blazer, D. (1982). Social support and mortality in an elderly community population. *American Journal of Epidemiology, 115*, 684–694.

Bond, K. C., Valente, T. W., & Kendall, C. (1999). Social network influences on reproductive health behaviors in urban northern Thailand. *Social Science & Medicine, 49*(12), 1599-1614.

Bongaarts, J., & Watkins, S. C. (1996). social interactions and contemporary fertility transitions. *Population and Development Review, 22*, 639–682.

Borgatti, S., Jones, C., & Everett, M. (1998). Network measures of social capital. *Connections, 21*(2), 27-36.

Borsari, B., & Carey, K. B. (2003). Descriptive and injunctive norms in college drinking: A Meta analytic integration. *Journal of Studies on Alcohol, 64*, 331-341.

Bourdieu, P. (1980). Le capital social: Notes provisoires [Social Capital: Interim Notes. *Actes de la Recherche en Sciences Sociales, 3*, 2-3.

Breiman, R. F., Streatfeld, P. M., Phelan, M., Shifa, N., Rashid, M., & Yunus, M. (2004). Effect of infant immunization on childhood mortality in rural Bangladesh: Analysis of health and demographic surveillance data. *Lancet, 364,* 2204-2211.

Bronte-Tinkew, J., & Dejong, G. F. (2005). Do household structure and household economic resources predict childhood immunization? Evidence from Jamaica and Trinidad and Tobago. *Population Research and Policy Review, 24*, 27-57.

Bozo, O., Toksabay, N. E., & Kurum, O. (2009). Activities of daily living, depression, and social support among elderly Turkish people. *Journal of Psychology, 143*(2), 193-205.

Brown, D. W., Burton, A. H., Gacic-Dobo, M., & Karimov, R. I. (2012). Data update: A summary of global immunization coverage through 2011. *The Open Infectious Diseases Journal, 6*, 71-75.

Brown, G. W., & Harris, T. (1978). *Social origins of depression*. London, UK: Tavistock.

Brummett, B. H., Barefoot, J. C., Siegler, I. C., Clapp-Channing, N. E., Lytle, B. L., Bosworth, H.B...Mark, D.B. (2001). Characteristics of socially isolated patients with coronary artery disease who are at elevated risk for mortality. *Psychosomatic Medicine, 63*(2), 267-272.

Brunson, E. (2013). The impact of social networks on parents' vaccination decisions. *Pediatrics, 131*(5), e1397–e1404.

Buhi, E. R., & Goodson, P. (2007). Predictors of adolescent sexual behavior and intention: A theory-guided systematic review. *Journal of Adolescent Health, 40*, 4-21.

Burt, R. S. (1983). Range. In R. S. Burt & M. J. Minor (Eds.), *Applied network analysis* (pp. 176-194). Beverly Hills, CA: Sage Publications.

Burt, R. S. (1984). Network *items and the general social survey*. *Social Networks, 6*, 293-339.

Burt, R. S. (1987). A note on strangers, friends, and happiness. *Social Networks, 9*(4), 311-332.

Burt, R. S. (1992). *Structural holes, the social structure of competition*. Cambridge, MA: Harvard University Press.

Burt, R. S. (1997). The contingent value of social capital. *Administrative Science Quarterly, 42*, 339-365.

Burt, R. S. (2000) The network structure of social capital. In R. Sutton & B. Staw (Eds.), *Research in organizational behavior* (pp. 345-423). Greenwich, CT: JAI Press.

Buttross, L. S., & Kastner, J. W. (2003). A brief review of adolescents and tobacco: What we know and don't know. *American Journal of Medical Science, 326*, 235-237.

Callaway, B. J. (1987). *Muslim Hausa women in Nigeria: Tradition and change*. Syracuse NY: Syracuse University Press.

Cassel, J. (1976). Contribution of social-environment to host-resistance—4th Wade Hampton Frost lecture. *American Journal of Epidemiology, 104*(2), 107–123.

Centers for Disease Control and Prevention. (2012). Global routine vaccination coverage, 2011. *Morbidity and Mortality Weekly Report, 61*(43), 883-885.

Chamala, S., & Shah, A. H. (1996). Adoption of formal agricultural credit by opinion leaders and other farmers in differentially developed villages of Bangladesh. *Savings and Development, 20*(4), 431-445.

Chen, X. P., Arzu, W., & Triandis, H. C. (2007). When does group norm or group identity predict cooperation in a public good dilemma? The moderating effects of idiocentrism and allocentrism. *International Journal of Inter-cultural Relations, 31*(2), 259-276.

Chouinard, M., & Robichaud-Ekstrand, S. (2007). Predictive value of the transtheoretical model to smoking cessation in hospitalized patients with cardiovascular disease. *European Journal of Cardiovascular Prevention and Rehabilitation, 14*, 51–58.

Christakis, N., & Fowler, J. (2007). The spread of obesity in a large social network over 32 years. *The New England Journal of Medicine, 357*, 370-379.

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine, 358*(21), 2249-2258.

Chumley, J. (2007). *Work, agriculture and the rise of female house seclusion in post-colonial Hausaland*. (Unpublished senior thesis project). University of Tennessee, Knoxville, TN. Retrieved from http://trace.tennessee.edu/utk_interstp2/8

Cialdini, R., & Goldstein, N. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology, 55*, 591-621.

Cluver, L., Bowes, L., & Gardner, F. (2010). Risk and protective factors for bullying victimization among AIDS-affected and vulnerable children in South Africa. *Child Abuse and Neglect, 34*(10), 793-803.

Cobb, S. (1976). Social support as a moderator of life stress. *Psychosomatic Medicine, 38*(5), 300-314.

Cohen, S., & Syme, L. S. (1985). Social support and health. Orlando, FL: Academic Press.

Coleman, J. (1990). *Foundations of social theory.* Cambridge, MA: Harvard University Press.

Conley, T. G., & Udry, C. R. (2001). Social learning through networks: The adoption of new agricultural technologies in Ghana. *American Journal of Agricultural Economics, 83*(3), 668-673.

Cook, W. L., & Goldstein, M. J. (1993). Multiple perspectives on family relationships: A latent variable model. *Child Development, 64,* 1377-1388.

Cornwell, B., Schumm, P., Laumann, E. O., & Graber, J. (2009). Social networks in the NSHAP Study: Rational, measurement, and preliminary findings. *Journal of Gerontolongy Series B: Psychological Sciences and Social Sciences, 64B*(Suppl 1), i47-i55.

Crowne, D. P., & Marlowe, D. (1964). *The approval motive*. New York, NY: John Wiley & Sons.

Cullum, J., O'Grady, M., Sandoval, P., Armel, S., & Tennen, H. (2013). Ignoring norms with a little help from my friends: Social support reduces normative influence on drinking behavior. *Journal of Social and Clinical Psychology, 32*(1), 17-33.

Davis, D. K., & Baron, S. J. (1981). A history of our understanding of mass communication. In D. K. Davis & S. J. Baron (Eds.), *Mass communication and everyday life: A perspective on theory and effects* (pp. 19-52). Belmont, CA: Wadsworth Publishing.

de Belvis, A. G, Avolio, M., Sicuro, L., Rosano, A., Latini, E., Damiani, G., & Ricciardi, W. (2008). Social relationships with HRQL: A cross-sectional survey among older Italian adults. *BMC Public Health, 8,* 348.

Department for International Development. (2005). *Promoting women's rights through Sharia in Northern Nigeria*. Unpublished manuscript, Center for Islamic Legal Studies, Ahmadu Bello University, Zaria, Nigeria. Retrieved from http://www.ungei.org/resources/files/dfid_promoting _womens_rights.pdf

Deutsch, M., & Gerard, H. B. (1955). A study of normative and informational social influences upon individual judgment. *Journal of Abnormal and Social Psychology, 51,* 629-636.

Doctor, H. V. (June 29, 2013). Personal communication with Allison Goldberg. Nahuche Health and Demographic Surveillance Site, PRRINN-MNCH. Nahuche, Zamfara State, Nigeria.

Doctor, H. V., Bairagi, R., Findley, S. E., Helleringer, S., & Tukur, D. (2011). Northern Nigeria Maternal, Newborn, and Child Health Programme: Selected analyses from population-based baseline survey. *The Open Demography Journal, 4* 11-21.

Doctor, H. V., Findley, S. E., & Jumare, A. (2011). Evidence-based health programme planning in northern Nigeria: Results from the Nahuche Health and Demographic Surveillance System pilot census. *Journal of Rural and Tropical Public Health, 10,* 21-28.

Doll, J., & Ajzen, I. (1992). Accessibility and stability of predictors in the theory of planned behavior. *Journal of Personality and Social Psychology, 63*, 754-765.

Donald, I., & Cooper, S. R. (2001). A facet approach to extending the normative component of the theory of reasoned action. *British Journal of Social Psychology, 40*, 599-621.

Durkheim, E. (1897). *On suicide*. New York, NY: Penguin Books.

Eisenberg, M. E., Neumark-Sztainer, D., Story, M., & Perry, C. (2005). The role of social norms and friends' influences on unhealthy weight-control behaviors among adolescent girls. *Social Science and Medicine, 60,* 1165-1173.

Elaigwu, J. I., & Gladima, H. (2003). The shadow of Sharia over Nigerian federalism. *Publius, 33*(3), 123-144.

El-Bassel, N., Gilbert, L., Wu, E., & Chang, M. (2006). A social network profile and HIV risk among men on methadone: Do social networks matter? *Journal of Urban Health, 83*(4), 602–613.

Emmons, K. M., Barbeau, E. M., Gutheil, C., Stryker, J. E., & Stoddard, A. M. (2007). Social influences, social context and health behaviors among working-class, multi-ethnic adults. *Health Education & Behavior, 34*, 315–334.

Eng, E., Naimoli, J., Naimoli, G., Parker, K., & Lowenthal, N. (1991). The acceptability of childhood immunization to Togolese mothers: A sociobehavioral perspective. *Health Education Quarterly, 18*, 97–110.

Erulkar, A. S., & Bello, M. (2007). *The experience of married adolescent girls in northern Nigeria.* Population Council. Abuja: Nigeria. Retrieved from http://www.popcouncil.org/pdfs/Nigeria_MarriedAdol.pdf

Expert Review Committee on Polio Eradication & Routine Immunization in Nigeria. (2010). *20th Meeting of the ERC on Polio Eradication & Routine Immunization in Nigeria (*Final Report on the 20th Meeting of the ERC in Nigeria). Abuja, Nigeria. Retrieved from http://www.polioeradication.org/Portals/0/Document/Resources/AdvisoryCertification/TAG/20ERCMeeting_Report_20101004.pdf

Falci, C., & McNeely, C. (2009). Too many friends: Social integration, network cohesion, and adolescent depressive symptoms. *Social Forces, 87*(4), 2031-2062.

Feder, G., & Savastano, S. (2006). The role of opinion leaders in the diffusion of knowledge: The case of integrated pest management. *World Development, 34*(7), 1287-1300.

Federal Ministry of Health, Nigeria. (2006). *National programme on immunization. Reaching Every Ward (REW) field guide*. Abuja: Nigeria. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCwQFjAA&url=http%3A%2F%2Fwww.gavialliance.org%2Fcountry%2Fnigeria%2Fdocuments%2Fcmyps%2Fcmyps-nigeria-2006-2010%2F&ei=24B-UsCvMeTjsASPrYDICw&usg=AFQjCNH7ycPPZPqJCAkl3KxA8d5zG4f01Q&sig2=Zknok2Gs9LEVYLyxR4TuDw&bvm=bv.56146854,d.cWc

Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure data-or tears: An application to educational enrollments in states of India. *Demography, 38*(1), 115-132.

Fiori, K., Antonucci, T., & Cortina, S. (2006). Social network typologies and mental health among older adults. *Journal of Gerontology: Psychological Sciences, 61B*, 25–32.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fleury, J. (1993). An exploration of the role of social networks in cardiovascular risk reduction. *Heart Lung, 22*(2), 134-144.

Foster, A. D., & Rosenzweig, M. R. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of Political Economy, 103*, 1176-1208.

Fowler, J. H. (2009). *Survey research methods. Applied research methods series* (Vol. 1, 4th ed.). Newbury Park, CA: Sage.

Fowler, J. H., & Christakis, N. A. (2008). The dynamic spread of happiness in a large social network: Longitudinal analysis over 20 years in the Framingham heart study. *British Medical Journal, 337*, 2338-2347.

Franks, M. M., Stephens, M. A., Rook, K. S., Franklin, B. A., Ketejian, B. A., & Artinian, T. N. (2006). Spouses' provision of health-related support and control to patients participating in cardiac rehabilitation. *Journal of Family Psychology, 20*, 311–318.

Freed, G. L., Katz, S. L., & Clark, S. J. (1996). Safety of vaccinations. Miss America, the media, and public health. *Journal of the American Medical Association, 276*(23), 1869-1872.

Friedman, S. R., Flom, P. L., Kottiri, B. J., Neaigus, A., Sandoval, M., Curtis, R., Zenilman, J. M. (2001). Consistent condom use in the heterosexual relationships of young adults who live in a high-HIV risk neighborhood and do not use "hard drugs." *AIDS Care, 13*(3), 285-296.

Friedman, S. R., Neaigus, A., Jose, B., Curtis, R., Goldstein, M., Ildefonso, G., des Jarlais, D. C. (1997). Sociometric risk networks and risk for HIV infection. *American Journal of Public Health, 87,* 1289–1296.

Gage, A., Sommerfelt, A., & Piani, A. (2007). Household structure and childhood immunization in Niger and Nigeria. *Demography, 34,* 295–309.

Gangarosa, E. J., Galazka, A. M., Wolfe, C. R. Phillips, L. M., Gangarosa, R. E., Miller, E. … Chen, R. T. (1998). Impact of anti-vaccine movements on pertussis control: The untold story. *Lancet, 351*(9099), 356–361.

GAVI Alliance (2012). *Report to the GAVI Alliance Board: Country Programme Update.* Geneva: Switzerland. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CEsQFjAE&url=http%3A%2F%2Fwww.gavialliance.org%2Fabout%2Fgovernance%2Fgavi-board%2Fminutes%2F2012%2F4-december%2Fminutes%2F14---country-programme-update%2F&ei=noGSUquOI8PdsATDzoH4Dg&usg=AFQjCNH7xQjbJMFGk_fd3DKm8iN8Fe1vWw&sig2=fyMEXwA-dkZ_iJWI2SMDTA&bvm=bv.56988011,d.cWc

GAVI Alliance. (2013). *Nigeria.* Geneva: Switzerland. Retrieved from http://www.gavialliance.org/country/nigeria/

Gellin, B. G., Maibach, E. W., & Marcuse, E. K. (2000). Do parents understand immunizations? A national telephone survey. *Pediatrics, 106*(5), 1097–1102.

Gerber, A. S., & Rogers, T. (2009). Descriptive social norms and motivation to vote: Everybody's voting and so should you. *Journal of Politics, 71*(1), 178-191.

Gerland, P. (2004, April). *Do social interactions affect individual HIV/AIDS attitudes and prevention strategies in rural Malawi?* Presentation at the Annual Meeting of the Population Association of America, Boston, Massachusetts.

Giles, L. C., Anstey, K. J., Walker, R. B., & Luszcz, M. A. (2012). Social networks and memory over 15 years of follow-up in a cohort of older Australians: Results from the Australian Longitudinal Study of Aging. *Journal of Aging Research,* 1-7. Retrieved from http://www.hindawi.com/journals/jar/2012/856048/

Global Polio Eradication Initiative. (2010). *Nigeria.* Geneva, SUI: World Health Organization. Retrieved from http://www.polioeradication.org/Infectedcountries/ Nigeria.aspx

Goldstein, H. (1999). *Multi-level statistical models* (4th ed.). London, UK: John Wiley & Sons Ltd.

Goleman, D. (1997). *Emotional intelligence*. New York, NY: Bantam.

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*, 1360-1380.

Graves, P. L., Thomas, C. B., & Mead, L. A. (1991). Familial and psychological predictors of cancer. *Cancer Detection and Prevention, 15*(1), 59-64.

Grilli, R., Ramsay, C., & Minozzi, S. (2002) Mass media interventions: Effects on health services utilisation. *Cochrane Database of Systematic Reviews*, 1. doi: 10.1002/14651858. CD000389.

Haines, V. A., Beggs, J. J., & Hurlbert, J. S. (2008). Contextualizing health outcomes: Do effects of network structure differ for women and men? *Sex Roles, 59*, 164-175.

Hansen, M. T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization sub-units. *Administrative Science Quarterly, 44*, 82-111.

Hayase, Y., & Liaw, K. L. (1997). Factors on polygamy in Sub-Saharan Africa: Findings based on the Demographic and Health Surveys. *The Developing Economies*, *35*(3), 293-327.

Henry, D., Guerra, N., Huesmann, R., Tolan, P., VanAcker, R., & Eron. L. (2000). Normative influences on aggression in urban elementary school classrooms. *American Journal of Community Psychology, 28*(1), 59-81.

Hershey, J. C., Asch, D. A., Thumasathit, T., Maszaros, J., & Waters, V. V. (1994). The roles of altriusim, free-riding, and bandwagoning in vaccination decisions. *Organizational Behavior and Human Decision-making Processes, 59*(2), 177–187.

Hill, R. A., & Dunbar, R. I. (2003). Social network size in humans. *Human Nature*, *14*(1), 53-72.

Hogg, M. A., & Reid, S. A. (2006). Social identity, self-categorization, and the communication of group norms. *Communication Theory, 16*, 7–30.

Hogset, H., & Barrett, C. B. (2010). social learning, social influence and projection bias: A caution on inferences based on proxy-reporting of peer behavior. *Economic Development and Cultural Change*, *58*(3), 563-589.

Homans, G. (1961). *Social behavior: It's elementary forms*. New York, NY: Harcourt Brace.

House, J. S., Robbins, C., & Metzner, H. L. (1982). The association of social relationships and activities with mortality: Prospective evidence from the Tecumseh Community Health Study. *American Journal of Epidemiology, 116*, 123–40.

Howe, L. D. (2012). Measuring socio-economic position for epidemiological studies in low and - middle income countries: A methods of measurement in epidemiology paper. *International Journal of Epidemiology, 41*(3), 871-886. Retrieved from http://www. popcouncil. org/pdfs/Nigeria_MarriedAdol.pdf

Huckfeldt, R., & Sprague, J. (1995). *Citizens, politics, and social communication: Information and influence in an election campaign.* New York, NY: Cambridge University Press.

Huesmann, L. R., & Guerra, N. G. (1997). Children's normative beliefs about aggression and aggressive behavior. *Journal of Personality and Social Psychology, 72*, 408-419.

Ibnouf, A., van den Borne, B., & Maarse, H. (2007). Immunisation coverage among under-five Sudanese children. *South African Family Practice, 49*(8), 14-19.

International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH). (2012). *Better health information for better health policy*. Retrieved from: http://www.indepth-network.org/AGM2008/3.Wednesday/Morning/Plenary %206/ INDEPTH%20Network_ED%20Presentation_Sept%202008.pdf

Israel, B. A. (1988). Social networks and health status: Linking theory, research, and practice. *Patient Counselling and Health Education, 4*, 65-79.

Israel, B. A., & Antonucci, T. (1987). Social network characteristics and psychological well-being. *Health Education Quarterly, 14*, 461-481.

Jackson, C., Cheater, F. M., & Reid, I. (2008). A systematic review of decision support needs of parents making child health decisions. *Health Expectations, 11*(3), 232–251.

Jacobs, J. (1960). *The death and life of great American cities*. New York, NY: Vintage.

Jager, A. (2005). Explaining the "accuracy" of proxy-reports on attitudes towards immigrants in Germany. Two approaches compared. *Metodoloski zvezki, 2*(1), 27-57.

