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Michelle Kagei April 5, 2017

Pediatric vaccination in rural Udaipur, India: The impact of agency, local perceptions, and social determinants of health on maternal health-seeking behaviors and current coverage

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Sciences with Honors

Department of Anthropology

2017

Abstract

Pediatric vaccination in rural Udaipur, India: The impact of agency, local perceptions, and social determinants of health on maternal health-seeking behaviors and current coverage

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As one of the most effective preventative public health measures, pediatric immunization significantly reduces global morbidity and mortality due to vaccine-preventable diseases. Though under-five mortality rate in India has sharply decreased over the years, low coverage still burdens many rural remote regions. Furthermore, pediatric immunization has recently reached a "plateau", in which the same increase in supply no longer translates to the same increase in coverage. Coverage in rural Udaipur is particularly low – nearly half that of national full immunization rates. Public and global health experts must reorient vaccination strategies to address the gross health inequities that exist in rural India. The aims of this study were to determine the current state of coverage and knowledge and to illuminate how local agency and perceptions of immunization influence the spectrum of maternal health-seeking behaviors in rural Udaipur district. Data were collected in conjunction with Seva Mandir, a non-governmental organization serving rural and tribal communities through development programs. In five Seva Mandir villages (two health intervention; one non-health intervention) and three non-intervention villages, thirty-three mothers with children between the ages of nine months and five years were interviewed about their health-seeking behaviors, experiences with immunization, and basic demographics. Contrary to the "spillover" hypothesis, in which non-health development programs would positively influence vaccine uptake, the worst vaccine knowledge and coverage was observed in non-health intervention villages. Though there was a relatively high level of general immunization awareness, very few mothers could name any vaccines or vaccine-preventable diseases. Even though mothers reported satisfaction with government services, interviews revealed that health workers provided very little information, suggestive of a paternalistic patient-provider relationship. While the most common reason for immunizing children was because an authority figure had instructed to do so, the most common reason for not immunizing children was because they did not understand why it was so important. With no inhibitory community beliefs or fear of side effects, the phenomenon of passive acceptance observed in these communities indicates a large clinical gap in communication. Future study must address factors that contribute to passive acceptance of immunization in these communities, including imbalances in the patient-provider relationship and the lack of agency that this brings about. Future intervention must focus on the improving services and attendance at the *anganwadi*, the main site of pediatric immunization in rural Udaipur.

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Acknowledgements

I would like to thank each individual from Seva Mandir and Emory University who has helped me along this journey. I would like to extend my thanks to Dr. Kusum Mather and Preeti Shatkawat for their support in organizing my field trips and data collection process. I learned an incredible amount about the local community and Seva Mandir's health interventions from our meetings. Additionally, I would like to thank my translators, Arjun Kumar, Niraj Jingar, and Gagan Sharma, for their immeasurable patience and reliable assistance. From Emory University, I would like to thank Dr. Joyce Flueckiger for her invaluable feedback regarding the qualitative, culturally-focused sections of my research. I would also like to thank Dr. Craig Hadley for helping me to frame the quantitative sections of my thesis and for teaching me an incredible amount of statistical methods in just a few hours. Finally, I would like to thank my advisor, Dr. Worthman. Over the past year, she has offered an incredible wealth of knowledge and constructive feedback. I truly appreciate her high level of commitment and endless support. It was such a pleasure to work with the above individuals and institutions – I enjoyed the research and writing process and look forward to future study.

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Introduction

Vaccination as a Critical Global Health Issue

Vaccination has a long history as an effective preventative public health measure, significantly reducing global morbidity and mortality with equivalent savings in human potential and healthcare. Even though pediatric vaccination currently prevents 2 million deaths per year worldwide, 2.5 million deaths per year continue to be caused by vaccine-preventable diseases, or VPDs, mainly in Africa and Asia among children under five years of age (Jheeta & Newell, 2008). Fully immunized children gain the greatest protection from vaccine-preventable diseases, ultimately leading to direct social and economic benefits through a healthy and productive life (Black et al., 2016). Vaccination coverage has improved significantly in many countries in Asia and Africa, but it recently has reached a plateau (Jheeta & Newell, 2008), in part because the regions that are the most remote and difficult to reach have not been prioritized. Combatting this stalled improvement in coverage requires reorientation of global and local vaccination policies and programs to directly address the needs of the people living in these remote places as well as those who are "invisible" to society - the world's poorest.