Jamil, K., Bhuiya, A., Streatfield, K., & Chakrabarty, N. (1999). The immunization programme in Bangladesh: Impressive gains in coverage, but gaps remain. *Health Policy & Planning, 14*(1), 49-58.

Jani, J. V., De Schacht, C., Jani, I. V., & Bjune, G. (2008). Risk factors for incomplete vaccination and missed opportunity for immunization in rural Mozambique. *BMC Public Health, 8*:161-168.

Kadobera, D., Sartorius, B., Masanja, H., Mathew, A., & Waiswa, P. (2012). The effect of distance to formal health facility on childhood mortality: Case of Ifakara DSS in rural Tanzania, 2005-2007. *Global Health Action, 5*. Retrieved from http://www.global healthaction.net/index.php/gha/article/view/19099. doi:10.3402/gha.v5i0.19099.

Kang, S. Y., Deren, S., Andia, J., Colon, H. M., & Robles, R. (2005). Egocentric HIV risk networks among Puerto Rican crack users in New York and in Puerto Rico: Impact on sex risk behaviors over time. *AIDS Education & Prevention, 17*(1), 53–67.

Katz, E., & Lazarsfeld, P. F. (1955). *Personal influence. The part played by people in the flow of mass communication*. Glencoe, IL: Free Press.

Kaufmann, J. R., & Feldbaum, H. (2009). Diplomacy and the polio immunization boycott in northern Nigeria. *Health Affairs, 28*(4), 1091-1101.

Keller, E. B., & Berry, J. L. (2003). *The influentials*. New York, NY: Free Press.

Kelly, J. A., Lawrence, J. S., Diaz, Y. E., Stevenson, Y. L., Hauth A. C., Brasfield, T. L., …Andrew M. E. (1991). HIV risk behavior reduction following intervention with key opinion leaders of population: An experimental analysis. *American Journal of Public Health, 81*(2), 168-171.

Kelsey, K., Earp, J. L., & Kirkley, B. G. (1997). Is social support beneficial for dietary change? A review of the literature. *Family Community Health, 20*(3), 70-82.

Kennedy, A., Lavail, K., Nowak, G., Basket, M., & Landry, S. (2011). Confidence about vaccines in the United States: Understanding parents' perceptions. *Health Affairs, 30*(6), 1151–1159.

King, M. F., & Bruner, G. C. (2000). Social desirability bias: A neglected aspect of validity testing. *Psychology and Marketing, 17*(2), 79-103.

Kiros, G. E., & White, M. J. (2004). Migration, community context, and child immunization in Ethiopia. *Social Science & Medicine, 59*(12), 2603-2616.

Knoke, D. (1990a). Networks of political action: Toward theory construction. *Social Forces, 68*, 1041-1063.

Knoke, D. (1990b). *Political networks: The structural perspective*. New York, NY: Cambridge University Press.

Kohler, P. H., Behrman, J., & Watkins, S. (2001). The density of social networks and fertility decisions: Evidence from South Nyanza District, Kenya. *Demography, 38*(1), 43-58.

Kramer, G. H. (1983). The ecological fallacy revisited: Aggregate-versus individual-level findings on economics and elections and sociotropic voting. *The American Political Science Review, 77*(1), 92-111.

Langsten, R., & Hill, K. (1998). The accuracy of mothers' reports of childhood vaccination: Evidence from rural Egypt. *Social Science & Medicine, 46*, 1205-1212.

Larson, P., Mathanga, D. P., Campbell, C. H., & Wilson, M. L. (2012). Distance to health services influences insecticide-treated net possession and use among six to 59 month-old children in Malawi. *Malaria Journal, 11*(18), 1-9 doi:10.1186/1475-2875-11-18.

Latkin, C., & Knowlton, A. (2000). New direction in HIV prevention among drug users. Settings, Norms, and Network Approaches to AIDS prevention (SNNAAP): A social influence approach. *Advances in Medical Sociology, 7*, 261-287.

Latkin, C. A., Forman, V., Knowlton, A., & Sherman, S. (2003). Norms, social networks, and HIV related risk behaviors among urban disadvantaged drug users. *Social Science & Medicine, 56*, 465-476.

Latkin, C. A., Sherman, S., & Knowlton, A. R. (2003). HIV prevention among drug users: outcome of a network-oriented peer outreach intervention. *Health Psychology, 22*, 332-339.

Laumann, E. D., Marsden, P. V., & Presndky, D. (1983). The boundary specification problem in network analysis. In R. Burt & M. Minor (Eds.), *Applied network analysis: A methodological introduction* (pp. 18-34). Beverly Hills, CA: Sage.

Lazarsfeld, P. F., Berelson, B., & Gaudet, H. (1944). *The people's choice: How the voter makes up his mind in a presidential campaign.* New York, NY: Columbia University Press.

Lazarsfeld, P. F., & Katz, E. (1955). *Personal influence: The part played by people in the flow of mass communications.* New York, NY: The Free Press.

Lee, S. (2005). Demand for immunization, parental selection, and child survival: Evidence from rural India. *Review of Economics of the Household, 3*, 171-197.

Lenzer, J. (2007). Nigeria files criminal charges against Pfizer. *British Medical Journal, 334*(7605), 1181.

Lewis, J., & Speers, T. (2003). Misleading media reporting? The MMR story. *Nature Reviews Immunology, 3*(11), 913–918.

Lin, N. (1999). Building a network theory of social capital. *Connections, 22*(1), 28-51.

Lin, N. (2001). *Social capital: A theory of social structure and action*. New York, NY: Cambridge University Press.

Lin, N., Woelfel, M. W., & Light, M. C. (1985). The buffering effect of social support subsequent to an important life event. *Journal of Health and Social Behavior, 26*, 247-263.

Lockwood, P., Jordan, C., & Kunda, Z. (2002). Motivation by positive or negative role models: Regulatory focus determines who will best inspire us. *Journal of Personality and Social Psychology, 83*(4), 854-864.

Luke, D. A., & Harris, J. K. (2007). Network analysis in public health: History, methods, and applications. *Annual Review of Public Health, 28*, 69-93.

Magnani, R. J., Rice, J. C., Mock, N. B., Abdoh, A. A., Mercer, D. M., & Tankari, K. (1996). The impact of primary health care services on under-five mortality in rural Niger. *International Journal of Epidemiology, 25*(3), 568-577.

Mahler, H. I., Kulik, J. A., Butler, H. A., Gerrard, M., & Gibbons, F. X. (2008). Social norms information enhances the efficacy of an appearance-based sun protection intervention. *Social Science & Medicine, 67*(2), 321-329.

Manning, M. (2009). Relative influence of descriptive and injunctive norms on behavioral intentions. *Electronic Doctoral Dissertations for UMass Amherst.* Paper AAI3372267 Retrieved from http://scholarworks.umass.edu/dissertations/AAI3372267

Manski, C. F. (1993). Identification of endogenous social effects: The reflection problem. *The Review of Economic Studies, 60*(3), 531-542.

Marsden, P. V. (1987). Core discussion networks of Americans. *American Sociological Review, 52*, 122-131.

MEASURE Demographic and Health Surveys and ICF Macro. (2010). *Questionnaires: Household, woman's and man's: Demographic and health surveys methodology.* Washington, DC: USAID.

Melnyk, V., van Herpen, E., van Trijp, H. C. (2010). The influence of social norms in consumer decision-making: A meta-analysis. *Advances in Consumer Research, 37*, 463-464.

Miguel, E., & Kremer, M. (2003). Networks, social learning, and technology adoption: The case of de-worming drugs in Kenya (Unpublished manuscript). University of California, Berkeley Center for Labor Economics, Berkeley, CA.

Montgomery, M. R., & Casterline, J. B. (1996). Social influence, social learning and new models of fertility. *Population and Development Review, 22*, 151–175.

Morris, M., Zavisca, J., & Dean, L. (1995). Social and sexual networks: Their role in the spread of HIV/AIDS among young gay men. *AIDS Education and Prevention, 7*, 24-35.

Moser, C. M., & Barrett, C. B. (2006). The complex dynamics of smallholder technology adoption: The case of SRI in Madagascar. *Agricultural Economics, 35*(3), 373-388.

Moskowitz, D. S., & Schwarz, J. C. (1982). Validity comparisons of behavior counts and ratings by knowledgeable informants. *Journal of Personality and Social Psychology, 42*, 518-528.

Munch, A., McPherson, J. M., & Smith-Lovin, L. (1997). Gender, children, and social contact: The effects of childrearing for men and women. *American Sociological Review, 62*, 509-520.

Munshi, K. (2004). Social learning in a heterogeneous population: Technology diffusion in the Indian Green Revolution. *Journal of Development Economics, 73*(2), 185-213.

Murray, C. H. (2010). Collaborative community-based care for South African children orphaned by HIV/AIDS. *Journal for Specialists in Pediatric Nursing, 15*(1), 88-92.

Murray, C. L., Shengelia, B., Gupta, N., Moussavi, S., Tandon, A., & Thieren, M. (2003). Validity of reported vaccination data in 45 countries. In C. L. Murray & D. B. Evans (Eds.), *Health systems performance assessment: Debates, methods, and empiricism* (pp. 265-271). Geneva, SUI: World Health Organization.

Mwakubo, S. M., Obare, G. A., Omini, J., & Mohammed, L. (2004). *The influence of social capital on sustainable agriculture in marginal areas, Kenya: A case study of Machacos and Taita-Taveta districts.* Research report presented to the International Food Policy Research Institute, Washington, D.C.

Mwaniki, P. K., Kabiru, E. W., & Mbugua, G. G. (2002). Utilisation of antenatal and maternity services by mothers seeking child welfare services in Mbeere District, Eastern Province, Kenya. *East African Medical Journal, 79*(4), 184-187.

National Population Commission Nigeria and ICF Macro (2009). *Nigeria Demographic and Health Survey 2008.* Abuja, Nigeria: National Population Commission and ICF Macro. Retrieved from http://www.measuredhs.com/pubs/pdf/FR222/FR222.pdf

Nederhof, A. J. (1985). Methods of coping with social desirability bias: A review. *European Journal of Social Psychology, 15*, 263-280.

Neighbors, C., Brown, G. A., Dibello, A. M., Rodriguez, L. M., & Foster, D. W. (2013). Reliance on god, prayer, and religion reduces influence of perceived norms on drinking. *Journal of Studies on Alcohol and Drugs, 74*(3), 361-368.

Neighbors, C., Lee, C. M., Lewis, M. A., Fossos, N., & Larimer, M. E. (2007). Are social norms the best predictor of outcomes among heavy-drinking college students? *Journal on Studies of Alcohol and Drugs, 68*, 556-565.

Ngowu, R., Larson, J. S., Kim, M. S. (2008). Reducing child mortality in Nigeria: A case study of immunization and systemic factors. *Social Science & Medicine, 67*, 161-164.

Nichter, M. (1995) Vaccinations in the Third World: A consideration of community demand. *Social Science and Medicine, 41*, 617-633.

Nisbet, E. C. (2005). The engagement model of opinion leadership: Testing validity within a European context. *International Journal of Public Opinion Research, 18*(1), 3-30.

Noar, S. M., Carlyle, K., & Cole, C. (2006). Why communication is crucial: Meta-analysis of the relationship between safer sexual communication and condom use. *Journal of Health Communication, 11*(4), 365–390.

Odusanya, O., Alufohai, E., Meurice, F., & Ahonkhai, V. I. (2008). Determinants of vaccination coverage in rural Nigeria. *BMC Public Health, 8*, 381-388.

Ojanuga, D., & Johnson, M. (1992). Hausa families and health care choices: Birth injuries in African communities. *Family Systems Medicine, 10*(4), 413-421.

Okun, M. A., Ruehlman, L., Karoly, P., Lutz, R., Fairholme, C., & Schaub, R. (2003). Social support and social norms: Do both contribute to predicting leisure-time exercise? *American Journal of Health Behavior, 27*, 493-507.

Oladokun, R. E., Lawoyin, T. O., & Adedokun, B. O. (2009). Immunization status and its determinants among children of female traders in Ibadan, South-Western Nigeria. *African Journal of Medicine & Medical Sciences, 38*(1), 9-15.

Olatunji, A., Doctor, H. V., Oluwatoni, I. A., & Jumare, A. (2011). *A report on the health and demographic surveillance – baseline census. Zamfara State: Nigeria*. Gusau, Zamfara State, Nigeria: Nahuche Health Research Centre.

Onyiriuka, A. N. (2005). Vaccination default rates among children attending a static immunization clinic in Benin City, Nigeria. *Journal of Medicine and Biomedical Research, 4*(1), 71-77.

Opel, D., & Marcuse, E. K. (2013). Window or mirror: Social networks' role in immunization decisions. *Pediatrics, 131*(5). e1619-1620.

Ornish, D. (1998). *Love & survival: The scientific basis for the healing power of intimacy*. New York, NY: Harper Collins.

Orth-Gomer, K., Rosengren, A., & Wilhelmsen, L. (1993). Lack of social support and incidence of coronary heart disease in middle-aged Swedish men. *Psychosomatic Medicine, 55*, 37-43.

Owais, A., Haif, B., Siddiqui, A. R., Agha, A., & Zaidi, A. K. (2011). Does improving maternal knowledge of vaccines impact infant immunization rates? A community-based randomized-controlled trial in Karachi, Pakistan. *BMC Public Health, 11*, 239-247.

Owino, L. O., Irimu, G., Olenja, J., & Meme, J. S. (2009). Factors influencing immunization coverage in Mathare Valley, Nairobi. *East African Medical Journal*, *86*(7), 323-329.

Oyo-Ita, A., Fakunle, B., Fajola, A., & Edet, E. (2012). Immunization coverage in selected communities in Niger Delta, Nigeria. *World Journal of Vaccines, 2*, 21-26.

Padula, C. A., & Sullivan, M. (2006). Long-term married couples' health promotion behaviors. *Journal of Gerontological Nursing, 32*, 37–47.

Paulussen, T. G., Hoekstra, F., Lanting, C. I., Buijs, G. B., & Hirasing, R. A. (2005). Determinants of Dutch parents' decisions to vaccinate their children. *Vaccine, 24*, 644-651.

Pepe, M. S., Janes, H., Longton, G., Leisenring, W., & Newcomb, P. (2004). Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. *American Journal of Epidemiology, 159,* 882–890.

Perisic, A., & Bauch, C. T. (2009a). A simulation analysis to characterize the dynamics of vaccinating behavior on contact networks. *BMC Infectious Diseases, 9*, 77-92.

Perisic, A., & Bauch, C. T. (2009b). Social contact networks and disease eradicability under voluntary vaccination. *PLoS Computational Biology, 5*(2), 1-8.

Perlman, D., & Fehr, B. (1987). The development of intimate relationships. In D. Perlman & S. Duck (Eds.), *Intimate relationships: Development, dynamics, and deterioration* (pp. 13-42). Newbury Park, CA: Sage.

Pescosolido, B. A. (1986). Migration, medical care preferences and the lay referral system: A network theory on role assimilation. *American Sociological Review, 51*, 523-540.

Pescosolido, B. A., & Georgianna, S. (1989). Durkheim, suicide, and religion: Towards a network theory of suicide. *American Sociological Review, 54*(1), 33-48.

Pescosolido, B. A., & Levy, J. A. (2002). The role of social networks in health, illness, disease, and healing: The accepting present, the forgotten past, and the dangerous potential for a complacent future. *Advances in Medical Sociology, 8*, 3-25.

Pool, G., Wood, W., & Leck, K. (1998). The self-esteem motive in social influence: Agreement with valued majorities and disagreement with derogated minorities. *Journal of Personality and Social Psychology, 75*(4), 967-975.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology, 24*, 1-24.

Prinstein, M. J., Boergers, J., & Spirito, A. (2001). Adolescents' and their friends' health-risk behavior: Factors that alter or add to peer influence. *Journal of Pediatric Psychology, 26*(5), 287–298.

Putnam, R. (1995). Bowling alone, revisited. *The Responsive Community, 5*(2), 18-33.

Rani, M., & Lule, E. (2004) Exploring the socioeconomic dimension of adolescent reproductive health: A multi country analysis. *International Family Planning Perspectives, 30*(3), 110–117. doi: 10.1363/3011004.

Renne, E. (1996). Perceptions of population policy, development, and family planning in northern Nigeria. *Studies in Family Planning*, *27*(3), 127-136.

Renne, E. (2006). Perspectives on polio and immunization in northern Nigeria. *Social Science & Medicine, 63*, 1857-1869.

Renne, E. (2010). *The politics of Polio in northern Nigeria.* Bloomington, Indiana: Indiana University Press.

Reno, R. R., Cialdini, R. B., & Kallgren, C. A. (1993). The trans-situational influence of social norms. *Journal of Personality and Social Psychology, 64*(1), 104-112.

Reynolds, J. (1992, March). *The expansion of Kulle in Nigerian Hausaland*. Paper presented at the New York African Studies Association Conference, New York, NY.

Rimal, R. N., & Real, K. (2003). Understanding the influence of perceived norms on behaviors. *Communication Theory, 13*(2), 184–203.

Rivas, A., & Sheeran, P. (2003). Descriptive norms as an additional predictor in the theory of planned behavior: A meta-analysis. *Current Psychology, 22*(3), 218-233.

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. T. Cacioppo & R. E. Petty (Eds.), *Social psychophysiology: A sourcebook* (pp. 153-176). New York, NY: Guilford.

Rogers, E. M. (1995). *Diffusion of innovations*, (4th ed.). New York, NY: The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: The Free Press.

Rogers, E. M., & Kincaid, D. L. (1981). *Communication networks: Toward a new paradigm for research*. New York, NY: Free Press.

Rosenquist, J. N., Murabito, J., Fowler, J. H., & Christakis, N. A. (2010). The spread of alcohol consumption behavior in a large social network. *Annals of Internal Medicine, 152*(7), 426-433.

Ross, L., Green, D., & House, P. (1976). The "False Consensus Effect": An egocentric bias in social perception and attribution processes. *Journal of Experimental Social Psychology, 13*, 279-301.

Rothenberg, R. B., Potterat, J. J., Woodhouse, D. E., Muth, S. Q., Darrow, W. W., & Klovdahl, A. S. (1998). Social network dynamics and HIV transmission. *AIDS, 12*, 1529-1536.

Rowley, T. J. (1997). Moving beyond dyadic ties: A network theory of stakeholder influences. *Academy of Management Review, 22*(4), 887-910.

Russek, L. G., & Schwartz, G. E. (1997). Perceptions of parental caring predict health status in midlife: A 35-year follow-up on the Harvard Mastery of Stress Study. *Psychosomatic Medicine, 59*(2), 144-149.

Rutenberg, N., & Watkins, S. C. (1997). The buzz outside the clinics: Conversations and contraception in Nyanza Province, Kenya. *Studies in Family Planning, 28*, 290–307.

Rutstein, S. O., & Johnson, K. (2004). *The DHS Wealth index* (DHS Comparative Report No. 6.) Calverton, Maryland: ORC Macro. Retrieved from http://www.childinfo.org/files /DHS_Wealth_Index_%28DHS_Comparative_Reports%29.pdf

Sallis, J. F., Grossman, R. M., Pinski, R. B., Patterson, T. L., & Nader, P. R. (1987). The development of scales to measure social support for diet and exercise behaviors. *Preventative Medicine, 16*(6), 825-836.

Schoeps, A., Gabrysch, S., Niamba, L., Sié, A., & Becher, H. (2010). The effect of distance to health-care facilities on childhood mortality in rural Burkina Faso. *American Journal of Epidemiology, 173*(5), 492-498.

Schooler, C., Chaffee, S., Flora, J., & Roser, C. (1998). Health campaign channels: Tradeoffs among reach, specificity, and impact. *Human Communications Research, 24*(3), 410-432.

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms: Research article. *Psychological Science, 18*(5), 429-434.

Schwarz, J. C., Barton-Henry, M. L., & Pruzinsky, T. (1985). Assessing child-rearing behaviors with the CPRBI: A comparison of ratings by mother, father, student, and sibling. *Child Development, 56*, 462-479.

Schwarz, N. G., Gysels, M., Pell, C., Gabor, J., Schile, M., Issifou, S…Pool, R. (2009). Reasons for non-adherence to vaccination at mother and child care clinics (MCCs) in Lambarene, Gabon. *Vaccine, 39*(27), 5371-5375.

Scott, J. (2000). *Social network analysis: A handbook* (2nd ed.). Newberry Park, CA: Sage.

Seeman, T., & Berkman, L. (1988). Structural characteristics of social networks and their relationship with social support in the elderly: Who provides support. *Social Science & Medicine, 26*(7), 737-749.

Seeman, T., & Syme, S. (1987). Social networks and coronary artery disease: A comparison of the structure and function of social relations as predictors of disease. *Psychosomatic Medicine, 49*(4), 341-354.

Sherif, M. (1936). *The psychology of social norms*. New York, NY: Harper Collins.

Siddiqi, N., Siddiqi, A. E., Nisar, N., & Khan, A. (2010) Mother's knowledge about EPI and its relation with age-appropriate vaccination of infants in per-urban Karachi. *Journal of Pakistan Medical Association, 60*(11), 940-944.

Simons, J. S., Neal, D. J., & Gaher, R. M. (2006). Risk for marijuana-related problems among college students: An application of zero-inflated negative binomial regression. *American Journal of Drug and Alcohol Abuse, 32*, 41-53.

Sinclair, V., & Dowdy, S. (2005). Development and validation of the Emotional Intimacy Scale. *Journal of Nursing Measurement, 13*(3), 193-206.

Singh, P. K., Rai, R. K., Alagarajan, M., & Singh, L. (2012). Determinants of maternity care services utilization among married adolescents in rural India. *PLoS ONE, 7*(2), 1-14. doi:10.1371/journal.pone.0031666

Skovdal, M. (2012). Coping with hardship through friendship: The importance of peer social capital among children affected by HIV in Kenya. *African Journal of AIDS Research, 11*(3), 241-250.

Smith, T. W. (1995). *The impact of the presence of others on a respondent's answers to questions* (General Social Survey (GSS) Methodological Report No. 86). Retrieved from University of Chicago, National Opinion Research Center Website: http://publicdata.norc.org:41000/gss/DOCUMENTS/REPORTS/Methodological_Reports/MR086.pdf

Smith, K. P., & Christakis, N. A. (2008). Social networks and health. *Annual Review of Sociology, 34*, 405-429.

Smith, P. J., Kennedy, A. M., Wooten, K., Gust, D. A., & Pickering, L. K. (2006). Association between health care providers' influence on parents who have concerns about vaccine safety and vaccination coverage. *Pediatrics, 118*(5), 1287-1292.

Sorensen, G., Stoddard, A. M., Dubowitz, T., Barbeau, E., Bigby, J., Emmons, K. M…Peterson, K. E. (2007). The influence of social context on changes in fruit and vegetable consumption. Results of the Healthy Directions studies. *American Journal of Public Health, 97*, 1216-1227.

Steyerberg, E. W., Vickers, A. J., Cook, N. R., Gerds, T., Gonen, M., Obuchowski, N., … Kattan, M. W. (2010). Assessing the performance of prediction models. *Epidemiology, 21*(1), 128-138.

Streefland, P., Chowdbury, A. M., & Ramos-Jimenez, P. (1999). Patterns of vaccination acceptance. *Social Science and Medicine, 49,* 1705-1716.

Stross, J. K., & Bole, G. G. (1980). Evaluation of a continuing education program in rheumatoid arthritis. *Arthritis and Rheumatology, 23*(7), 846–849.

Sun, G. W., Shook, T. L., & Kay, G. L. (1996). Inappropriate use of bivariable analysis to screen risk factors for use in multivariable analysis. *Journal of Clinical Epidemiology, 49*(8), 907-916.

Tadesse, H., Deribew, A., & Woldie, M. (2009) Predictors of defaulting from completion of child immunization in south Ethiopia, May 2008: A case control study. *BMC Public Health, 9,* 150, 1-6.

Takum, T., Padung, D., Joshua, V., Mnickam, P., & Murhekar, M. V. (2011). Programmatic and beneficiary-related factors for low vaccination coverage in Papum Pare district, Arunachal Pradesh, India. *Journal of Tropical Pediatrics, 57*(4), 251-275.

Terhell, E., van Groenou, M. B., & van Tilburg, T. (2007). Network contact changes in early and later post-separation years. *Social Networks, 29,* 11–24.

Terre, L., Drabman, R., Meydrech, E., & Hsu, H. (1992). Relationship between peer status and health behaviors. *Adolescence, 27,* 595–602.

The Partnership for Reviving Routine Immunisation in Northern Nigeria, Maternal, Newborn and Child Health Programme. (2010). *2010 Annual Report*. Abuja: Nigeria. Retrieved from http://www.prrinn-mnch.org/documents/PRRINN-MNCHAnnualReport2010.pdf

Tilly, C. (1984). *Big structures, large processes, huge comparisons*. New York, NY: Russell Sage Foundation.

Ueno, K. (2005). The effects of friendship networks on adolescent depressive symptoms. *Social Science Research, 34,* 484-510.

Umar, A. (1989). No free EPI vaccines to states from '90. *New Nigerian,* 27 October.

Umar, N. (2013). Email exchange with Allison Goldberg. Nahuche Health and Demographic Surveillance Site, PRRINN-MNCH. Nahuche, Zamfara State, Nigeria.

United Nations Children's Fund. (2005). *Progress for children: A report card on immunization.* New York, NY: Author. Retrieved from http://www.unicef.org/ progressforchildren /2005n3/PFC3_English2005.pdf

United Nations Children's Fund. (2010). *Childinfo: Monitoring the situation of children and women.* New York, NY: Author. Retrieved from http://www.child info.org/ immunization_status.html

United States Agency for International Development. (2010). *Reaching young married women in northern Nigeria with information on healthy timing and spacing of pregnancy: Findings from a community survey*. Washington, DC: Author. Retrieved from http://www.esdproj. org/site/DocServer/nigeria_report_community_survey _final_draft_november_1_2.pdf

United States Agency for International Development and MEASURE Evaluation Population and Reproductive Health. (2011). *Urban-rural and poverty-related inequalities in health status: Spotlight on Nigeria*. Washington, DC: Author. Retrieved from http://www.cpc.unc.edu/measure/prh/research /best-country-fact-sheets/Urban-rural%20country%20fact%20sheet%20Nigeria.pdf

University of Pennsylvania. (2006). *Malawi Longitudinal Study of Families and Health (MLSFH)*. Retrieved from http://malawi.pop.upenn.edu/about-malawi

Urberg, K. A., Degirmencioglu, S. M., & Pilgrim, C. (1997). Close friend and group influence on adolescent cigarette smoking and alcohol use. *Developmental Psychology, 33*(5), 834-844.

Viera, A. J., & Garrett, J. M. (2005). Understanding inter-observer agreement: The Kappa statistic. *Family Medicine*, 37(5), 360-363.

Voorhees, C., Murray, D., Welk, G., Birnbaum, A., Rikisi, K. M., Johnson, C. C., … Jobe, J. B. (2005). The role of peer social network factors and physical activity in adolescent girls. *American Journal of Health Behavior, 29*(2), 183-190.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications.* New York, NY: Cambridge University Press.

Weimann, G. (1994). *The influentials. People who influence people*. Albany, NY: State University of New York Press.

Weimann, G., Tustin, D. H., Vuren, D. V., & Foubert, F. P. (2007). Looking for opinion leaders: Traditional vs. modern measures in traditional societies. *International Journal of Public Opinion Research, 19*(2), 173-190.

Wellman, B. (1983). Network analysis: Some basic principles. In R. Collins (Ed.), *Sociological theory* (pp. 155-200). San Francisco, CA: Jossey-Bass.

Wellman, B. (1988). Structural analysis: From method to metaphor to theory and substance. In B. Wellman & S. D. Berkowitz (Eds.), *Social structures: A network approach* (pp. 19-61). Cambridge, UK: Cambridge University Press.

Wellman, B., & Berkowitz, S. D. (1988). *Social structures: A network approach*. Cambridge, UK: Cambridge University Press.

Wellman, B., & Wortley, S. (1990). Different strokes from different folks: Community ties and social support. *American Journal of Sociology, 96*, 558-588.

White, H., Boorman, S., & Brieger, R. (1976). Social structure from multiple networks I. Blockmodels of roles and positions. *American Journal of Sociology, 81*, 730-780.

White, K. M., Terry, D. J., & Hogg, M. A. (1994). Safer sex behavior: The role of attitudes, norms, and control factors. *Journal of Applied Social Psychology, 24*, 2164-2192.

Wild, L. G., Flisher, A. J., & Roberson, B. A. (2011). Risk and resilience in orphaned adolescents living in a community affected by AIDS. *Youth and Society, 45*, 140-162. doi: 10.1177/0044118X11409256.

Wood, Y. R. (1984). Social support and social networks: Nature and measurement. In P. McReynolds & G. J. Chelune (Eds.), *Advances in psychological assessment* (Vol. 6, pp. 312-353). San Francisco, CA: Jossey-Bass.

Wood, W., Pool, G., Leck, K., & Purvis, D. (1996). Self-definition, defensive processing, and influence: The normative impact of majority and minority groups. *Journal of Personality and Social Psychology, 71*(6), 1181-1193.

World Health Organization. (2002). *World Health Organization traditional medicine strategy 2002–2005*. Retrieved from www.who.int/medicines/ publications/traditional policy/en/index.html

World Health Organization. (2005). *Towards universal coverage of basic health services: Contribution to routine immunization in Nigeria* (Interim Report). Retrieved from http://www.who.int/countries/nga/areas/immunization_ireport.pdf

World Health Organization. (2010). *WHO vaccines for preventable diseases: Monitoring system*. Retrieved from World Health Organization, Department on Immunization, Vaccines, and Biologicals website: http://www.who.int/immunization/en/

Wright, J., Lubben, F., & Mkandawire, M. B. (2007). Young Malawians on the interaction between mental health and HIV/AIDS. *African Journal of AIDS Research, 6*(3), 297-304.

Yahya, M. (2007). Polio vaccines – "*No Thank You*!" Barriers to polio eradication in northern Nigeria. *African Affairs, 106*, 185-204.

Youm, Y., & Laumann, E. O. (2002). Social network effects on the transmission of sexually transmitted diseases. *Sexually Transmitted Disorders, 29*(11), 689-697.

Zea, M. C., Reisen, C., Poppen, P., Echeverry, M., & Bianchi, F. (2004). Disclosure of HIV-Positive status to Latino gay men's social networks. *American Journal of Community Psychology, 33*, 107-116.

APPENDIX A:

FIELD WORKER TRAINING, PILOT TESTING, & DATA COLLECTION PROCEDURE DETAILS

Selection & Training of Field Workers

Twenty-five individuals were interviewed to be field workers in the study. These individuals participated in a 30-45 minute interview, where they were evaluated on four criteria: 1) level of fluency in English and Hausa (the predominant, local language of northern Nigeria); 2) indigenicity (also from a rural community in Zamfara State); 3) experience collecting data from human subjects using survey instruments; and 4) interviewing skills, assessed through the observation of a mock interview. Nine of the 25 individuals (8 females and 1 male) were hired to be field workers.

The field workers participated in an intensive, three-day training. The training covered the following topics: 1) research question and study aims; 2) study population and eligibility criteria; 3) routine immunization schedule in Nigeria; 4) data collection methods, including strategies for interview administration; 5) informed consent procedures; and 6) strategies for ensuring participant confidentiality. The field workers practiced administering the surveys in different scenarios (e.g. assuming the mother/caregiver was not married; assuming that the vaccination card for the child was only partially complete) to prepare themselves to administer the survey under a range of conditions. Finally, the field workers reviewed the interview guides for clarify and comprehension. They made modifications to the interview guides during the training and translated all consent forms and surveys into Hausa to ensure the guides' quality and cultural appropriateness.

At the end of the training, the field workers participated in a pilot, where they practiced administering the interviews to women (two women per female interviewer) and opinion leaders (1 traditional medicine provider, 1 religious leader, and 1 political leader) in one of the HDSS villages that was not selected for study inclusion. The purpose of this pilot was to offer constructive feedback about their administration of interviews, body language, and ability to protect respondent confidentiality and privacy. Based on the participation and results of the pilot, we made changes as a team to the study protocol and surveys.

Data Collection Procedures

After the data collection training and "pilot" were complete, the data collection process began. Every morning, I met with the district head and village chiefs to get approval to collect interviews in their communities. The HDSS manager notified all political leaders about our data collection plan one-day prior to our arrival. Once approved to enter a community, the trained interviewers were provided with the following materials: 1) 15-20 surveys and consent forms; 2) a diagram indicating the different parts of the body where immunizations are administered; 3) two pens and highlighters; 4) a list of eligible respondents, assigned to each field worker; 5) a list of all the women living in the eligible respondents' compounds, who could be designated as "peers;" 6) water; 7) a lunch stipend; and 8) cell phone minutes to call me if they needed assistance. With guidance from the HDSS supervisors, a short debriefing was held and the field workers began the interview process.

The interview process for the mothers/caregivers went as follows. First, the field workers asked the first adult that they saw in the compound for permission to enter the premises. If the head of the compound was home (which was rarely the case since most men work on the farm during the day), he was asked for permission to enter the home. Otherwise, any other adult

family member could give the field worker permission to enter. Once permission was received, the field workers identified a potential respondent, introduced herself to the respondent, and started the informed consent process. If the respondent agreed and was able to participate in the study, the field worker would conduct the interview. Interviews with the mothers/caregivers were conducted over 13 consecutive days.

Data collection of the opinion leader interviews operated somewhat differently. The male field worker, hired to conduct all opinion leader interviews, started data collection one day after the female field workers. That way, the interviews completed with the female respondents could be used to generate a list of opinion leaders that the mothers/caregivers mentioned as influencing their childhood immunization decisions. The same informed consent process used to interview the mother/caregivers was used to interview the opinion leaders.

The HDSS staff member was responsible with collecting point-level census data from key venues using a GPS device over a seven-day period. Since the individual collecting these data worked full-time for the HDSS, he knew how to locate most of the key venues (health facilities, central mosques, markets) in the communities. Interviews with opinion leaders were conducted over 12 consecutive days.

The study employed strict quality control measures throughout the data collection period. I located each field worker between three to five times each day to check their completed interviews and discuss any questions or problems the field workers faced in the field. I also encouraged the field workers to call me with any questions or concerns that needed immediate attention. When I found documentation errors or inconsistencies in the completed surveys, I immediately sent the field workers back to the mother/caregiver for a "revisit" to the address them.

APPENDIX B:

CONSENT FORM FOR OPINION LEADERS

PRRINN-MNCH/HDSS

Attached to Protocol: IRB-AAAI7653
Principal Investigator: Peter Alan Messeri
IRB Protocol Title: Social Networks and Routine Immunization Practices in Northern Nigeria: A Social Network Analysis of Routine Immunization Uptake in Bungudu LGA, Zamfara State, Northern Nigeria

Consent Number: **CF-AAAJ4018**
Participation Duration: 15 minutes
Anticipated Number of Subjects: 128

Contact

Contact	Title	Contact Type	Numbers
Henry Doctor	Associate Research Scientist	Emergency	Cell: 070-642-367-92
Allison Goldberg		Co-Investigator	Cell: 080-335-780-69

Research Purpose
The purpose of this study is to investigate the impacts of parents' social networks on their decision to immunize, or not immunize, their children

Information on Research Purpose
We are doing this research study to find out your opinion about the use of childhood immunizations. You are being asked to take part in this study because you are a leader or health provider in your village. About 128 leaders and health providers are expected to be enrolled in this study. All of these leaders and providers live in Bungudu.

Invitation to Participate
The purpose of this form is to give you information to help you decide if you want to take part in this research study. This consent form includes information about: why the study is being done; the things that you will be asked to do if you are in the study; any known risks involved; any potential benefit; and options, other than taking part in this study, that you have. An interviewer will discuss the study with you. If at any time you have questions about the study, please ask him. Take all the time you need to decide whether you want to take part in this research study. The purpose of this research is described in the 'Purpose' section of this consent form.

Procedures
You will be asked a series of questions regarding your opinion about childhood vaccinations. The research forms will not ask for your name, address, or other identifying information. Taking part in this study will last 20 minutes.

Risks
This research study involves questions that may be sensitive and personal in nature. It is possible that answering some questions may cause some stress. Feel free to skip questions that you do not feel comfortable answering.

Another risk of taking part in this study is the possibility of a loss of confidentiality. Loss of confidentiality includes having your personal information shared with someone who is not on the study team and was not supposed to see or know about your information. The study team plans to protect your confidentiality. Their plans for keeping your information private are described in the 'confidentiality' section of this consent form.

Although it is not a risk, taking part in this study also involves the inconvenience of giving 20 minutes of your time in order to complete an interview.

Benefits
You may not get a direct benefit from participating in this study. However, the information collected from this research may help others in the future.

Confidentiality
Any information collected during this study that can identify you by name will be kept confidential. You will not be contacted in the future to provide additional information. We will do everything we can to keep your data secure, however, complete confidentiality cannot be promised. Despite all of our efforts, unanticipated problems, such as a stolen computer may occur, although it is highly unlikely. Your questionnaire responses will be assigned a code number, and separated from your name or any other information that could identify you. Only the following individuals and/or agencies will be able to look at and copy your research records: The investigators and the Institutional Review Board ('IRB') of Columbia University and Zamfara State, and the sponsor of this study, the Partnership for Reviving Routine Immunisation in Northern Nigeria, Maternal, Newborn, and Child Health Programme (PRRINN-MNCH), including persons working with PRRINN-MNCH.

Additional Costs

There are no costs to participating in this study.

Voluntary Participation
Participation in this study and completing the research questionnaires is voluntary. You may choose to participate or not, and you may choose not to answer any question that you do not want to answer. You can also choose to stop at any time. If you decide not to complete the questionnaire, it will not affect your rights in any way.

Additional Information Questions
If you have any questions about the study, please feel free to ask your interviewer.

If later you have any questions regarding the study, you should call the co-investigator, Allison Goldberg, 080-335-780-69. If you have any questions about your rights as a research subject, you should contact the Columbia University Institutional Review Board by phone at (212) 305-5883 or by email at askirboffice@columbia.edu. More information about taking part in a research study can be found on the Columbia University IRB website at: http://www.cumc.columbia.edu/dept/irb.

You will be provided with a copy of this informational form after your interview is complete.

Statement of Consent
I have read the consent form and talked about this research study, including the purpose, procedures, risks, benefits and alternatives with the researcher. Any questions I had were answered to my satisfaction. I am aware that by signing below, I am agreeing to take part in this research study and that I can stop being in the study at any time. I am not waiving (giving up) any of my legal rights by signing this consent form. I will be given a copy of this consent form to keep for my records.