Set forth by the United Nations, the third Sustainable Development Goal calls to “end preventable deaths of newborns and children under five years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 births and under-five mortality to at least as low as 25 per 1,000 live births” (United Nations, 2015). In India, under-five mortality rate has decreased sharply from 248 per 1,000 live births in 1960 to 48 per 1,000 live births in 2015 (World Bank, 2010). Although this is certainly an impressive public health feat, the country still has various issues to overcome in order to reach the third Sustainable Development Goal.

The world's second most populous country, India suffers from a high prevalence of chronic and infectious disease, including a massive burden of vaccine-preventable diseases such as measles. At a national level, the vaccination rate for measles is merely 66% - it is estimated that the 81,725 annual deaths from measles in India accounts for three-quarters of global deaths and that two-thirds of children who die of measles and other preventable diseases would have survived if they had been immunized (Laxminarayan & Ganguly, 2011). In order to revitalize global and local vaccination efforts, current immunization programs and policies must be revisited to address critical gaps, particularly focusing on rural, low-income populations in India.

Background

Current Vaccination Policies, Rural Healthcare Infrastructure, & Seva Mandir

There is a long history of government immunization programs in India, which has more recently become intertwined with the vaccination efforts of non-governmental organizations. Following the success of the Smallpox Eradication Programme, the World Health Organization launched the global Expanded Programme on Immunization in 1974, intended to encourage national comprehensive immunization and vaccination programs that focused on preventing tuberculosis, diphtheria, pertussis, tetanus, polio, and measles (Streefland, Chowdhury, & Ramos-Jimenez, 1999a). In 1978, the Indian government launched the Expanded Programme for Immunization and later relaunched it as the Universal Immunization Program in 1985. The goal of the updated program was to extend six antigens through four vaccines - Bacillus Calmette–Guérin (BCG), measles, oral polio vaccine (OPV), and diphtheria, pertussis, tetanus (DPT) - to small children and tetanus to pregnant women (Laxminarayan & Ganguly, 2011). Although government-recommended vaccination schedules may vary slightly, the current World Health

Organization and UNICEF-recommended package of immunization consists of one dose BCG, three doses DPT, three doses OPV, and one dose measles by the age of one year, each given on separate occasions. This protocol necessitates five visits to a public health facility or vaccination center (Banerjee, Duflo, Glennerster, & Kothari, 2012). Later, in 2009, the National Technical Advisory Group - the Indian government's official authority regarding immunization programs - recommended a new form of vaccination known as the "pentavalent" vaccine. Combining five different antigens (diphtheria, tetanus, pertussis, hepatitis B, and HiB), this new formulation, in principle, can reduce the number of visits necessary for complete vaccination for children under the age of five in India (Laxminarayan & Ganguly, 2011).

Currently, the Union Ministry of Health and Family Welfare is responsible for the creation and implementation of programs regarding family welfare, prevention, and control of major diseases. Although the wide-reaching systems of the current rural healthcare infrastructure in India have proven to be effective in terms of providing services where none previously existed, there are various gaps in the systems that must be addressed. The existing healthcare structure comprises three main tiers below hospitals, the most localized being the sub-center, then the primary health center (PHC), and then the community health center (CHC) (Bhandari & Dutta, 2007).

Primarily, the sub-center is most peripheral from the mainstream healthcare system and is staffed by one auxiliary nurse-midwife or "ANM" (village-level female health worker) and one multipurpose worker. These centers contain the most basic drugs and provide services related to maternal and child health, family welfare, nutrition, immunization, diarrhea control, and control of infectious disease (Bhandari & Dutta, 2007). For every six existing sub-centers, the Indian government mandates the provision of one primary health center serving as a place of referral.

Further, primary health centers have relatively more advanced medical technology and are staffed with a medical officer (MD), fourteen paramedicals, and other staff members. The main focus of these primary health centers is on preventive and promotive aspects of health for rural populations with limited access to education and healthcare (Bhandari & Dutta, 2007). Lastly, community health centers serve as the referral center per four primary health centers and are the most well-staffed, with four medical specialists (a surgeon, a general physician, a gynecologist, a pediatrician) and twenty-one paramedicals. They also house the most advanced medical facilities, typically housing an operating theater, an x-ray machine, a labor room, and laboratory facilities (Bhandari & Dutta, 2007).