Signature

Study Participant

Print Name_____Signature_____Date_____

Person Obtaining Consent

Print Name_____Signature_____Date_____

APPENDIX C:

VILLAGE CHIEF SURVEY

In collaboration with
ZAMFARA STATE MINISTRY OF HEALTH
PRRINN-MNCH PROGRAMME
BUNGUDU HEALTH AND DEMOGRAPHIC SURVEILANCE SYSTEM
VILLAGE CHIEFS AND IMMUNIZATIONS SURVEY

TIME INTERVIEW STARTED ……					AM PM

FW NAME AND 2-DIGIT CODE:							
NAME OF VILLAGE CHIEF:							
Tick the box at the end of the row if the respondent is the District Head:							
VILLAGE NAME WHERE LEADS:							
NAME OF VILLAGE WHERE LIVES:							
COMPOUND NAME AND 6-DIGIT ID (if met at home):							
TENURE AS VILLAGE CHIEF IN THIS VILLAGE: ____MONTHS _____YEARS							
INTERVIEWER VISITS (Circle the date of the visit that resulted in a complete interview):	1	2	3				
DETAILS OF VISIT ATTEMPTS (Indicate which visit you are referring to (1,2, or 3):							
DATE OF INTERVIEW :	D D	M M	*2*	*0*	*1*	*1*	
RESULTS OF INTERVIEW (complete at end of interview): (1=COMPLETED, 2= PARTIAL INTERVIEW; 3=RESPONDENT NOT AVAILABLE, 4=ABSENT FOR EXTENDED PERIOD, 5=REFUSED, 6=POSTPONED, 7=RESPONDENT NOT ELIGIBLE, 8=OTHER)							

DATE FORMS CHECKED BY SUPERVISOR	D D	M M	*2*	*0*	*1*	*1*		

Interviewer Note: These questions are for the village chiefs in the villages where women are being interviewed about their children's immunizations.

Read the following statement to the village chief: "NOW I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR PERCEPTIONS AND ACTIVITIES RELATED TO CHILDHOOD IMMUNIZATIONS"

Page 1

Q1	When you hold village meetings, including those specifically for women, do you ever speak about child immunizations?	NO..... 0→SKIP TO Q4 YES..... 1
Q2	How often do you speak about child immunizations at these meetings? **READ LIST**	SOME MEETINGS…… 1 MOST MEETINGS..... 2 EVERY MEETING..... 3
Q3	What do you say about child immunizations in these village meetings? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	IMMUNIZATIONS CAN PREVENT DEATH…… 1 IMMUNIZATIONS CAN PREVENT DISEASE…… 2 IMMUNIZATIONS HAVE COMMUNITY BENEFITS…. 3 IMMUNIZATIONS CAN CAUSE INFERTILITY…….. 4 IMMMUNIZATIONS CAN CAUSE AIDS…….. 5 IMMUNIZATIONS ARE NOT SAFE…….. 6 IMMUNIZATIONS ARE NOT EFFECTIVE…….. 7 OTHER (SPECIFY: _____) 8
Q4	Do you ever speak about child immunizations outside of village meetings?	NO..... 0→SKIP TO Q6 YES..... 1
Q5	How many times have you spoken outside of village meetings about child immunizations?	ONCE…….. 1 TWICE…….. 2 THREE OR MORE TIMES…….. 3
Q6	Do you approve or disapprove of the use of child immunizations? **READ LIST**	STRONGLY DISAPPROVES IT…….. 1→SKIP TO Q8 DISAPPROVES IT..... 2→SKIP TO Q8 CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5
Q7	What have you done to show that you approve of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** ***SKIP* TO END OF SURVEY FOR ALL RESPONDENTS WHO ANSWERED THIS QUESTION, EXCEPT THOSE WHO REPORT THAT THEY "HAVE CONCERNS, BUT ACCEPT IT" IN Q6**	SAID HE APPROVES IT AT MEETINGS..... 1 SAID APPROVES IT IN PUBLIC..... 2 ENCOURAGES WOMEN TO GO TO CLINIC……. ADVOCATES FOR IMMUNIZATIONS 3 BEFORE/DURING IMMUNIZATION CAMPAIGNS.... 4 DISPELLS MYTHS ABOUT IMMUNIZATIONS..... 5 VACCINATED OWN CHILD..... 6 NOTHING..... 7 OTHER (_____) 8
Q8	What are your biggest concerns about immunizing child(ren)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	METHOD 1. MAKES CHILD SICK (FEVER, SORE)…….. 1 2. AFRAID CAUSES INFERTILITY…….. 2 3. AFRAID CAUSES HIV…….. 3 4. NOT EFFECTIVE…….. 4 5. TRADITIONAL MEDICINE PREFERED..... 5 CLINICS 5 6. TOO FAR AWAY…….. 6 7. COSTS TOO MUCH…….. 7 8. NOT AVAILABLE WHEN NEED IT..... 8 9. WAIT TOO LONG…….. 9 10. ATTITUDE OF STAFF…… 10 11. OTHER (_____) 11

Q9	What have you done to show that you <u>disapprove</u> of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	SAID DISAPPROVES IT AT MEETINGS..... DISCOURAGES WOMEN TO GO TO CLINIC..... PARTICIPATE IN PROTESTS AGAINST IMMUNIZATIONS..... REFUSED TO VACCINATE OWN CHILD..... NOTHING..... OTHER (SPECIFY: _____)	1 2 3 4 5 6

<u>INTERVIEWER:</u> THANK RESPONDENT FOR HIS/HER PARTICIPATION IN SURVEY.

TIME INTERVIEW ENDED.....

				AM PM

APPENDIX D:

RELIGIOUS LEADER SURVEY

In collaboration with
ZAMFARA STATE MINISTRY OF HEALTH
PRRINN-MNCH PROGRAMME
BUNGUDU HEALTH AND DEMOGRAPHIC SURVEILANCE SYSTEM
RELIGIOUS LEADERS AND IMMUNIZATIONS SURVEY

TIME INTERVIEW STARTED ……					AM PM

FW NAME AND 2-DIGIT CODE:							
NAME OF RELIGIOUS LEADER:							
NAME OF VILLAGE WHERE LEADS:							
NAME OF VILLAGE WHERE LIVES:							
COMPOUND NAME AND 6-DIGIT ID:							
NAME OF MOSQUE (if more than 1, document primary mosque):							
TENURE AS RELIGIOUS LEADER AT PLACE OF WORSHIP IN THIS VILLAGE: __MONTHS ___YEARS							
TYPE OF RELIGIOUS LEADER:							
INTERVIEWER VISITS (Circle the date of the visit that resulted in a complete interview):	1	2	3				
DETAILS OF VISIT ATTEMPTS (Indicate which visit you are referring to (1, 2, or 3)):							
DATE OF INTERVIEW :	D	D	M	M	2	0	1	1
RESULTS OF INTERVIEW (complete at end of survey): (1=COMPLETED, 2= PARTIAL INTERVIEW, 3= RESPONDENT NOT AVAILABLE, 4=ABSENT FOR EXTENDED PERIOD, 5=REFUSED, 6=POSTPONED, 7=RESPONDENT NOT ELIGIBLE, 8=OTHER)								

DATE FORMS CHECKED BY SUPERVISOR	D	D	M	M	2	0	1	1

Interviewer Note: These questions are for the religious leaders in the villages where women are being interviewed about their children's immunizations.

Read the following statement to the religious leader: "NOW I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR PERCEPTIONS AND ACTIVITIES RELATED TO CHILDHOOD IMMUNIZATIONS"

Page 1

Q1	When you are at mosque, do you ever speak about child immunizations?	NO..... YES.....	0→SKIP TO Q3 1
Q2	How often do you speak about child immunizations at mosque? **READ LIST**	SOME MAIN SERVICES…….. MOST MAIN SERVICES..... EVERY MAIN SERVICE.....	1 2 3
Q3	When you are at Koranic school, do you ever speak about child immunizations? **IF RESPONDENT SAYS "NO" TO Q1& Q3, *SKIP* TO Q6**	NO..... YES..... NOT APPLICABLE (DOES NOT TEACH AT KORANIC SCHOOL).....	0→SKIP TO Q5 1 2→SKIP TO Q5
Q4	How often do you speak about child immunizations at Koranic school? **READ LIST**	SOME CLASSES…….. MOST CLASSES..... EVERY CLASS.....	1 2 3
Q5	What do you say about child immunizations in mosque and/or Koranic school? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	IMMUNIZATIONS CAN PREVENT DEATH…… IMMUNIZATIONS CAN PREVENT DISEASE…… IMMUNIZATIONS HAVE COMMUNITY BENEFITS… IMMUNIZATIONS CAN CAUSE INFERTILITY…… IMMMUNIZATIONS CAN CAUSE AIDS…… IMMUNIZATIONS ARE NOT SAFE…… IMMUNIZATIONS ARE NOT EFFECTIVE…… OTHER (SPECIFY: _____)	1 2 3 4 5 6 7 8
Q6	Do you ever speak about child immunizations outside of mosque/Koranic school?	NO..... YES.....	0 →SKIP TO Q8 1
Q7	How many times have you spoken outside of mosque/Koranic school about child immunizations?	ONCE…….. TWICE…….. THREE OR MORE TIMES…….	1 2 3
Q8	Do you approve or disapprove of the use of child immunizations? **READ LIST**	STRONGLY DISAPPROVES IT…….. DISAPPROVES IT..... HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... APPROVES IT..... STRONGLY APPROVES IT.....	1→SKIP TO Q10 2→SKIP TO Q10 3 4 5
Q9	What have you done to show that you approve of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** ***SKIP* TO END OF SURVEY FOR ALL RESPONDENTS WHO ANSWERED THIS QUESTION, EXCEPT THOSE WHO REPORT THAT THEY "HAVE CONCERNS, BUT ACCEPT IT" IN Q8**	SAID HE APPROVES IT AT SERVICES/CLASSES..... SAID APPROVES IT IN PUBLIC..... ENCOURAGES WOMEN TO GO TO CLINIC…….. ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S)..... DISPELLS MYTHS ABOUT IMMUNIZATIONS..... VACCINATED OWN CHILD..... NOTHING..... OTHER (_____)	1 2 3 4 5 6 7 8

Q10	What are <u>your</u> biggest concerns about immunizing child(ren)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	<u>METHOD</u> 1. MAKES CHILD SICK (FEVER, SORE)..... 1 2. AFRAID CAUSES INFERTILITY..... 2 3. AFRAID CAUSES HIV..... 3 4. NOT EFFECTIVE..... 4 5. TRADITIONAL MEDICINE PREFERED..... 5 <u>CLINICS</u> 5 6. TOO FAR AWAY..... 6 7. COSTS TOO MUCH..... 7 8. NOT AVAILABLE WHEN NEED IT..... 8 9. WAIT TOO LONG..... 9 10. ATTITUDE OF STAFF..... 10 11. OTHER (_____)..... 11
Q11	What have you done to show that you <u>disapprove</u> of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	SAID DISAPPROVES IT AT SERVICES/CLASSES..... 1 SAID DISAPPROVES IT IN PUBLIC..... 2 DISCOURAGES WOMEN TO GO TO CLINIC..... 3 PARTICIPATE IN PROTESTS AGAINST IMMUNIZATIONS..... 4 REFUSED TO VACCINATE OWN CHILD..... 5 NOTHING..... 6 OTHER (SPECIFY: _____) 7

<u>INTERVIEWER:</u> THANK RESPONDENT FOR HIS PARTICIPATION IN SURVEY.

TIME INTERVIEW ENDED.....

				AM PM

APPENDIX E:

TRADITIONAL HEALER SURVEY

In collaboration with
ZAMFARA STATE MINISTRY OF HEALTH
PRRINN-MNCH PROGRAMME
BUNGUDU HEALTH AND DEMOGRAPHIC SURVEILANCE SYSTEM
TRADITIONAL HEALERS AND IMMUNIZATIONS SURVEY

TIME INTERVIEW STARTED …… | | | | | AM PM

FW NAME AND 2-DIGIT CODE:						
NAME OF TRADITIONAL HEALER:						
VILLAGE NAME:						
COMPOUND NAME AND 6-DIGIT ID:						
NAME OF CLINIC (if works outside of home):						
TENURE AS TRADITIONAL HEALER IN THIS VILLAGE: ____MONTHS _____YEARS						
TYPE OF TRADITIONAL HEALER:						
INTERVIEWER VISITS (Circle the date of the visit that resulted in a complete interview):	1	2	3			
DETAILS OF VISIT ATTEMPTS (Indicate which visit you are referring to (1, 2, or 3)):						
DATE OF INTERVIEW :	D D	M M	2 0 1 1			
RESULTS OF INTERVIEW (complete at end of interview): (1=COMPLETED, 2= PARTIAL INTERVIEW; 3=RESPONDENT NOT AVAILABLE, 4=ABSENT FOR EXTENDED PERIOD, 5=REFUSED, 6=POSTPONED, 7=RESPONDENT NOT ELIGIBLE, 8=OTHER)						

DATE FORMS CHECKED BY SUPERVISOR ..... | D D | M M | 2 0 1 1 |

Interviewer Note: These questions are for the traditional healers in the villages where women are being interviewed about their children's immunizations.

Read the following statement to the traditional healer: "NOW I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR PERCEPTIONS AND ACTIVITIES RELATED TO CHILDHOOD IMMUNIZATIONS"

Q1	Do you ever speak with women who visit you to get care for their child about child immunizations?	NO.....	0 SKIP TO Q4
		YES.....	1

Page 1

Q2	How often do you speak to women who visit you to get care for their child about child immunizations? **READ LIST**	SOME VISITS MOST VISITS EVERYVISIT	1 2 3
Q3	What do you say about child immunizations to women when they visit you to seek care for their child? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	IMMUNIZATIONS CAN PREVENT DEATH IMMUNIZATIONS CAN PREVENT DISEASE IMMUNIZATIONS HAVE COMMUNITY BENEFITS IMMUNIZATIONS CAN CAUSE INFERTILITY IMMMUNIZATIONS CAN CAUSE AIDS IMMUNIZATIONS ARE NOT SAFE IMMUNIZATIONS ARE NOT EFFECTIVE OTHER (SPECIFY: _____)	1 2 3 4 5 6 7 8
Q4	Do you ever speak about child immunizations outside of your clinic (e.g. when not providing care)?	NO YES	0→SKIP TO Q6 1
Q5	How many times have you spoken outside of clinic (e.g. when not providing care) about child immunizations?	ONCE TWICE THREE OR MORE TIMES	1 2 3
Q6	Do you approve or disapprove of the use of child immunizations? **READ LIST**	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT	1→SKIP TO Q8 2→SKIP TO Q8 3 4 5
Q7	What have you done to show that you approve of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** ***SKIP* TO END OF SURVEY FOR ALL RESPONDENTS WHO ANSWERED THIS QUESTION, EXCEPT THOSE WHO REPORT THAT THEY "HAVE CONCERNS, BUT ACCEPT IT" IN Q6**	SAID APPROVES IT DURING CLIENT VISITS SAID APPROVES IT IN PUBLIC ENCOURAGES WOMEN TO GO TO CLINIC ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S) DISPELLS MYTHS ABOUT IMMUNIZATIONS VACCINATED OWN CHILD NOTHING OTHER (_____)	1 2 3 4 5 6 7 8
Q8	What are your biggest concerns about immunizing child(ren)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	METHOD 1. MAKES CHILD SICK (FEVER, SORE) 2. AFRAID CAUSES INFERTILITY 3. AFRAID CAUSES HIV 4. NOT EFFECTIVE 5. TRADITIONAL MEDICINE PREFERED CLINICS 6. TOO FAR AWAY 7. COSTS TOO MUCH 8. NOT AVAILABLE WHEN NEED IT 9. WAIT TOO LONG 10. ATTITUDE OF STAFF 11. OTHER (_____)	 1 2 3 4 5 5 6 7 8 9 10 11

Q9	What have you done to show that you disapprove of child immunizations? **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	SAID DISAPPROVES IT DURING CLIENT VISITS SAID DISAPPROVES IT IN PUBLIC DISCOURAGES WOMEN TO GO TO CLINIC PARTICIPATE IN PROTESTS AGAINST IMMUNIZATIONS REFUSED TO VACCINATE OWN CHILD NOTHING OTHER (SPECIFY: _____)	1 2 3 4 5 6

INTERVIEWER: THANK RESPONDENT FOR HIS/HER PARTICIPATION IN THIS SURVEY.

TIME INTERVIEW ENDED……						AM PM

APPENDIX F:

CONSENT FORM FOR MOTHERS/CAREGIVERS

PRRINN-MNCH/HDSS

Attached to Protocol: IRB-AAAI7653
Principal Investigator: Peter Alan Messeri
IRB Protocol Title: Social Networks and Routine Immunization Practices in Northern Nigeria: A Social Network Analysis of Routine Immunization Uptake in Bungudu LGA, Zamfara State, Northern Nigeria

Consent Number: **CF-AAAJ4018**
Participation Duration: 30 minutes
Anticipated Number of Subjects: 550

Contact

Contact	Title	Contact Type	Numbers
Henry Doctor	Associate Research Scientist	Emergency	Cell: 070-642-367-92
Allison Goldberg		Co-Investigator	Cell: 080-335-780-69

Research Purpose
The purpose of this study is to investigate the impacts of parents' social networks on their decision to immunize, or not immunize, their children

Information on Research Purpose
We are doing this research study to find out your opinion about the use of childhood immunizations. You are being asked to take part in this study because you are a mother/caregiver. About 550 mothers/caregivers are expected to be enrolled in this study. All of these mothers/caregivers live in Bungudu.

Invitation to Participate
The purpose of this form is to give you information to help you decide if you want to take part in this research study. This consent form includes information about: why the study is being done; the things that you will be asked to do if you are in the study; any known risks involved; any potential benefit; and options, other than taking part in this study, that you have. An interviewer will discuss the study with you. If at any time you have questions about the study, please ask her. Take all the time you need to decide whether you want to take part in this research study. The purpose of this research is described in the 'Purpose' section of this consent form.

Procedures
You will be asked a series of questions regarding your opinion about childhood vaccinations. The research forms will not ask for your name, address, or other identifying information. Taking part in this study will last 45 minutes.

Risks

This research study involves questions that may be sensitive and personal in nature. It is possible that answering some questions may cause some stress. Feel free to skip questions that you do not feel comfortable answering.

Another risk of taking part in this study is the possibility of a loss of confidentiality. Loss of confidentiality includes having your personal information shared with someone who is not on the study team and was not supposed to see or know about your information. The study team plans to protect your confidentiality. Their plans for keeping your information private are described in the 'confidentiality' section of this consent form.

Although it is not a risk, taking part in this study also involves the inconvenience of giving 45 minutes of your time in order to complete an interview.

Benefits

You may not get a direct benefit from participating in this study. However, the information collected from this research may help others in the future.

Confidentiality

Any information collected during this study that can identify you by name will be kept confidential. You will not be contacted in the future to provide additional information. We will do everything we can to keep your data secure, however, complete confidentiality cannot be promised. Despite all of our efforts, unanticipated problems, such as a stolen computer may occur, although it is highly unlikely. Your questionnaire responses will be assigned a code number, and separated from your name or any other information that could identify you. Only the following individuals and/or agencies will be able to look at and copy your research records: The investigators and the Institutional Review Board ('IRB') of Columbia University and Zamfara State, and the sponsor of this study, the Partnership for Reviving Routine Immunisation in Northern Nigeria, Maternal, Newborn, and Child Health Programme (PRRINN-MNCH), including persons working with PRRINN-MNCH.

Additional Costs

There are no costs to participating in this study.

RESPONDENT ID# (12-DIGITS): ___|___|___|___|___|___|___|___|___|___|___|___|

Voluntary Participation
Participation in this study and completing the research questionnaires is voluntary. You may choose to participate or not, and you may choose not to answer any question that you do not want to answer. You can also choose to stop at any time. If you decide not to complete the questionnaire, it will not affect your rights in any way.

Additional Information Questions
If you have any questions about the study, please feel free to ask your interviewer.

If later you have any questions regarding the study, you should call the co-investigator, Allison Goldberg, 080-335-780-69. If you have any questions about your rights as a research subject, you should contact the Columbia University Institutional Review Board by phone at (212) 305-5883 or by email at askirboffice@columbia.edu. More information about taking part in a research study can be found on the Columbia University IRB website at: http://www.cumc.columbia.edu/dept/irb.