However, this framework has not been realized "on the ground". At each tier, medical facilities are inadequate for meeting service goals for the rural population - in 2005, there were 12% fewer sub-centers, 16% fewer primary health centers, and 50% fewer community health centers than was recommended by the Union Ministry of Health and Family Welfare (Bhandari & Dutta, 2007). These shortages likely can be attributed to a lack of healthcare funding in the public sector in rural areas. National and state surveys from India demonstrate that even though 75% of healthcare spending of India is in the private sector and is largely concentrated in urban areas, this source of funding accounts for only 5-25% of immunization spending in most states (Yazbeck, 2009). Furthermore, the shortage in health facilities available for rural populations directly translates to a shortage of health workers and resources available for the very same people. In theory and in practice, such shortages generate poorer health outcomes among rural, low-income populations in India, including low levels of complete immunization.

Further, other government schemes and systems exist in conjunction with this three-tier system with the goal of providing healthcare for all Indian citizens. In response to a spectrum of

health issues, including high infant and child mortality, the Government of India initiated the Integrated Child Development Service (ICDS) scheme in 1975. This system assigns one trained "*anganwadi"* worker per population of 1000, with the objective of bridging gaps in healthcare and education. *Anganwadi* centers provide a courtyard play center and a non-formal pre-school education, focused on stimulating physical, motor, social, emotional, language, and cognitive development of children (Arora, Bharti, & Mahajan, 2006). Furthermore, they offer several integrated health services, including supplementary nutrition, immunization, health check-ups, and referral services for child under the age of six and pregnant mothers (Chudasama et al., 2016). *Anganwadi* workers are women who provide basic healthcare services both at centers and in homes; typically, they are from the community that they serve (Humairah, 2011).

Moreover, it is important to note that the government is not working alone. Throughout India, there are more than seven-hundred non-governmental organizations (NGOs) fighting for human rights such as gender equality and universal education and healthcare. Embedded within many health-related NGOs are vaccination programs, which have been relatively successful in improving equitable health care delivery (Abdullah, 2008). Seva Mandir, an interdisciplinary non-governmental organization serving the greater rural area of Udaipur, Rajasthan, including Jhadol, Kherwara, Girwa, Kotra, and Badgaon blocks, offers such programs (Seva Mandir, 2016). Like other NGOs, Seva Mandir works in over 700 villages, both with and without government interventions. They offer a wide range of developmental programs, including local self-governance, education, sustainable natural resources, women's empowerment, youth development, child care, and social enterprises. Following their organizational model focused on "transforming lives through democratic and participatory development" (Seva Mandir, 2016), they employ and train local people in rural villages to provide services to fellow community

members. Hiring local people who are well-respected in the community both mitigates the increasing shortage of healthcare workers (Aluttis, Bishaw, & Frank, 2014) and strengthens patient-provider relationships, as people can work with someone they know and trust. The health unit of Seva Mandir is headed by Dr. Kusum Mather, a physician who has worked with the organization for many years. This unit includes a "*balsakhi*", or community pre-school program, in which children up to five years of age daily attend a "*balwadi*", or daycare center, to gain some education basics, to receive a nutritious mid-day meal, and to have their health monitored. The woman in charge of the center, the *balsakhi*, is from the local community and has been trained by Seva Mandir to track the vaccination statuses of local children. Additionally, there is a separate vaccination program in which camps are held monthly by Seva Mandir staff in various zones. These camps are advertised in advance and typically have strong attendance (Seva Mandir, 2016).

Alongside the allopathic medical services provided by government schemes and Seva Mandir programs, there is a myriad of traditional forms of medicine that contribute to the medical landscape of India. Particularly in regions where there is limited access to allopathic healthcare facilities, traditional medicine is commonly used in Rajasthan. Primarily, folk medicines derived from plants have been an integral part of traditional forms of healing as well as local culture, customs, and religious rites (Kumar, 2012). These products, which serve as chemotherapeutic agents, are largely used among tribal populations in Rajasthan; the information is passed down orally through generations. For example, in Jodhpur, Rajasthan, a large number of people have assumed an ethnopharmacological approach to managing their Type 2 diabetes, using medicinal plants (Goyal, 2015).

Furthermore, a more established, government-recognized traditional system of medicine exists – AYUSH, or Ayurveda, yoga, naturopathy, Unani, siddha, and homeopathy (Manasi & Raju, 2015). Due to safety concerns of pharmacological drugs in recent years, there has been a push for research into how traditional plant-based systems like AYUSH can be used to provide better healthcare for Indian citizens. However, the overall demand for traditional healers and herbal medicine is diminishing as modern medicine spreads throughout rural India (Katewa, Chaudhary, & Jain, 2004).