You will be provided with a copy of this informational form after your interview is complete.

Statement of Consent
I have read the consent form and talked about this research study, including the purpose, procedures, risks, benefits and alternatives with the researcher. Any questions I had were answered to my satisfaction. I am aware that by signing below, I am agreeing to take part in this research study and that I can stop being in the study at any time. I am not waiving (giving up) any of my legal rights by signing this consent form. I will be given a copy of this consent form to keep for my records.

Signature

Study Participant

Print Name_____Signature_____Date_____

Person Obtaining Consent

Print Name_____Signature_____Date_____

APPENDIX G:

HOUSEHOLD SURVEY

In collaboration with
ZAMFARA STATE MINISTRY OF HEALTH
PRRINN-MNCH PROGRAMME
NAHUCHE HEALTH AND DEMOGRAPHIC SURVEILANCE SYSTEM
SOCIAL NETWORKS AND IMMUNIZATIONS SURVEY

TIME INTERVIEW STARTED …… | | | | | AM PM

FW NAME & 2-DIGIT CODE:												
COMPOUND ID (6-DIGITS):												
VILLAGE NAME:												
CHILD NAME & 12-DIGIT CHILD ID (refer to "eligible child" list for info)												
RESPONDENT NAME & 12-DIGIT RESPONDENT ID (refer to "all women" in compound list for info)												

RELATIONSHIP TO CHILD (Tick which option best defines the respondent's relationship to the child):

_____MOTHER _____OTHER CARETAKER (e.g. because mother is deceased/absent)

INTERVIEWER VISITS (Circle the date of the visit that resulted in a complete interview):	1	2	3

DETAILS OF VISIT ATTEMPTS (Indicate which visit you are referring to (1,2, or 3):

DATE OF INTERVIEW	D	D	M	M	*2*	*0*	*1*	*1*

RESULTS OF INTERVIEW (complete at end of interview):

(1=COMPLETED, 2=PARTIAL INTERVIEW, 3= RESPONDENT NOT AT HOME, 4=ENTIRE HH ABSENT FOR EXTENDED PERIOD, 5=REFUSED, 6=POSTPONED, 7=RESPONDENT NOT ELIGIBLE, 8=OTHER)

DATE FORMS CHECKED BY SUPERVISOR ….. | D | D | M | M | *2* | *0* | *1* | *1* |

Interviewer Note: **ASK THE FOLLOWING QUESTIONS TO ENSURE THE WOMAN BEING INTERVIEWED MEETS THE ELIGIBILITY CRITERIA FOR THE SURVEY.**

1a.	Do you have at least one child that is between 9 months and 18 months of age?	NO……..0 YES……1 TICK HERE IF CHILD OBSERVED TO CONFIRM AGE_____	→IF NO, DO NOT PROCEED WITH INTERVIEW

1b.	How old are you now? **RECORD AGE IN COMPLETED YEARS AND CONFIRM AGE ON "ALL WOMEN IN COMPOUND" LIST**	AGE IN YEARS. ……..|___|___|	☐ IF WOMAN IS LESS THAN 14 YEARS OF AGE, DO NOT PROCEED WITH INTERVIEW ☐ IF WOMAN IS BETWEEN 14-17 YEARS OF AGE, ASK Q1C ☐ IF WOMAN IS 18 YEARS OF AGE OR HIGHER, PROCEED WITH SURVEY
1c.	Are you married or have you ever been married before?	NO……..0 YES……1	☐ IF 'NO', DO NOT PROCEED WITH INTERVIEW

INTERVIEWER: NOW I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOU, YOUR PERCEPTIONS AND EXPERIENCES WITH CHILDHOOD IMMUNIZATIONS, AND PEOPLE YOU TALK TO ABOUT CHILDHOOD IMMUNIZATIONS.

SECTION 1. PERCEPTIONS AND EXERPEINCES WITH IMMUNIZATIONS

"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT YOUR PERCEPTIONS OF IMMUNIZATIONS AND YOUR EXPERIENCES WITH THEM."

*ASK THE WOMAN TO REFER TO THE CHILD PRE-SELECTED FOR THE STUDY. IF THE WOMAN HAS MORE THAN 1 CHILD BETWEEN 9 MONTHS AND 18 MONTHS OF AGE, ASK HER TO RANDOMLY SELECT **ONE** OF THEM TO REFER TO IN THE SURVEY.*

Q1	Have you ever heard about immunizations?	NO YES	0→END SURVEY 1
Q2	Do you think that any immunizations have the ability to protect children against disease?	NO YES SUSPECTS/MAYBE	0 1 2
Q3	Do you think that any immunizations have the ability to protect children against death?	NO YES SUSPECTS/MAYBE	0 1 2
Q4	How many children in your village do you think have received any immunization? **READ LIST**	NONE OF THE CHILDREN LESS THAN HALF OF THE CHILDREN HALF OF THE CHILDREN MOST OF THE CHILDREN ALL OF THE CHILDREN	0 1 2 3 4
Q5	Do you think that having ____ (Q4 RESPONSE) in your village immunized is good or bad?	BAD GOOD	0 1
Q6	Do you approve or disapprove of immunizations?	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT NOT SURE	1 2 3 4 5 8
Q7	When was the last time you heard about child immunizations from the media? BY MEDIA, I MEAN NEWSPAPERS, RADIO, TV, DVD, OR POSTERS	NEVER IN THE LAST WEEK IN THE LAST MONTH IN THE LAST 6 MONTHS 6 MONTHS OR MORE	0 1 2 3 4
Q8	Have you ever visited a health clinic/facility to immunize your child?	NO YES	0 1
Q9	How would you describe your experiences when you had your child immunized at the health clinic/facility? **READ LIST**	THEY WERE ALL BAD SOME WERE BAD SOME BAD/SOMEGOOD SOME WERE GOOD ALL GOOD NOT APPLICABLE (NEVER IMMUNIZED CHILD AT FACILITY/CLINIC)	1 2 3 4 5 6
Q10	Why do you describe your experiences getting your child immunized at the health clinic/facility as _____ (Q9 RESPONSE)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** Note: If the response to Q9 is "some good/some bad," probe respondent for a description of both good and bad experiences getting her child immunized.	BAD 1. IMMUNIZATIONS TOO COSTLY 2. NOT AVAILABLE WHEN NEEDED IT 3. WAITED LONG TIME TO GET 4. HEALTH PROVIDER/STAFF WERE IMPOLITE 5. HEALTH PROVIDER/STAFF DID NOT EXPLAIN IMMUNIZATIONS TO ME 6. THE FACILITY WAS DIRTY GOOD 7. IMMUNIZATIONS CHEAP/FREE 8. DID NOT WAIT LONG AT CLINIC 9. HEALTH PROVIDER/STAFF WERE FRIENDLY 10. HEALTH PROVIDERS WERE WELL-TRAINED 11. THE FACILITY WAS CLEAN 12. OTHER (_____)	 1 2 3 4 5 6 7 8 9 10 11 12

		13. NOT APPLICABLE (NEVER IMMUNIZED CHILD AT HEALTH FACILITY/CLINIC)…..... 13
Q11	Have you ever immunized your child as part of an immunization campaign?	NO…..... 0 YES..... 1
Q12	How many immunizations campaigns have you participated in?	NONE..... 0 ONE..... 1 TWO..... 2 THREE OR MORE..... 3
Q13	How would you describe your experiences when you had your child immunized during the immunization campaigns? READ LIST	THEY WERE ALL BAD……..... 1 SOME WERE BAD……..... 2 SOME BAD/SOME GOOD……..... 3 SOME WERE GOOD……..... 4 ALL GOOD……..... 5 NOT APPLICABLE (NEVER IMMUNIZED CHILD AT CAMPAIGN)……..... 6
Q14	Why do you describe your experiences getting your child immunized at the immunization campaigns as (Q13 RESPONSE)? DO NOT READ LIST CIRCLE ALL MENTIONED Note: If the response to Q13 is "some good/some bad," probe respondent for a description of both good and bad experiences getting her child immunized.	BAD 1. WAITED TOO LONG…….. 1 2. VOLUNTEERS/STAFF WERE IMPOLITE……..... 2 3. VOLUNTEERS/STAFF DID NOT EXPLAIN IMMUNIZATIONS TO ME…… 3 GOOD 4. IMMUNIZATIONS FREE…….. 4 5. DID NOT WAIT LONG…….. 5 6. VOLUNTEERS/STAFF WERE FRIENDLY…….. 6 7. STAFF WELL-TRAINED…….. 7 8. OTHER (_____) 8 14. NOT APPLICABLE (NEVER IMMUNIZED CHILD AT CAMPAIGN)…..... 9
SECTION 2. HEALTH PROVIDERS/TRADITIONAL HEALERS AND IMMUNIZATIONS *"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT YOUR RELATIONSHIP WITH YOUR CHILD'S HEALTH PROVIDERS.* *PLEASE REFER TO **THE SAME** CHILD DISCUSSED IN SECTION 1."*		
Q15	Have you ever visited a health clinic/facility to get care for your child?	NO…..... 0 YES..... 1
Q16	What is the name of the health clinic/facility that you last visited to get care for your child?	_____ NOT APPLICABLE (NEVER VISITED CLINIC/FACILITY)… NA
Q17	Thinking about when you attend this health clinic/facility, how long does it take you to travel there, by foot?	0-29MIN……..... 1 30 MIN – 59 MIN……..... 2 1HR – 2HRS……..... 3 2HRS AND ABOVE……..... 4 NOT APPLICABLE (DON'T GO TO CLINIC/FACILITY)..... 5
Q18	Have you ever visited other health clinics/facilities to get care for your child?	NO..... 0 YES..... 1
Q19	What are the names of these other health clinics/facilities that you visited? LIST UP TO 3 OTHER FACILITIES	1. _____ 2. _____ 3. _____ NOT APPLICABLE (NEVER VISITED OTHER CLINICS/FACILITIES).....NA

Q20	Why did you visit these other facilities to get care for your child? DO NOT READ LIST CIRCLE ALL MENTIONED	TO SEE A SPECIALIST ..... 1 CLOSER TO HOME ..... 2 HEALTH PROVIDERS/STAFF AT OTHER FACILTIY WERE IMPOLITE ..... 3 OTHER HEALTH FACILITY WAS DIRTY ..... 4 WAITED LONG TIME TO GET CARE ..... 5 TREATMENT/DRUGS NOT AVAILABLE WHEN NEEDED ..... 6 OTHER (_____) 7 NOT APPLICABLE (DID NOT VISIT OTHER FACILITIES) 8
Q21	When was the last time you went to any health clinic/facility to get care for your child?	NEVER ..... 0 IN THE LAST WEEK ..... 1 IN THE LAST MONTH ..... 2 IN THE LAST 6 MONTHS ..... 3 6 MONTHS OR MORE 4
Q22	Thinking about the times when you visited the health clinic/facility, did your health provider ever talk to you about immunizing your child?	NO ..... 0 YES ..... 1 NOT APPLICABLE (NEVER VISITED CLINIC/FACILITY) 2
Q23	Thinking about the times when you visited the health clinic, were you ever educated in a group about child immunizations?	NO ..... 0 YES ..... 1 NOT APPLICABLE (NEVER VISITED CLINIC/FACILITY) 2
Q24	Has a community health education worker (CHEW) ever spoken to you about immunizing your child? This can be outside of the health clinic/facility that you mentioned.	NO ..... 0 YES 1
Q25	Has a traditional birth attendant ever spoken to you about immunizing your child? This can be outside of the clinic/facility you mentioned.	NO ..... 0 YES 1
Q26	Have you ever spoken to anyone in your women's savings group (WISH group) about immunizing your child?	NO ..... 0 YES ..... 1 NOT APPLICABLE (NOT MEMBER OF A WISH GROUP) 2
Q27	Have you ever visited a traditional healer to get care for your child in this village?	NO ..... 0 YES 1
Q28	What is the name of the traditional healer that you most often visit to get care for your child in this village?	_____ (NAME OF TRADITIONAL HEALER) NOT APPLICABLE (NEVER VISITED TRADITIONAL HEALER) .....NA
Q29	When was the last time you went to this traditional healer to get care for your child?	NEVER ..... 0 IN THE LAST WEEK ..... 1 IN THE LAST MONTH ..... 2 IN THE LAST 6 MONTHS ..... 3 6 MONTHS OR MORE 4
Q30	Thinking about the times you visited a traditional healer, how many times have you ever heard him/her speak about child immunizations? READ LIST	NEVER ..... 0 ONCE ..... 1 TWICE ..... 2 THREE OR MORE TIMES 3
Q31	Does your traditional healer approve or disapprove of child immunizations? READ LIST	STRONGLY DISAPPROVES IT ..... 1→SKIP TO Q33 DISAPPROVES IT ..... 2→SKIP TO Q33 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT ..... 3 APPROVES IT ..... 4 STRONGLY APPROVES IT ..... 5 NOT SURE ..... 8 NOT APPLICABLE (DOESN'T VISIT HEALER) 9

Q32	What has your traditional healer done to show that he/she approves of child immunizations? DO NOT READ LIST CIRCLE ALL MENTIONED	SAID APPROVES IT DURING VISITS..... 1 SAID APPROVES IT IN PUBLIC..... 2 ENCOURAGES WOMEN TO GO TO CLINIC..... 3 ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S)..... 4 DISPELLS MYTHS ABOUT IMMUNIZATIONS ..... 5 SAW HIS/HER CHILD GET IMMUNIZED..... 6 TOLD HUSBAND THAT WE SHOULD IMMUNIZE CHILD... 7 OTHER PEOPLE TOLD ME HE/SHE APPROVES IT..... 8 OTHER (_____)..... 9 NOT APPLICABLE (DOESN'T VISIT HEALER)..... 10
Q33	When you have had to make decisions about your child(ren)'s health, has your household ever turned to your healer for guidance/help?	NO..... 0 YES..... 1 NOT APPLICABLE (DOESN'T VISIT HEALER)..... 2
SECTION 3. HUSBAND AND IMMUNIZATIONS *"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT YOUR HUSBAND AND HIS VIEWS ON IMMUNIZATIONS"*		
Q34	What is your relationship to your husband?	1ST WIFE..... 1 2ND WIFE..... 2 3RD WIFE..... 3 4TH WIFE..... 4
Q35	Have you ever spoken to your husband about immunizing your child(ren)?	NO..... 0 YES..... 1
Q36	Does your husband approve or disapprove of child immunizations? READ LIST	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q38 (Sec 4) DISAPPROVES IT..... 2→SKIP TO Q38 (Sec 4) HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE..... 8
Q37	What has your husband done to show that he approves of child immunizations? DO NOT READ LIST CIRCLE ALL MENTIONED	HE GAVE ME STANDING PERMISSION TO IMMUNIZE OUR CHILD(REN)..... 1 HE WENT TO THE HEALTH CLINIC WITH ME TO IMMUNIZE OUR CHILD(REN)..... 2 HE PARTICIPATED IN IMMUNIZATION CAMPAIGN(S)..... 3 OTHER (_____) 4
SECTION 4. VILLAGE CHIEF AND IMMUNIZATIONS: *"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT YOUR RELATIONSHIP WITH YOUR VILLAGE CHIEF AND HIS VIEWS ON IMMUNIZATIONS"*		
Q38	How long have you lived in this village? Note: If lived in village since birth, circle "SB"	_____MONTHS _____YEARS SINCE BIRTH..... SB
Q39	What is the name of the chief of your village?	_____ (NAME OF CHIEF)
Q40	How often do you attend village meetings, including those specifically for women? READ LIST	NEVER..... 0 SOME TIMES A MEETING IS HELD..... 1 MOST TIMES A MEETING IS HELD..... 2 EVERY TIME A MEETING HELD..... 3
Q41	Thinking about the meetings you attend, how often have you ever heard your village chief talk about child immunizations?	NEVER..... 0 ONCE..... 1 TWICE..... 2 THREE OR MORE TIMES..... 3

Q42	Does your village chief approve or disapprove of the use of child immunizations? READ LIST	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT NOT SURE	1→SKIP TO Q44 2→SKIP TO Q44 3 4 5 8
Q43	What has your village chief done to show that he approves of child immunizations? DO NOT READ LIST CIRCLE ALL MENTIONED	SAID HE APPROVES IT AT MEETINGS/IN PUBLIC ENCOURAGES WOMEN TO GO TO CLINIC ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S) DISPELLS MYTHS ABOUT IMMUNIZATIONS SAW HIS CHILD GET IMMUNIZED TOLD HUSBAND THAT WE SHOULD IMMUNIZE CHILD OTHER PEOPLE TOLD ME HE APPROVES IT OTHER (_____)	1 2 3 4 5 6 7 8
Q44	When your family has had difficulties (e.g. a family feud or conflict), has your household ever turned to your village chief for guidance/help?	NO YES	0 1
Q45	When you have had to make decisions about getting your child immunized, has your household ever turned to your village chief for guidance/help?	NO YES	0 1
SECTION 5. RELIGIOUS LEADER AND IMMUNIZATIONS: *"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT YOUR RELATIONSHIP WITH YOUR RELIGIOUS LEADER AND HIS VIEWS ON IMMUNIZATIONS"*			
Q46	How often do you attend Koranic school? READ LIST Note: Koranic classes at home is included.	NEVER SOME CLASSES MOST CLASSES EVERY CLASS NOT APPLICABLE (NOT MUSLIM)	0→SKIP TO Q54 1 2 3 4→SKIP TO Q61 (Sec 6)
Q47	What is the name of the Koranic school that you attend most often in this village?	_____ (NAME OF SCHOOL) If schooled at home, write the name of the school that the malam teaches at.	
Q48	What is the name of the malam that you most often learn from in this village?	_____ (NAME OF MALAM)	
Q49	Thinking about when you go to Koranic school, how often do you hear your malam speak about child immunizations? READ LIST	NEVER SOME TIMES A CLASS IS HELD MOST TIMES A CLASS IS HELD EVERY TIME A CLASS IS HELD NOT APPLICABLE (DOESN'T ATTEND CLASS)	0 1 2 3 4
Q50	How many times have you ever heard your malam speak about child immunizations?	NEVER ONCE TWICE THREE OR MORE TIMES	0 1 2 3
Q51	Does your malam approve or disapprove of the use of child immunizations? READ LIST	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT NOT SURE	1→SKIP TO Q53 2→SKIP TO Q53 3 4 5 8
Q52	What has your malam done to show that he approves of child immunizations? DO NOT READ LIST	SAID HE APPROVES IT AT SERVICES/IN PUBLIC ENCOURAGES WOMEN TO GO TO CLINIC ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S)	1 2 3