Current Vaccine Coverage

Due to the success of public health efforts like the Expanded Programme for Immunization and the Universal Immunization Program, vaccination rates throughout India have improved significantly in recent years. However, as mentioned previously, coverage has plateaued in many parts of the world, particularly in India, which lags behind other countries with similar per capita GDPs. For example, between 1990 and 2001, while Bangladesh displayed a national vaccination rate of 82% for children two years and under, India barely reached half of that coverage (Laxminarayan & Ganguly, 2011). Ultimately, this large disparity in immunization directly translated to disparities in overall health outcomes for the population, as the probability of dying before the age of five fell more than twice as quickly in Bangladesh than in India (Laxminarayan & Ganguly, 2011). In part, this large disparity between Bangladesh and India is at least partially attributable to concentration of NGOs and population density. For example, the World Bank (2016) reported that the population density in India was 441 per square kilometer of land area, compared to 1,237 in Bangladesh. Even though parts of rural Bangladesh are certainly hard to reach, a higher population density suggests that targeted interventions in one specific area

reach a larger proportion of people in Bangladesh than in India. Furthermore, after the government of Bangladesh made its commitment to reach universal child immunization by 1990, the program received strong support from non-governmental organizations and donor agencies (Jamil, Bhuiya, Streatfield, & Chakrabarty, 1999).

Even though under current legislation, immunization services are technically available and free for all Indian citizens at peripheral health centers, vaccination rates remain relatively low. The third National Family Health Survey (NFHS-3) reported that from 2005-2006, only 44% of Indian children ages one to two years had received the entire basic package (one dose BCG, three doses DPT, three doses OPV, measles) recommended by the World Health Organization (Banerjee et al., 2012). Coverage exhibits significant disparities between states and regions in India. In 2010, UNICEF reported that 16 out of 29 states had vaccination rates higher than the national average of 61%. On the other end of the spectrum, the national average is weighed down by poorly performing states such as Rajasthan, which reported a complete vaccination rate of 53% in the same year (Mathew, 2012). It is also important to consider disparities related to the rural-urban divide – though the overall vaccination rate for the state of Rajasthan was 53%, this number drops to 22% in rural Rajasthan. Most rural regions of India are difficult to reach, but some are even more inaccessible than others, hours away from highways or paved roads. A 2012 study on immunization in Rajasthan reported complete vaccination rates of less than 2% in the area of the present study, an economically-disadvantaged population in rural Udaipur (Banerjee et al., 2012).

As mentioned previously, non-governmental organizations' vaccination programs and interventions are essential for improving local coverage. In collaboration with the Massachusetts Institute of Technology's Jameel Abdul Poverty Action Lab (J-PAL), Seva Mandir conducted a

baseline survey across sixty villages in rural and tribal areas of Udaipur from 2003-2004. This survey revealed shocking pre-intervention levels - only 4.2% of children between one and two years of age had received full immunization as recommended by the World Health Organization and UNICEF; however, the large majority of children - 67.5% - were partially immunized and therefore "on track" to become fully immunized (Tiwari, Gop, Fraker, Sarkar, & Morris, 2007). Thereafter, Seva Mandir and J-PAL implemented an intervention that boosted immunization rates through improved regularity in supply of, access to, and demand for vaccines. In one cohort of villages, more regular vaccination camps were held with expanded staff and resources, while in the other cohort, a small incentive of food was added to increase attendance. In the group with improved services complete vaccination coverage increased from 6% to 17%, while in the villages with the additional incentive, immunization rates increased to 38% (Seva Mandir, 2010). These results clearly demonstrate large disparities in vaccination coverage, particularly between villages untouched by Seva Mandir and regions where the non-governmental organization has interventions. It should be noted that villages in rural and tribal regions of Udaipur district have particularly low coverage, much lower than the national complete immunization average.

Predictors of Vaccination

Social Determinants of Health

As a larger set of forces that both shape and are shaped by health outcomes, social determinants of health are frequently associated with gross inequities in health, both on a global scale and in India. Defined by the World Health Organization as "the conditions in which people are born, grow, live, and age, and the wider set of forces and systems shaping the conditions of daily life", social determinants of health can range from an individual's religious affiliation to a

country's political climate (World Health Organization, 2017). These factors lead to health disparities most often through differential access to healthcare resources or increased exposure to harmful environments or infectious agents among disadvantaged populations. In current health reform efforts, collaborators are increasingly considering the importance of social determinants of health, which will be essential to combat current health gaps within populations (Nambiar, Muralidhalan, Garg, Daruwalla, & Ganesan, 2015).