	CIRCLE ALL MENTIONED	DISPELLS MYTHS ABOUT IMMUNIZATIONS ..... 4 SAW HIS CHILD GET IMMUNIZED..... 5 TOLD HUSBAND THAT WE SHOULD IMMUNIZE CHILD.... 6 OTHER PEOPLE TOLD ME HE APPROVES IT..... 7 OTHER (_____) 8
Q53	When you have had to make decisions about getting your child immunized, has your household ever turned to your traditional healer for guidance/help?	NO..... 0 YES..... 1
Q54	What is the name of the imam that you most often speak with in your village? Note: If the woman does not speak to an imam directly, ask her to refer to the imam that her household most often communicates with.	_____ (NAME OF IMAM) NOT APPLICABLE (SHE, AND HER FAMILY, DO NOT SPEAKS WITH AN IMAM).....NA
Q55	Thinking about when you, or your household, meet with your imam, how often do you hear him speak about child immunizations? READ LIST	NEVER..... 0 SOME TIMES WE MEET..... 1 MOST TIMES WE MEET..... 2 EVERY TIME WE MEET..... 3 NOT APPLICABLE (NEVER MET IN PERSON/WITH FAMILY) 4
Q56	How many times have you ever heard your imam speak about child immunizations?	NEVER..... 0 ONCE..... 1 TWICE..... 2 THREE OR MORE TIMES..... 3
Q57	Does your imam approve or disapprove of the use of child immunizations? READ LIST	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q59 DISAPPROVES IT..... 2→SKIP TO Q59 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE..... 8
Q58	What has your imam done to show that he approves of child immunizations? READ LIST CIRCLE ALL MENTIONED	SAID HE APPROVES IT AT SERVICES/IN PUBLIC..... 1 ENCOURAGES WOMEN TO GO TO CLINIC..... 2 ADVOCATES FOR IMMUNIZATIONS BEFORE/DURING IMMUNIZATION CAMPAIGN(S)..... 3 DISPELLS MYTHS ABOUT IMMUNIZATIONS ..... 4 SAW HIS CHILD GET IMMUNIZED..... 5 TOLD HUSBAND WE SHOULD IMMUNIZE CHILD..... 6 OTHER PEOPLE TOLD ME HE APPROVES IT..... 7 OTHER (_____)..... 8
Q59	When your family has had difficulties (e.g. a family feud or conflict), has your household ever turned to your imam for guidance/help?	NO..... 0 YES..... 1
Q60	When you have had to make decisions about getting your child immunized, has your household ever turned to your imam for guidance/help?	NO..... 0 YES..... 1

SECTION 6. INFORMAL CONVERSATIONS ABOUT IMMUNIZATIONS

*"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT PEOPLE YOU HAVE **CHATTED WITH (HAD INFORMAL CONVERSATIONS WITH)** ABOUT CHILD IMMUNIZATIONS. REFER TO **THE SAME** CHILD DISCUSSED IN SECTIONS 1 & 2."*

Q61	How many people have you chatted with about child immunizations? I mean people other than your husband, religious leader(s), village chief, and traditional/faith healer.	TOTAL NUMBER _____	

Q62	How many people have you chatted with about child immunizations that live in your compound? I mean people other than your husband, religious leader(s), village chief, and traditional/faith healer.	TOTAL NUMBER_____	
Q63	Could you please give me the names of three women who live in your compound that you have chatted with about immunizations? As I said earlier, this information will be completely confidential. IF LESS THEN 3 ARE NAMED, PROBE: CAN YOU THINK OF ANYONE ELSE? HOW ABOUT SITTING IN ON A CONVERSATION, EVEN IF YOU, **YOURSELF, DIDN'T SAY ANYTHING?** IF MORE THEN 3 ARE NAMED, ASK THEM TO LIST THOSE WOMEN IN THEIR COMPOUND THAT THEY MOST OFTEN CHAT WITH ABOUT IMMUNIZATIONS. THEN, ASK Q64-Q75 FOR EACH WOMAN NAMED, STARTING WITH WOMAN 1, THEN WOMAN 2, THEN WOMAN 3.	NAME: 1. _____ ID#: __|__|__|__|__|__|__|__|__|__|__|__|__|__| 2. _____ ID#: __|__|__|__|__|__|__|__|__|__|__|__|__|__| 3. _____ ID#: __|__|__|__|__|__|__|__|__|__|__|__|__|__| **LOOK AT THE "ALL WOMEN IN COMPOUND" LIST GIVEN** TO YOU. DOCUMENT THE NAME AND CORRESPONDING 12-DIGIT ID NUMBER FOR EACH OF THE THREE WOMEN MENTIONED BY THE RESPONDENT IN THE SPACE PROVIDED. DO NOT SHOW THE WOMAN THE LIST. Note: The respondent may name a woman by her pet name. In this **scenario, look at the list of "all women in the compound" and identify those** women with the same sir name. Ask the respondent to confirm which individual she is referring to using this list.	

QUESTION			#1	#2	#3	
Q64	What is your relationship to (NAME)? 1=friend 2=co-wife 3=sister-in-law/sister in marriage 4=mother-in-law 5=husband`s mother 6=other female relative 7=step-parent 8=other (specify:_____)		__|__	__|__	__|__	

			#1	#2	#3
Q65	How close is (NAME) to you? READ LIST	MET ONCE OR TWICE A FRIEND CONFIDANT	1 2 3	1 2 3	1 2 3
Q66	How old is (NAME)?	<18 YEARS OF AGE 18—44 YEARS OF AGE 44—65 YEARS OF AGE >65 YEARS OF AGE	1 2 3 4	1 2 3 4	1 2 3 4
Q67	How often do you speak with (NAME)?	FEW TIMES A YEAR FEW TIMES A MONTH FEW TIMES A WEEK DAILY	1 2 3 4	1 2 3 4	1 2 3 4
Q68	How many times have you spoken with (NAME) about child immunizations?	ONCE TWICE THREE OR MORE TIMES	1 2 3	1 2 3	1 2 3
Q69	Has (NAME) ever recommended that you immunize you child(ren)?	NO YES	0 1	0 1	0 1
Q70	Does (NAME) approve or disapprove of immunizations?	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT NOT SURE	0 1 2 3 4 5 8	0 1 2 3 4 5 8	0 1 2 3 4 5 8

Q71	How do you know (NAME) does, or does not, support immunizations? **DO NOT READ LIST**	SHE TOLD ME..... SAW HER CHILD GET IMMUNIZED..... OTHERS TOLD ME SHE IMMUNIZED..... OTHER (SPECIFY: _____) DON'T KNOW……..... NOT APPLICABLE (NO CHILD).....	1 2 3 4 8 9	1 2 3 4 8 9	1 2 3 4 8 9
Q72	Has (NAME) immunized any of her children? **IF NO CHILD (CIRCLED RESPONSE OPTION '9'), SKIP TO Q74**	NO……..... YES..... SUSPECTS/MAYBE……..... DON'T KNOW……..... NOT APPLICABLE (NO CHILD).....	0 1 2 8 9	0 1 2 8 9	0 1 2 8 9
Q73	How did (NAME) describe her experiences getting her child immunized to you? **READ LIST**	THEY WERE ALL BAD……..... SOME WERE BAD……..... SOME BAD/SOME GOOD……..... SOME WERE GOOD……..... ALL GOOD……..... NEVER TALKED ABOUT IT..... NOT APPLICABLE (NEVER IMMUNIZED CHILD).....	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Q74	Do you remember why (NAME) described her experiences getting his/her child immunized as _____ (Q72 RESPONSE)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** **Note: If the response to Q72 is "some good/some bad," probe respondent for a description of <u>both</u> good and bad experiences getting her child immunized.**	<u>BAD</u> 1. IMMUNIZATIONS TOO COSTLY…… 2. NOT AVAILABLE WHEN NEEDED IT.. 3. WAITED LONG TIME TO GET..... 4. HEALTH PROVIDER/STAFF WERE IMPOLITE……..... 5. HEALTH PROVIDER/STAFF DID NOT EXPLAIN IMMUNIZATIONS…..... 6. THE FACILITY WAS DIRTY…..... <u>GOOD</u> 7. IMMUNIZATIONS CHEAP/FREE..... 8. DID NOT WAIT LONG AT CLINIC…... 9. HEALTH PROVIDER/STAFF WERE FRIENDLY……..... 10. HEALTH PROVIDERS WERE WELL-TRAINED……..... 11. THE FACILITY WAS CLEAN..... 12. OTHER (_____) NOT APPLICABLE (NEVER IMMUNIZED CHILD)….....	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Q75	Thinking about all the people that you said you have discussed immunizations with (**READ**: your husband, village chief, traditional healer, religious leader, CHEW, TBA, WISH GROUP, and women you said you chatted with in your compound), who do you think has had the <u>most influence</u> on your decision to immunize, or not immunize, your child? **Circle Only One Option** **WRITE THE THREE NAMES IN THE SPACE PROVIDED IN RIGHT COLUMN**	(NAME #1_____)……..... (NAME #2_____)……..... (NAME #3_____)……..... VILLAGE CHIEF……..... CHEW……..... WISH GROUP ……..... TBA……..... TRADITIONAL HEALER…… RELIGIOUS LEADER……..... HUSBAND……..... NOT APPLICABLE (NEVER IMMUNIZED CHILD)…..			1 2 3 4 5 6 7 8 9 10 13
Q76	"I would now like to ask you how well the women you told me you **chat with** about child immunizations know each other. For each pair that I mention, please tell me whether they are confidants, friends, met each other once or twice, or that they don't know each other. ASK WHETHER THE WOMEN RECORDED KNOW EACH OTHER AND HOW WELL THEY DO SO BY ASKING "DOES (NAME OF WOMAN #1), CONSIDER (NAME OF WOMAN #2) A CONFIDANT, FRIEND, SOME SHE HAS ONLY MET ONCE OR TWICE, OR SOMEONE SHE DOES NOT KNOW AT ALL?" RECORD THE **CODE** (BELOW) IN THE					

	CORRESPONDING CELL. DO NOT WRITE IN SHADED AREA. CONFIDANT .....1 FRIENDS.....2 MET EACHOTHER ONCE OR TWICE.....3 DON'T KNOW EACHOTHER.....4

RECORD NAMES FROM Q63	**#1**	**#2**	**#3**
#1	NA		
#2	NA	NA	
#3	NA	NA	NA

SECTION 7. IMMUNIZATION HISTORY

*"NOW I AM GOING TO ASK YOU QUESTIONS ABOUT YOUR CHILD'S IMMUNIZATION HISTORY. PLEASE REFER TO THE **SAME** CHILD DISCUSSED IN THIS SURVEY."* ***ASK RESPONDENT FOR THIS CHILD'S VACCINATION CARD AND USE IT TO FOR Q77.***

READ THE NOTE BELOW TO ENSURE THAT YOU PROPERLY COMPLETE Q77 USING THE VACCINATION CARD FOR THEIR CHILD. **Note:** If a date is listed ON THE VACCINATION CARD, enter it. If the date is INCOMPLETE, enter the parts that are there (e.g. month and/or year). If **the antigen is shown as given (with a check mark, for example) but no date, then enter 07/07/1907. Put 09/09/1909 if the health card is not seen or the health card is completely blank, and then SKIP TO QUESTION 79.**

Q77	**VACCINATIONS ON CARD:** BCG POLIO 0 POLIO 1 POLIO 2 POLIO 3 DPT 1 DPT 2 DPT 3 MEASLES YELLOW FEVER HEPATITIS B1 HEPATITIS B2 HEPATITIS B3 VITAMIN A1 VITAMIN A2	Date received (d d/ mm/ yyyy) __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __ __ __ / __ __ / __ __ __ __	IF **ALL** IMMUNIZATIONS ON THE LIST HAVE BEEN GIVEN, **SKIP TO END OF SURVEY**
Q78	Has your child had any immunizations that are not recorded on this card, including immunizations given in an immunization campaign? **CIRCLE 1 (YES) ONLY IF THE RESPONDENT MENTIONS AT LEAST ONE OF THE IMMUNIZATIONS IN Q77 THAT ARE NOT RECORDED AS HAVING BEEN GIVEN. THEN WRITE '06/06/1906' AS THECODE FOR THOSE VACCINES MENTIONED IN THE APPROPRIATE ROW IN Q77.**	NO.....0 YES.....1 If the respondent indicates that her child received more **polio drops than required in the dosage (more than 4)**, document the number of additional polio drops the child received on the line below. Probe to make sure that she means "more than 4." **Then answer Q82-Q83.** _____ (# of additional polio drops)	**AFTER COMPLETING THIS QUESTION, SKIP TO END OF SURVEY.** **SKIP TO Q82 FOR THOSE WHO INDICATED THAT THEIR CHILD RECEIVED MORE THAN 4 POLIO DROPS.**
Q79	Did your child ever get a BCG vaccination against tuberculosis, that is, an injection in the arm or shoulder that usually causes a scar?	NO.....0 YES.....1	IF YES, OBSERVE SCAR _____(Tick Here if Seen)
Q80	Did your child ever get a polio vaccine, that is, drops in the mouth?	NO.....0 YES.....1	
Q81	How many times was the polio vaccine given? **If more than 4 drops were given, ask Q82-Q83.**	_____ NUMBER OF TIMES	

	Otherwise, SKIP to Q84.	NOT APPLICABLE (NEVER GIVEN POLIO VACCINE).....NA	
Q82	Do you think that having your child receive the polio vaccine (number in Q81 or add numbers in Q77 + Q78) times is good or bad?	BAD……..0 GOOD.....1	
Q83	Why do you think having your child receive polio drops (# of times received polio vaccine) times is (Q82 RESPONSE)? **WRITE RESPONSE IN SPACE PROVIDED**	_____ _____ _____	**SKIP TO END OF SURVEY FOR THOSE WHO ANSWERED Q78.**
Q84	Did your child ever get a DPT vaccination, that is, an injection given in the thigh or buttocks, sometimes at the same time as polio drops?	NO.....0 YES.....1	
Q85	How many times was the DPT vaccine given?	_____ NUMBER OF TIMES NOT APPLICABLE (NEVER GIVEN DPT VACCINE) .....NA	
Q86	Did your child ever get a measles injection or an MMR injection - that is, a shot in the arm at the age of 9 months or older – to prevent him/her from getting measles?	NO.....0 YES.....1	
Q87	Was your child every given a vitamin A dose, vitamin A can come in a capsule or syrup?	NO.....0 YES.....1	
Q88	How many times was your child given a dose of Vitamin A?	_____ NUMBER OF TIMES NOT APPLICABLE (NEVER GIVEN VITAMIN A).....NA	

ADDED QUESTIONS: PERCEPTIONS AND EXPERIENCES WITH VACCINATIONS: *"NOW I AM GOING TO ASK YOU SOME QUESTIONS ABOUT VACCINATIONS. VACCINATIONS ARE IMMUNIZATIONS THAT ARE ADMINISTERED BY INJECTION, USUALLY AT A HEALTH FACILITY/CLINIC. THIS DOES **NOT** INCLUDE THE POLIO VACCINE."*

Q89	Why did you decide **not** to go to the health clinic/facility to vaccinate your child? **NOTE: Ask this question only if the respondent reported that she never vaccinated her child at a clinic/facility (the answer to Q8 is 'NO').** **Important: tell the respondent that you are referring to the immunizations that you can only get a facility. This includes BCG, DPT, measles, yellow fever, and hepatitis B. All of these vaccines that are administered through injection. Emphasize that the respondent should not refer to the polio vaccine when answering this question**	METHOD 1. MAKES CHILD SICK (FEVER, SORE) 2. AFRAID CAUSES INFERTILITY 3. AFRAID CAUSES HIV 4. NOT EFFECTIVE 5. TRADITIONAL MEDICINE PREFERED OPPOSITION 6. HUSBAND DID NOT GIVE ME PERMISSION TO GO TO FACILITY TO VACCINATE CHILD 7. LEADER (RELIGIOUS, POLITICAL) OPPOSED CLINICS 8. TOO FAR AWAY 9. COSTS TOO MUCH 10. NOT AVAILABLE WHEN NEED IT 11. WAIT TOO LONG FOR IT 12. ATTITUDE OF STAFF OTHER REASONS 13. DIDN'T KNOW OTHER VACCINES, BESIDES POLIO, EXISTED 14. NOT A PRIORITY (E.G. TOO BUSY, OTHER THINGS TO DO) 15. DON'T NEED, GET POLIO VACCINE AT HOME 16. OTHER (_____)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Q90	What are your biggest concerns (fears, worries, issues) about vaccinating your child? **Emphasize that this does not include the polio vaccine.**	0. NO CONCERNS METHOD 1. MAKES CHILD SICK (FEVER, SORE) 2. AFRAID CAUSES INFERTILITY 3. AFRAID CAUSES HIV 4. NOT EFFECTIVE 5. TRADITIONAL MEDICINE PREFERED OPPOSITION 6. HUSBAND/OTHER RELATIVE OPPOSED 7. LEADER (RELIGIOUS, POLITICAL) OPPOSED CLINICS 8. TOO FAR AWAY 9. COSTS TOO MUCH 10. NOT AVAILABLE WHEN NEED IT 11. WAIT TOO LONG 12. ATTITUDE OF STAFF 13. OTHER (_____)	0 1 2 3 4 5 6 7 8 9 10 11 12 13
Q91	Do you think that the polio vaccine can prevent your child from getting diseases (for example, measles, yellow fever) other than polio?	NO YES	0 1
SECTION 2. HUSBAND, PROVIDERS, LEADERS, AND PEERS' APPROVAL OF VACCINATIONS CHANGE HEADING.			
Q92	Does your traditional healer approve or disapprove of child vaccinations? **Emphasize that this does not include the polio vaccine.** **READ LIST**	STRONGLY DISAPPROVES IT DISAPPROVES IT HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT APPROVES IT STRONGLY APPROVES IT NOT SURE NOT APPLICABLE (DOESN'T VISIT HEALER)	1→SKIP TO Q94 2→SKIP TO Q94 3 4 5 8 9→SKIP TO Q94

Q93	What has your traditional healer done to show that he/she approves of child vaccinations? **Emphasize that this does <u>not</u> include the polio vaccine.**	SAID APPROVES IT DURING VISITS..... 1 SAID APPROVES IT IN PUBLIC..... 2 ENCOURAGES WOMEN TO GO TO CLINIC..... 3 DISPELLS MYTHS ABOUT VACCINATIONS... ..... 4 SAW HIS/HER CHILD GET VACCINATED (<u>DOES NOT INCLUDE POLIO</u>)..... 5 TOLD HUSBAND THAT WE SHOULD VACCINATE CHILD (DOES NOT INCLUDE <u>POLIO</u>)..... 6 OTHER PEOPLE TOLD ME HE/SHE APPROVES IT..... 7 OTHER (_____)..... 8
Q94	Does your husband approve or disapprove of child <u>vaccinations</u>? **Emphasize that this does <u>not</u> include the polio vaccine.** **READ LIST**	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q96 DISAPPROVES IT..... 2→SKIP TO Q96 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE..... 8
Q95	What has your husband done to show that he approves of child <u>vaccinations</u>? **Emphasize that this does <u>not</u> include the polio vaccine.** **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	HE GAVE ME STANDING PERMISSION TO VACCINATE OUR CHILD(REN) (THIS DOES NOT INCLUDE <u>POLIO</u>)..... 1 HE WENT TO THE <u>HEALTH CLINIC</u> WITH ME TO VACCINATE OUR CHILD..... 2 OTHER (_____) 3
Q96	What are your husband's biggest concerns (fears, worries, issues) about <u>vaccinating</u> your child? **Emphasize that this does <u>not</u> include the polio vaccine.** **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	0. NO CONCERNS..... 0 <u>METHOD</u> 1. MAKES CHILD SICK (FEVER, SORE)..... 1 2. AFRAID CAUSES INFERTILITY..... 2 3. AFRAID CAUSES HIV..... 3 4. NOT EFFECTIVE..... 4 5. TRADITIONAL MEDICINE PREFERED..... 5 <u>OPPOSITION</u> 6. OTHER RELATIVE OPPOSED..... 6 7. LEADER (RELIGIOUS, POLITICAL) OPPOSED..... 7 <u>OTHER</u> 8. CLINIC TOO FAR AWAY..... 8 9. NOT NECESSARY, SINCE CAN GET POLIO VACCINE AT HOME..... 9 10. DOESN'T WANT ME TO LEAVE HOUSE..... 10 11. OTHER (_____) 11
Q97	Does your village chief approve or disapprove of the use of child <u>vaccinations</u>? **REFER TO THE CHIEF THAT THE RESPONDENT MENTIONED BY NAME IN THE SURVEY** **Emphasize that this does <u>not</u> include the polio vaccine.** **READ LIST**	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q99 DISAPPROVES IT..... 2→SKIP TO Q99 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE..... 8