In this context, one potential health inequity is differential vaccination coverage, which leads to disparities in morbidity and mortality due to vaccine-preventable diseases within populations. Though there is a myriad of social and structural determinants of health, only particular elements tend to have strong relationships with immunization rates. The present thesis will explore those social factors found to be most relevant, including maternal education, maternal age, child gender, family size, birth order, religion, caste, income, and location of residence.

I. Maternal Education

In various contexts, maternal education has proven to be a significant predictor of pediatric health outcomes, including but not limited to breastfeeding and vaccination (Parashar, 2005). In theory, more maternal general education creates a double benefit in which women's empowerment and health education interact and translate to better health. While higher literacy likely means that a mother can read and follow instructions given by healthcare staff, more years in school often leads to self-empowerment and the confidence to demand and pursue healthcare services. A 2005 study on inequities in coverage of preventive child health interventions reported large disparities in vaccination coverage among levels of maternal education in Udaipur – the complete immunization rate was 20% for the children of mothers with little to no literacy, 27%

for less than five years of education, 42% for five to seven years, and 70% for more than eight years (Mathew, 2012). Analyses of the third National Family Health Survey (NFHS-3) and reports from the Department of Family Welfare and the ICMR 1999 survey demonstrate nearly identical results in other regions of India (Mathew, 2012).

This correlation between maternal education and child health outcomes has been observed in many parts of the world (Desai & Alva, 1998). In a 2012 study, researchers used data from the Indian Human Development Survey of 2004-2005 to establish the pathways through which this relationship occurs. It was determined that though social capital and more autonomy within the household may potentially influence outcomes, human capital (health knowledge) and cultural capital (communication skills) were the most important factors (Vikram, Vanneman, & Desai, 2012).

II. Maternal Age

Another distinct predictor of the status of child immunization in a household is maternal age. As a woman gets older, she gains more life experience regarding childcare, and in theory, could attain more years of education or exposure to public health messages. Therefore, while controlling for other factors, households with older mothers may display increased vaccine uptake among children under the age of five years. A 2009 UNICEF survey reported that complete vaccination rates did not differ much between maternal age groups, but the 2005-2006 National Family Health Survey (NFHS-3) of India reported a complete vaccination rate of 39.8% for the infants of women eighteen years or younger and a complete vaccination rate of 43.6% for the infants of older mothers (Mathew, 2012). Though the literature suggests that the association between maternal age and immunization coverage may not necessarily be compelling, the relationship must be examined in the context specific to this study.

III. Gender of Child

The phenomenon of gender bias in favor of male infants and children is neither new nor confined to India. In rural subsistence-farming communities, many factors drive this state of inequity, including the belief that sons are more useful for work and the cost of dowry required for daughters to marry (Stroope, 2015). Given the patriarchal context in which parents make decisions for their children regarding marriage, education, work, and health, it is not surprising that differential health outcomes based on gender have been reported over the years. Analysis of the countrywide 1992-2006 Indian National Family Health Survey revealed that among children aged five years and younger, females had significantly lower immunization coverage (p-value < 0.01) than males for BCG, DPT, and measles; for OPV, however, the gender disparity narrowed over time (Corsi et al., 2009). The narrowing gap for OPV may be partially attributable to heavy campaigning for polio vaccination in the turn of the century, which had the potential to mitigate the effect of gender bias.

IV. Size of Family and Birth Order

In addition to the aforementioned factors, household characteristics like family size and birth order of individual children are prevalent social determinants of health. Research has suggested that household size and number of children are associated with lower vaccination coverage. In Goa, a relatively high-coverage state, 98.4% of infants were fully immunized in households of three or fewer people, compared to 85.4% in households of three to six and 68% in households greater than six (Mathew, 2012). Larger family size can be indicative of little to no access to family planning services for mothers in each household. Hence, an increased number of both children and adults in the household serves as a potential proxy for lower levels of education, lesser empowerment for women, and limited access to reproductive health services.

Additionally, larger family size means that household's needs will increase, expanding the financial burden on the family and potentially discouraging the pursuit of vaccination and other healthcare services.