Q98	What has your village chief done to show that he approves of child vaccinations? **Emphasize that this does not include the polio vaccine.** **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	SAID APPROVES IT DURING MEETINGS/IN PUBLIC..... 1 ENCOURAGES WOMEN TO GO TO CLINIC…..…… 2 DISPELLS MYTHS ABOUT VACCINATIONS ... …….. 3 SAW HIS/HER CHILD GET VACCINATED (DOES NOT INCLUDE POLIO)..... 4 TELLS HUSBANDS THAT THEY SHOULD VACCINATE CHILD (DO NOT INCLUDE POLIO)..... 5 OTHER (_____)..... 6 7
Q99	Does your malam approve or disapprove of the use of child vaccinations? **Emphasize that this does not include the polio vaccine.** **REFER TO THE MALAM THAT THE RESPONDENT MENTIONED BY NAME IN THE SURVEY** **READ LIST**	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q101 DISAPPROVES IT..... 2→SKIP TO Q101 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE…..... 8 NOT APPLICABLE (DOESN'T STUDY WITH MALAM). 9→SKIP TO Q101
Q 100	What has your malam done to show that he approves of child vaccinations? **Emphasize that this does not include the polio vaccine.** **DO NOT READ LIST** **CIRCLE ALL MENTIONED**	SAID APPROVES IT DURING CLASS/IN PUBLIC..... 1 ENCOURAGES WOMEN TO GO TO CLINIC…..…… 2 DISPELLS MYTHS ABOUT VACCINATIONS... …….. ... 3 SAW HIS CHILD GET VACCINATED (DO NOT INCLUDE POLIO)..... 4 TOLD HUSBAND THAT WE SHOULD VACCINATE CHILD (DO NOT INCLUDE POLIO)..... 5 OTHER PEOPLE TOLD ME HE APPROVES IT…….. 6 OTHER (_____)..... 7
Q 101	Does your imam approve or disapprove of the use of child vaccinations? **REFER TO THE IMAM THAT THEY RESPONDENT MENTIONED BY NAME IN THE SURVEY** **READ LIST**	STRONGLY DISAPPROVES IT..... 1→SKIP TO Q103 DISAPPROVES IT..... 2→SKIP TO Q103 HAS CONCERNS (WORRIES, FEARS, ISSUES), BUT ACCEPTS IT..... 3 APPROVES IT..... 4 STRONGLY APPROVES IT..... 5 NOT SURE…..... 8
Q 102	What has your imam done to show that he approves of child vaccinations? **Emphasize that this does not include the polio vaccine.** **READ LIST** **CIRCLE ALL MENTIONED**	SAID APPROVES IT DURING MEETINGS/IN PUBLIC..... 1 ENCOURAGES WOMEN TO GO TO CLINIC…..…… 2 DISPELLS MYTHS ABOUT VACCINATIONS... ..... 3 SAW HIS CHILD GET VACCINATED (DO NOT INCLUDE POLIO)..... 4 TOLD HUSBAND THAT WE SHOULD VACCINATE CHILD (DO NOT INCLUDE POLIO)..... 5 OTHER PEOPLE TOLD ME HE APPROVES IT…….. 6 OTHER (_____)..... 7

ASK THE FOLLOWING QUESTIONS BY REFERING TO THOSE WOMEN THAT THE RESPONDENT HAS **INFORMAL CONVERSATIONS WITH** ABOUT IMMUNIZATIONS. ***CONTINUE TO FOCUS ON VACCINATIONS IN THE FOLLOWING QUESTIONS.***

			#1	#2	#3
Q 103	Has (NAME) ever recommended that you vaccinate you child(ren)? **Emphasize that this does not include the polio vaccine.**	NO……..... YES……....	0 1	0 1	0 1

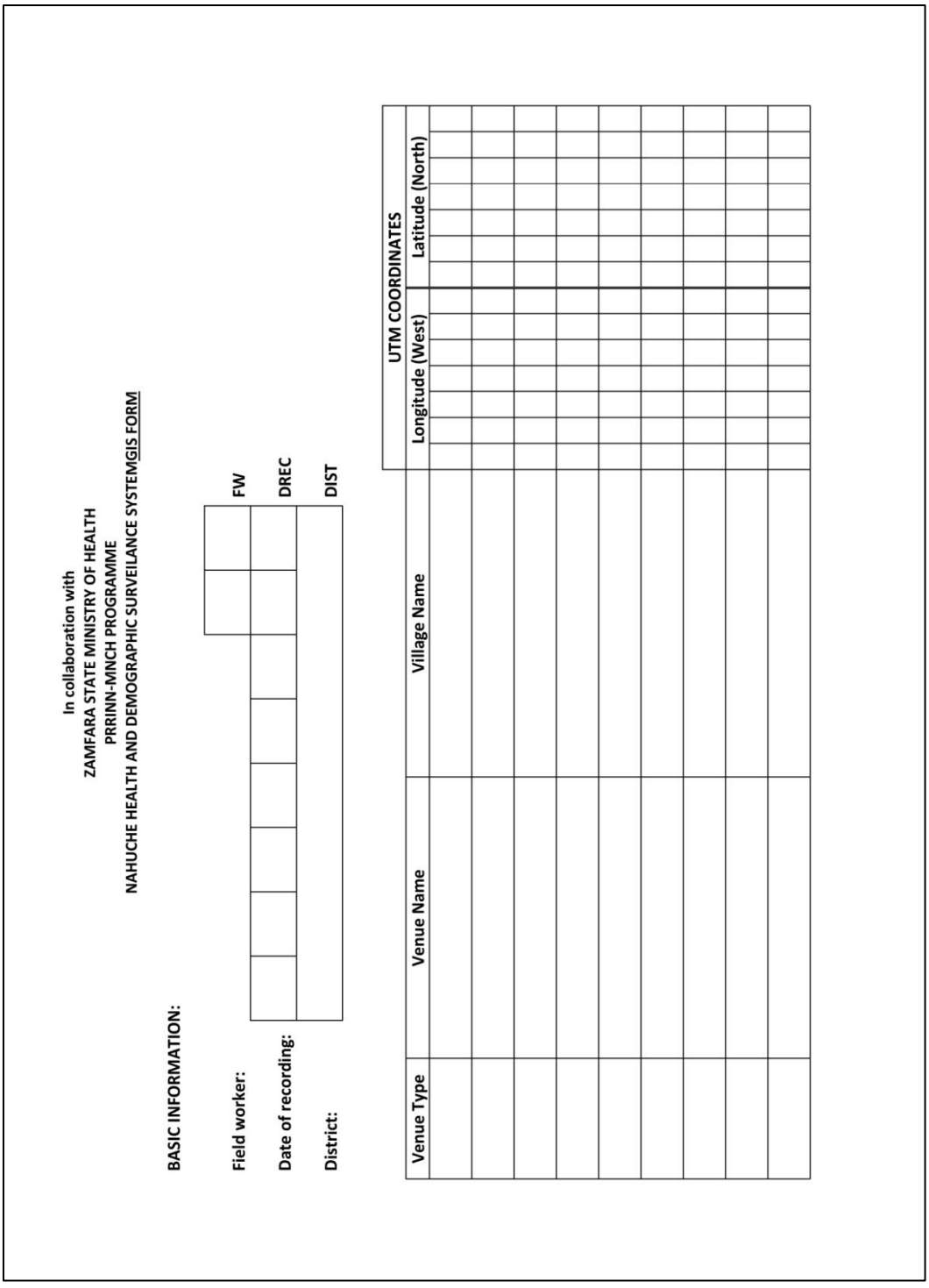
Q 104	Has (NAME) vaccinated any of her children? **Emphasize that this does not include the polio vaccine.**	NO… YES SUSPECTS/MAYBE… DON'T KNOW… NOT APPLICABLE (NO CHILD)	0 1 2 8 9	0 1 2 8 9	0 1 2 8 9
Q 105	How do you know (NAME) did, or did not, vaccinate any of her children? **Emphasize that this does not include the polio vaccine.** **DO NOT READ LIST**	SHE TOLD ME SAW HER CHILD GET VACCINATED OTHERS TOLD ME… OTHER (SPECIFY: _____) DON'T KNOW…	1 2 3 4 8	1 2 3 4 8	1 2 3 4 8
Q 106	How did (NAME) describe her experiences getting her child vaccinated to you? **Emphasize that this does not include the polio vaccine.** **READ LIST**	THEY WERE ALL BAD… SOME WERE BAD… SOME BAD/SOME GOOD… SOME WERE GOOD… ALL GOOD… NEVER TALKED ABOUT IT NOT APPLICABLE (NEVER VACCINATED CHILD)	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Q 107	Do you remember why (NAME) described her experiences getting his/her child vaccinated as _____ (Q106 RESPONSE)? **Emphasize that this does not include the polio vaccine.** **DO NOT READ LIST** **CIRCLE ALL MENTIONED** **Note: If the response to Q106 is "some good/some bad," probe respondent for a description of both good and bad experiences getting her child vaccinated.**	BAD 1. VACCINATIONS TOO COSTLY… 2. NOT AVAILABLE WHEN NEEDED IT.. 3. WAITED LONG TIME TO GET 4. HEALTH PROVIDER/STAFF WERE IMPOLITE… 5. HEALTH PROVIDER/STAFF DID NOT EXPLAIN VACCINATIONS… 6. THE FACILITY WAS DIRTY… GOOD 7. VACCINATIONS CHEAP/FREE 8. DID NOT WAIT LONG AT CLINIC… 9. HEALTH PROVIDER/STAFF WERE FRIENDLY… 10. HEALTH PROVIDERS WERE WELL-TRAINED… 11. THE FACILITY WAS CLEAN 12. OTHER (_____) NOT APPLICABLE (NEVER VACCINATED).	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Q 108	What are (NAME) biggest concerns (worries, fears, issues) about vaccinating child(ren)? **DO NOT READ LIST** **CIRCLE ALL MENTIONED** **Emphasize that this does not include the polio vaccine.**	0. NO CONCERNS… METHOD 1. MAKES CHILD SICK (FEVER, SORE)… 2. AFRAID CAUSES INFERTILITY… 3. AFRAID CAUSES HIV… 4. NOT EFFECTIVE… 5. TRADITIONAL MEDICINE PREFERED. OPPOSITION 6. HUSBAND/OTHER RELATIVE OPPOSED… 7. LEADER (RELIGIOUS, POLITICAL) OPPOSED… CLINICS 8. TOO FAR AWAY… 9. COSTS TOO MUCH… 10. NOT AVAILABLE WHEN NEEDED IT.. 11. OTHER (SPECIFY: _____) NEVER DISCUSSED…	0 1 2 3 4 5 6 7 8 9 10 11 12	0 1 2 3 4 5 6 7 8 9 10 11 12	0 1 2 3 4 5 6 7 8 9 10 11 12

INTERVIERWER: THANK RESPONDENT FOR HER PARTICIPATION IN THE SURVEY.

TIME INTERVIEW ENDED…… | | | | | AM PM |

APPENDIX H:

GIS FORM



In collaboration with
ZAMFARA STATE MINISTRY OF HEALTH
PRRINN-MNCH PROGRAMME
NAHUCHE HEALTH AND DEMOGRAPHIC SURVEILANCE SYSTEMGIS FORM

BASIC INFORMATION:

Field worker: FW

Date of recording: DREC

District: DIST

Venue Type	Venue Name	Village Name	UTM COORDINATES	
			Longitude (West)	Latitude (North)

APPENDIX I:

IRB APPROVAL FORMS

Review Correspondence

Protocol Number: IRB-AAAI7653 Protocol

Notification Date:	**11/09/2011**
From:	**IRB Office**
To:	**Researcher**
Subject:	**RASCAL IRB Protocol IRB-AAAI7653 (Protocol)**
	Protocol
Text:	On October 3, 2011, the above-mentioned study was reviewed and approved by the Chair or Designee of Columbia University Medical Center Institutional Review Board (IRB)#2. It met the regulatory guidelines for expedited review, category #7. You may now begin human research for this study.

During the approval period, all subjects enrolled not only must provide voluntary informed consent to participate in the study, but also must sign a copy of the appropriate stamped consent document(s). A copy of the consent document(s) must be given to the subjects for their record.

The following study-related materials were approved:
- HDSS Training Manual
- Consent form CF - AAAJ4100
- Consent form CF - AAAJ4018
- HH Survey Cover Page, attached 9/15/11
- HH Survey, attached 09/16/2011
- Village Chief Survey, attached 08/27/2011
- Religious Leader Survey, attached 08/27/2011
- Traditional Healer Survey, attached 08/27/2011

Any proposed changes in the protocol must be immediately submitted to the IRB for review and approval prior to implementation, unless such a change is necessary to avoid immediate harm to the participants. Additionally, any unanticipated problems that involve risks to subjects must be reported to the IRB in accordance with the CUMC Unanticipated Problems: Reporting to the IRB of Unanticipated Problems Involving Risks policy, dated January 24, 2008. All submissions for modifications and unanticipated problems must be submitted through RASCAL.

Renewal applications should be submitted 60 days before the expiration date of this study through RASCAL. Failure to obtain renewal of your study prior to the expiration date will require discontinuance of all research activities for this study, including enrollment of new subjects. You must inform the IRB in writing when your study has been completed.

If you have any questions regarding this approval, please call Rachel Lally at (212) 342-0948.

Columbia University appreciates your commitment towards the ethical conduct of human research.

ZAMFARA STATE OF NIGERIA

ZAMFARA STATE RESEARCH ETHICS COMMITTEE
MINISTRY OF HEALTH, GUSAU

OFFICE:
J.B Yakubu Secretariat
G usau, Zamfara State

Our Ref......
Your Ref......

26th September, 2011
Date.....

Dear Allison Goldberg,

Re-Social Ties And Routine Immunization Practices In Northern Nigeria: A Three –Tiered Methodological Approach To Assessing Routine Immunization In Bungudu Local Government Are Zamfara State

The Zamfara State Research Ethics Committee has examined the above proposal you submitted to it and has therefore giving you permission to go ahead with the research. Only that, people of Nahuce has numerous series of interviews and questions relating to routine immunization etc, that there is no need of conducting another FGD as stated in your proposal; such FGD data are already captured in HDSS center. We wish you a successful outcome.

Yours faithfully,

Alh Abubakar Abdullahi Anka
Secretary, ZSREC

APPENDIX J:

ALTERNATIVE MODERATION ANALYSIS

Measures

The variables included in these models follow the same measurement approach delineated in Chapter 3**.**

Equations

Closeness & Injunctive Norms (Alternative to Hypothesis 4A)

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij} + \beta_{20} S_{21ij} + \quad)}$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and j representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents ties within networks that are close and supportive of immunizations. S_{19} represents ties within networks that are not close and supportive of immunizations. S_{20} represents ties within networks that are not close and not supportive of immunizations. The reference category in this analysis is ties that are close and not supportive of immunizations. is the random intercept varying over compounds (level 2). This equation was modeled twice – in mothers/caregivers' opinion leader networks versus peer networks.

Closeness & Descriptive Norms (Alternative to Hypothesis 4B)

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij +} \beta_{20} S_{21ij +} \quad)}$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and j representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents ties within networks that are close and observed to immunized child. S_{19} represents ties within networks that are not close and observed to immunize child. S_{20} represents ties within networks that are not close and not observed to immunize child. The reference category in this analysis is ties that are close and not observed to immunize child. is the random intercept varying over compounds (level 2). This equation was modeled twice – in mothers/caregivers' opinion leader networks versus peer networks.

Frequency of Communication about Immunizations & Injunctive Norms (Alternative to Hypothesis 5A)

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij +} \beta_{20} S_{21ij +} \quad)}$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and j representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents ties within networks that have frequently communicated about immunizations and are supportive of immunizations. S_{19} represents ties within networks that have not frequently communicated about immunizations and are supportive of immunizations. S_{20} represents ties within networks that have not frequently

communicated about immunizations and are not supportive of immunizations. The reference category in this analysis is ties that have frequently communicated about immunizations and are not supportive of immunizations. is the random intercept varying over compounds (level 2). This equation was modeled twice – in mothers/caregivers' opinion leader networks versus peer networks.

Frequency of Communication about Immunizations & Descriptive Norms (Alternative to Hypothesis 5B)

$$\mathbf{Pr(Y_{ij}=1|X_{ij}, S_{ij}, \quad) = logit^{1}(\alpha + \beta_1 X_{1ij...} + \beta_{17} X_{17ij} + \beta_{18} S_{18ij} + \beta_{19} S_{19ij} + \beta_{20} S_{21ij} + \quad)}$$

In this model, Pr [Y_{ij} = 1] is the probability that the respondent immunized her child with the DPT vaccine, with i representing the individual and j representing the clustering of individuals in compounds. X_1 to X_{17} are the covariates, including the 11 dummy variables that represent the 22 paired villages in this study. S_{18} represents ties within networks that have frequently communicated about immunizations and have been observed to immunize their child. S_{19} represents ties within networks that have not frequently communicated about immunizations and have been observed to immunize their child. S_{20} represents ties within networks that have not frequently communicated about immunizations and are not supportive of immunizations. The reference category in this analysis is ties that have frequently communicated about immunizations and have not been observed to immunize their child. is the random intercept varying over compounds (level 2). This equation was modeled twice – in mothers/caregivers' opinion leader networks versus peer networks.

Expected Outcomes

In the above analyses, I expect the coefficients for S_{18} (close/frequently communicated about immunizations and are supportive/have been observed to immunize their child) S_{19} (not

close/infrequently communicated about immunizations and are supportive/have been observed to immunize their child), and S_{20} (not close/infrequently communicated about immunizations and are not supportive/have not been observed to immunize child) to be significant and positive. This implies that closeness and frequency of communication about immunization use are moderating the influence of normative beliefs and practices and that there are higher rates of immunization use among mothers/caregivers in these categories than mothers/caregivers in the reference category (close/frequently communicated about immunizations and are not supportive/have not been observed to immunize their child). I also expect S_{18} and S_{19} to have larger positive values than S_{20}, since this would capture the normative network effects on the mothers/caregivers' immunization use. This is equivalent to the interaction term between closeness or frequency of communication about immunizations and normative beliefs and practices being positive and significant. If S_{18} and S_{19} are both positive and significant and S_{20} is not significant, then closeness and frequency of communication do not strengthen the influence of injunctive and descriptive norms on immunization use.

Confound Variable Codes

1. Disttofacility (Distance to health facility that offers immunization services)
2. Relationtochild (Relationship to child)
3. Prevfacilityexp (Previous experience at health facility that offers immunization services)
4. Talkhealthprof (Number of health professionals talked to about immunizations)
5. Mediaexp (Previous media exposure about immunizations)
6. HusbandsupportIZ (Perceived husband support for immunizations)

Fixed effects at the village level were included in all analyses to reduce heterogeneity across the 22 paired villages in this study. However, I do not include the output in the tables below.

Results

Closeness & Injunctive Norms (Alternative to Hypothesis 4A)

Opinion leader networks.

***Main variable c*odes:** Emot+supportO (close + support for immunizations), Noemot+suppportO (Not close + supportive of immunizations), Noemot+nosupportO (Not close + supportive of immunizations)

```
Random-effects logistic regression              Number of obs      =       499
Group variable: compound                        Number of groups   =       364
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     32.33
Log likelihood  = -175.02543                    Prob > chi2        =    0.0720
------------------------------------------------------------------------------
        dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------+-----------------------------------------------------------
    Emot+supportO |   1.730719   .8214536     2.11   0.035        .1207    3.340739
  Noemot+supportO |   1.243338   .7392999     1.68   0.113    -.2056627     3.69234
Noemot+nosupportO |   .8137697   .9193851     0.89   0.376     -.988192    2.615731
  Relationtochild |   1.135299   1.108856     1.02   0.306     -1.03802    3.308617
                  |
   Disttofacility |
          5-10km  |   .6664255   1.065748     0.63   0.532    -1.422402    2.755253
          =>10km  |  -.6722943   1.373197    -0.49   0.624    -3.363712    2.019123
                  |
  Prevfacilityexp |   1.518935   .5539308     2.74   0.006     .4332505    2.604619
   Talkhealthprof |   .8062453   .2724786     2.96   0.003     .2721971    1.340294
                  |
         Mediaexp |
 in 1 or more mon |   .2669255   .8938227     0.30   0.765    -1.484935    2.018786
  within last mon |   1.192373   .8731027     1.37   0.172    -.5188769    2.903623
                  |
 Husbandsupportiz |
       ambivalent |  -.4709318   1.543343    -0.31   0.760    -3.495828    2.553965
          support |   1.442818   1.197084     3.21   0.028     .9034228    3.789060
            _cons |  -7.665742   2.001542    -3.83   0.000    -11.58869   -3.742791
------------------+-----------------------------------------------------------
         /lnsig2u |   1.816733   .5199168                      .7977145    2.835751
```

***Interpretation*.** Injunctive norms in opinion leader networks do *not* have an independent influence on mothers/caregivers' immunization use (i.e., Emot+supportO is greater than zero and statistically significant, but Noemot+supportO is not statistically significant). However, closeness strengthens the influence of injunctive norms on mothers/caregivers' immunization use within this network (i.e., Emot+supportO is greater than zero and statistically significant). These

results are consistent with the results from the moderation test in the main text of this dissertation.

Peer networks.

***Main variable codes*.** Emot+supportP (close + support for immunizations), Noemot+suppportP (Not close + supportive of immunizations), Noemot+nosupportP (Not close + supportive of immunizations)

```
Random-effects logistic regression              Number of obs      =       355
Group variable: compound                        Number of groups   =       251
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     30.53
Log likelihood  = -125.14056                    Prob > chi2        =    0.1062
------------------------------------------------------------------------------
        dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------+-----------------------------------------------------------
    Emot+supportP |   1.109529   .9535928     1.98   0.054      .780479    2.957536
  Noemot+supportP |   1.426955   .7713446     1.85   0.064    -.0848529    2.938763
Noemot+nosupportP |   1.086637   1.252871     0.88   0.386     -3.54222    1.368945
  Relationtochild |   1.423364   1.839398     0.77   0.439     -2.18179    5.028518
                  |
   Disttofacility |
          5-10km  |   2.544001   1.261588     2.02   0.044     .0713342    5.016667
          =>10km  |  -1.572322     1.3777    -1.14   0.254    -4.272565    1.127921
                  |
  Prevfacilityexp |   2.127923   .6584362     3.23   0.001     .8374115    3.418434
   Talkhealthprof |   .7393734   .2883882     2.56   0.010     .1741429    1.304604
                  |
         Mediaexp |
 in 1 or more mon |   .7906286   .9470307     0.83   0.404    -1.065517    2.646775
  within last mon |   1.737771   .9297246     1.87   0.062    -.0844553    3.559998
                  |
 Husbandsupportiz |
       ambivalent |  -1.062743   1.726702    -0.62   0.538    -4.447017    2.321531
          support |   .5153439   1.375789     1.97   0.058      .051153    3.211841|
            _cons |  -8.976714   2.386678    -3.76   0.000    -13.65452   -4.298911
------------------+-----------------------------------------------------------
         /lnsig2u |   1.510887   .6091354                      .3170035     2.70477
------------------+-----------------------------------------------------------
          sigma_u |   2.128555   .6482891                      1.171754    3.866637
              rho |   .5793339     .14845                      .2944551    .8196418
------------------------------------------------------------------------------
```

***Interpretation*.** Injunctive norms in peer networks have an independent influence on mothers/caregivers' immunization use (i.e., Emot+support and and Noemot+suppportP are positive and statistically significant). However, closeness does *not* strengthens the influence of injunctive norms on mothers/caregivers' immunization use within this network (i.e.,

Emot+support and Noemot+suppportP are greater than zero and statistically significant, yet Noemot+nosupportP is not statistically significant).These results are consistent with the results from the moderation test in the main text of this dissertation.

Closeness & Descriptive Norms (Alternative to Hypothesis 4B)

Opinion leader network.

***Main variable codes*.** Emot+observeO (close + observed immunization use), Noemot+observeO (not close + observed immunization use), Noemot+notobserveO (not close + did not observe immunization use)

```
Random-effects logistic regression              Number of obs      =       513
Group variable: compound                        Number of groups   =       374
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     34.10
Log likelihood  = -181.36577                    Prob > chi2        =    0.0480
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
    Emot+observeO |    .053018   .8582047     0.06   0.951    -1.629032    1.735068
  Noemot+observeO |   .7534197   .5790586     1.30   0.193    -.3815144    1.888354
Noemot+noobserveO |   .1470218   1.582776     0.09   0.926    -2.955161    3.249205
  Relationtochild |   1.252704   1.066972     1.17   0.240    -.8385229    3.343931
                  |
   Disttofacility |
          5-10km |   1.070758   1.002703     1.07   0.286    -.8945035     3.03602
          =>10km |  -1.402237   1.346049    -1.04   0.298    -4.040445    1.235971
                  |
  Prevfacilityexp |    1.67114   .5363327     3.12   0.002     .6199473    2.722333
   Talkhealthprof |   .7560819    .258537     2.92   0.003     .2493587    1.262805
                  |
         Mediaexp |
 in 1 or more mon |   .8309283   .8774306     0.95   0.344    -.8888042    2.550661
  within last mon |   1.695733    .884467     1.92   0.055    -.0377907    3.429256
                  |
 Husbandsupportiz |
       ambivalent |  -.6117261   1.493116    -0.41   0.682     -3.53818    2.314728
          support |   1.588622    1.16079     2.37   0.021     .6864844    3.863728
            _cons |  -7.719772   1.934467    -3.99   0.000    -11.51126   -3.928287
------------------+------------------------------------------------------------
         /lnsig2u |   1.753707   .5139788                      .7463267    2.761087
------------------+------------------------------------------------------------
          sigma_u |   2.403325   .6176292                      1.452322    3.977062
              rho |   .6371138   .1188318                      .3906643    .8278177
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    18.88 Prob >= chibar2 = 0.000
```

***Interpretation*.** Descriptive norms in opinion leader networks do *not* have an independent influence on mothers/caregivers' immunization use (i.e., none of the main variables are statistically significant). Closeness also does *not* strengthen the influence of descriptive norms on mothers/caregivers' immunization use within this network (i.e., Emot+observeO and Noemot+observeO are not statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.

Peer networks.

***Main variable codes*.** Emot+observeP (close + observed immunization use), Noemot+observeP (not close + observed immunization use), Noemot+notobserveP (not close + did not observe immunization use)

```
Random-effects logistic regression              Number of obs      =       513
Group variable: compound                        Number of groups   =       374
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     38.22
Log likelihood  = -179.69274                    Prob > chi2        =    0.0173
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
    Emot+0bserveP |   .7746131   .7429022     2.50   0.034      .481449    1.830675
  Noemot+observeP |    .876277   .4982204     1.76   0.079     -.100217    1.852771
Noemot+noobserveP |   .6954658   .8584786     0.81   0.418    -2.378053    .9871213
  Relationtochild |   1.272695   .9589227     1.33   0.184    -.6067594    3.152148
                  |
   Disttofacility |
          5-10km |    1.00668   .9139323     1.10   0.271    -.7845945    2.797954
          =>10km |  -1.501166   1.218202    -1.23   0.218    -3.888798    .8864657
                  |
  Prevfacilityexp |   1.624215   .5013571     3.24   0.001      .641573    2.606857
   Talkhealthprof |   .7355944   .2466675     2.98   0.003     .2521349    1.219054
                  |
         Mediaexp |
 In 1 or more mon |   .8689551   .8080688     1.08   0.282    -.7148307    2.452741
  Within last mon |   1.633836    .794956     2.06   0.040     .0757513    3.191922
                  |
 Husbandsupportiz |
       ambivalent |  -.4195026   1.403607    -0.30   0.765    -3.170521    2.331516
          support |   1.449542   1.104686     1.96   0.059     .7156023    3.614687|
            _cons |  -7.378057   1.744737    -4.23   0.000    -10.79768   -3.958435
------------------+-----------------------------------------------------------
        /lnsig2u |   1.433872   .5402362                      .3750287    2.492716
------------------+-----------------------------------------------------------
          sigma_u |   2.048148    .553242                      1.206248    3.477654
              rho |   .5604589   .1330843                      .3066519    .7861493
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    13.63 Prob >= chibar2 = 0.000
```

***Interpretation*.** Descriptive norms in peer networks have an independent influence on mothers/caregivers' immunization use (i.e., Emot+observe and Noemot+observeP). However, closeness does *not* strengthen the influence of descriptive norms on mothers/caregivers' immunization use within this network (i.e., Emot+observe and Noemot+observeP are greater than zero and statistically significant, yet Noemot+noobserveP is not statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.

Frequency of Communication about Immunizations & Injunctive Norms (Alternative to Hypothesis 5A)

Opinion leader networks.

***Main variable codes*.** Comm+supportO (frequent communication about immunizations + support for immunizations), Nocomm+suppportO (Infrequent communication about immunizations + supportive of immunizations), Nocomm+nosupportO (Infrequent communication about immunizations + supportive of immunizations)

```
Random-effects logistic regression              Number of obs      =       499
Group variable: compound                        Number of groups   =       364
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     32.31
Log likelihood  = -175.26511                    Prob > chi2        =    0.0722
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
    Comm+supportO |   .5099169   .7582037     0.23   0.951    -1.629032    1.735068
  Nocomm+supportO |   .7990324   .6883958     1.16   0.246    -.5501986    2.148263
Nocomm+nosupportO |   .4933086   .6422771     0.77   0.442    -.7655315    1.752149
  Relationtochild |   .9672202   1.113225     0.87   0.385    -1.214661    3.149101
                  |
   DisttoFacility |
          5-10km  |   .8440956   1.009275     0.84   0.403    -1.134046    2.822238
          =>10km  |  -1.146387   1.329228    -0.86   0.388    -3.751626    1.458852
                  |
  Prevfacilityexp |   1.430431   .5291398     2.70   0.007     .3933364    2.467526
   Talkhealthprof |   .7685482   .2632668     2.92   0.004     .2525547    1.284542
                  |
         Mediaexp |
 In 1 or more mon |    .377798   .8532262     0.44   0.658    -1.294495    2.050091
  Within last mon |   1.257423   .8337167     1.51   0.131     -.376632    2.891478
                  |
 Husbandsupportiz |
       ambivalent |   -.496871   1.502303    -0.33   0.741    -3.441331    2.447589
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------

          support |   1.480549   1.174761     3.26   0.028     .8219394    3.783038
            _cons |  -7.721819   1.995862    -3.87   0.000    -11.63364   -3.810002
-----------------+------------------------------------------------------------
        /lnsig2u |    1.69904   .5326004                      .6551624    2.742917
-----------------+------------------------------------------------------------
         sigma_u |   2.338524   .6227494                      1.387608    3.941095
             rho |   .6243826   .1249102                      .3691919    .8252125
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    17.12 Prob >= chibar2 = 0.000
```

Interpretation. Injunctive norms in opinion leader networks do *not* have an independent influence on mothers/caregivers' immunization use (i.e., none of the main variables are statistically significant). Frequency of communication about immunizations does *not* strengthen the influence of injunctive norms on mothers/caregivers' immunization use within this network (i.e., Comm+support and Nocomm+suppportO are not statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.

Peer networks.

***Main variable codes*.** Comm+supportP (frequent communication about immunizations + support for immunizations), Nocomm+suppportP (Infrequent communication about immunizations + supportive of immunizations), Nocomm+nosupportP (Infrequent communication about immunizations + supportive of immunizations)

```
Random-effects logistic regression              Number of obs      =       355
Group variable: compound                        Number of groups   =       251
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     30.52
Log likelihood  = -125.52973                    Prob > chi2        =    0.1063
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
    Comm+supportP |   1.524513   .3133872     2.08   0.030     .9978351    3.446861
  Nocomm+supportP |   1.577505   .7858605     2.01   0.045     .0372467    3.117763
Nocomm+nosupportP |   1.486389   1.207658     0.40   0.687    -2.853355    1.880576
  Relationtochild |   1.494126   1.899521     0.79   0.432    -2.228867    5.217119
                  |
   DisttoFacility |
          5-10km  |   2.622822   1.271362     2.06   0.039     .1309981    5.114646
          =>10km  |  -1.535534   1.364313    -1.13   0.260    -4.209538    1.138471
                  |
  Prevfacilityexp |    2.12799   .6567281     3.24   0.001     .8408266    3.415153
   Talkhealthprof |   .7038678   .2845916     2.47   0.013     .1460786    1.261657
                  |
------------------------------------------------------------------------------
       dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
         Mediaexp |
 In 1 or more mon |   .7486296   .9395122     0.80   0.426     -1.09278     2.59004
  Within last mon |     1.6787   .9277202     1.81   0.070    -.1395977    3.496999
Husbandsupportiz |
       ambivalent |  -1.150302   1.710382    -0.67   0.501    -4.502589    2.201985
          support |   .4316157     1.3562     1.96   0.050     .2264870    3.089719
            _cons |  -8.999057   2.371306    -3.79   0.000    -13.64673   -4.351383
-----------------+------------------------------------------------------------
        /lnsig2u |   1.494993   .6108935                      .2976638    2.692322
-----------------+------------------------------------------------------------
         sigma_u |   2.111707    .645014                      1.160478    3.842646
             rho |   .5754556   .1492452                      .2904533    .8177944
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    10.63 Prob >= chibar2 = 0.001
```

***Interpretation*.** Injunctive norms in peer leader networks have an independent influence on mothers/caregivers' immunization use (i.e., Comm+supportP and Nocomm+suppportP are positive and statistically significant). Frequency of communication about immunizations does *not* strengthen the influence of injunctive norms on mothers/caregivers' immunization use within this network (i.e., Comm+supportP and Nocomm+suppportP are greater than zero and

statistically significant, yet Nocomm+nosupportP is not statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.

Frequency of Communication about Immunizations & Descriptive Norms (Alternative to Hypothesis 5B)

Opinion leader networks.

Main variable codes. Comm+observeO (frequent communication about immunizations + observed immunization use), Nocomm+observeO (Infrequent communication about immunizations + observed immunization use), Nocomm+noobserveO (Infrequent communication about immunizations + did not observe immunization use)

```
Random-effects logistic regression              Number of obs      =       513
Group variable: compound                        Number of groups   =       374
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     34.25
Log likelihood  = -181.60445                    Prob > chi2        =    0.0463
------------------------------------------------------------------------------
        dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------+-----------------------------------------------------------
    Comm+observeO |   1.482558   .2076582     1.80   0.087      .953354    2.880576
   Noomm+observeO |   .5836836   .5289371     1.10   0.270     -.453014    1.620381
Nocomm+noobserveO |   .1079993   3.496707      .03   0.975     -6.961419   6.745421
  Relationtochild |   1.082179   1.032031     1.05   0.294    -.9405636    3.104922
                  |
   DisttoFacility |
          5-10km  |   .9868079   .9909925     1.00   0.319    -.9555017    2.929118
          =>10km  |  -1.356613   1.330204    -1.02   0.308    -3.963765    1.250539
                  |
  Prevfacilityexp |   1.639812   .5304425     3.09   0.002     .6001641     2.67946
   Talkhealthprof |   .7657013   .2581663     2.97   0.003     .2597047    1.271698
                  |
         Mediaexp |
 In 1 or more mon |   .7411597   .8620389     0.86   0.390    -.9484055    2.430725
  Within last mon |   1.634601    .872801     1.87   0.061    -.0760573     3.34526
                  |
 Husbandsupportiz |
       ambivalent |  -.5643067   1.482344    -0.38   0.703    -3.469648    2.341034
          support |   1.560795   1.152206     3.35   0.026     .6974868    3.819077
            _cons |   -7.62824   1.914551    -3.98   0.000    -11.38069   -3.875789
------------------+-----------------------------------------------------------
         /lnsig2u |   1.737508   .5129897                      .7320671     2.74295
------------------+-----------------------------------------------------------
          sigma_u |   2.383939   .6114682                      1.442004    3.941159
              rho |   .6333606   .1191239                      .3872752    .8252172
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    19.02 Prob >= chibar2 = 0.000
```

Interpretation. Descriptive norms in opinion leader networks do *not* have an independent influence on mothers/caregivers' immunization use (i.e., Comm+observeO is greater than zero

and statistically significant, but Nocomm+observeO is not statistically significant). Frequency of communication about immunizations strengthens the influence of descriptive norms on mothers/caregivers' immunization use within this network (i.e., Comm+observeO is greater than zero and statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.

Peer networks.

Main variable codes. Comm+observeP (frequent communication about immunizations + observed immunization use), Nocomm+observeP (Infrequent communication about immunizations + observed immunization use), Nocomm+noobserveP (Infrequent communication about immunizations + did not observe immunization use)

```
Random-effects logistic regression              Number of obs      =       513
Group variable: compound                        Number of groups   =       374
Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       1.4
                                                               max =         5
                                                Wald chi2(22)      =     37.46
Log likelihood  = -180.19283                    Prob > chi2        =    0.0210
------------------------------------------------------------------------------
        dptdepvar |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------+-----------------------------------------------------------
    Comm+observeP |   1.503642   .9621760     2.09   0.043     .3421523    3.349435
  Nocomm+observeP |   .8756208   .4767921     1.94   0.066    -.0588745    1.810116
Nocomm+noobserveP |   .1533124   .8314871     1.96   0.054     .0782997    3.476372
  Relationtochild |   1.304198   .9745274     1.34   0.181    -.6058409    3.214236
                  |
   DisttoFacility |
          5-10km  |   .9611132   .9345361     1.03   0.304     -.870544     2.79277
          =>10km  |  -1.514878    1.23424    -1.23   0.220    -3.933943    .9041876
                  |
  Prevfacilityexp |    1.70299   .5084128     3.35   0.001     .7065195    2.699461
   Talkhealthprof |   .6841171     .24009     2.85   0.004     .2135493    1.154685
                  |
         Mediaexp |
 In 1 or more mon |   .7805968   .8005113     0.98   0.329    -.7883766     2.34957
  Within last mon |   1.555009   .7923559     1.96   0.050     .0020203    3.107999
                  |
 Husbandsupportiz |
       ambivalent |  -.4755542   1.405916    -0.34   0.735    -3.231099     2.27999
          support |   1.378641   1.099788     2.25   0.020     .7769036    3.534186
            _cons |  -7.370476   1.746825    -4.22   0.000    -10.79419   -3.946761
------------------+-----------------------------------------------------------
         /lnsig2u |   1.462761   .5425782                      .3993272    2.526195
------------------+-----------------------------------------------------------
          sigma_u |   2.077947   .5637244                      1.220992    3.536358
              rho |   .5675626   .1331678                      .3118423    .7917237
------------------------------------------------------------------------------
Likelihood-ratio test of rho=0: chibar2(01) =    13.52 Prob >= chibar2 = 0.000
```

***Interpretation*.** Descriptive norms in peer networks have an independent influence on mothers/caregivers' immunization use (i.e., all of the main variables are statistically significant). Frequency of communication about immunizations strengthens the influence of descriptive norms on mothers/caregivers' immunization use within this network (i.e., Comm+observeP, Nocomm+observeP, Nocomm+NoobserveP are greater than zero and statistically significant). These results are consistent with the results from the moderation test in the main text of this dissertation.