Birth order also may be a strong determinant of immunization status. The third National Family Health Survey (NFHS-3) substantiated this from 2005-2006, revealing that as birth order increased, vaccination coverage declined – first-born was 54.6%, second-born 45.3%, third-born 29.9%, and fourth and later-born 18.5% (Corsi et al., 2009). These statistics seem to indicate that some households drop out of vaccination programs over time and as more children are born. However, the number of household members may be a confounding factor in this analysis. For example, while the sample size for first child reflects the results for families that have one or more children, the sample size for the fourth child only includes families that have four or more children. Therefore, because larger family size is typically associated with lower overall immunization rates, family size could be the main factor driving health outcomes rather than birth order.

V. Religion

Both on a global scale and within India, religion serves to unite and to divide. While over three-quarters of Indians practice Hinduism, smaller populations practice Islam, Sikhism, and Christianity. Religious minority populations frequently face discrimination and injustice with respect to basic human rights like access to healthcare (Mathew, 2012). Current research in India demonstrates that Muslim communities have limited healthcare infrastructure, resulting in disparities in health outcomes. Results from the third National Health Family Survey (NFHS-3) revealed that while Christian and Sikh households had the highest complete vaccination rates

from 2005-2006, Muslim households had lower complete coverage than Hindu families (Mathew, 2012).

VI. Caste and Income

As highly interrelated factors, social caste and income are strong direct predictors of health status for populations around the world (Coelho & Belden, 2016). "*Dalits"*, or "untouchables", and individuals from scheduled castes mainly live in rural communities with little to no infrastructure. Though current government interventions aim to provide healthcare services like immunization programs to these populations, they are frequently neglected and relegated to being "invisible" in society. Additionally, tribal populations, which are not technically part of the caste system, face stigma and discrimination from mainstream society (Coelho & Belden, 2016). In 2005, UNICEF reported a 49.8% complete vaccination rate among infants from scheduled tribes, 58.9% among scheduled castes, 60.6% among other "backward" castes (OBCs), and 66.3% among all other castes (Mathew, 2012). These differences likely are mediated through factors such as education and the status of women. Other important considerations in relation to caste and social status are physical barriers and limitations on social interaction. For example, it is stigmatized for individuals from higher castes to share food, water, or even close physical space with those from lower castes. In Pauri Gharwal, a rural community in Uttar Pradesh, because vaccination often took place in the home of a higher-caste individual, scheduled tribe members were not able to enter, which generated resentment among mothers (Streefland, Chowdhury, & Ramos-Jimenez, 1999b). Evidently, vaccine acceptance behaviors must be considered in relation to local norms and situations.

Furthermore, household income serves as a more straightforward structural determinant of health. In 2005, in Udaipur district, vaccination coverage was examined in relation to

household income. It was found that from the lowest to the highest quartile of wealth, respective complete immunization rates were 19%, 29%, 46%, and 68% (Mathew, 2012). The most marked difference between quartiles is between the third and fourth – this is likely because the top five to ten-percent of richest Indians hold a disproportionate amount of wealth and have children with immunization coverage at or near one-hundred-percent.

VII. Residence

Area of residence serves as the last critical determinant of health that pertains to vaccination. Primarily, the rural-urban divide mandates that there are large disparities in access to education and healthcare resources. More healthcare facilities are concentrated in urban and suburban areas (Das, 2012). Additionally, better public transportation and roads make these facilities more accessible in urban rather than rural areas. At a national level, the third National Family Health Survey (NFHS-3) of India showed that from 2005-2006, 57.6% of urban infants were fully vaccinated in stark contrast to 38.6% in rural areas (Corsi et al., 2009).

Implicated in this rural-urban divide, location of residence relative to vaccination centers can have a large impact on vaccination coverage. One might expect that rural households farther away from vaccination services would be more likely to have partially or unimmunized children. Indeed, a study on inequities in coverage of preventative child health interventions in Udaipur revealed that complete vaccination rate was 55% for households within one kilometer of a vaccination center, 47% for one to two kilometers away, 32% for two to seven kilometers away, and 30% for greater than seven kilometers away (Mathew, 2012).

Availability and Accessibility

Logistical issues such as availability and accessibility are strong predictors of vaccine coverage globally (Mathew, 2012). These include, but are not limited to, lack of resources,

information, and personnel, as well as problems with transportation and cost. In combination with the aforementioned social determinants of health, these factors lead to sharp disparities in health outcomes, especially among low-income, rural populations in India.

I. Vaccine Availability

Though India remains one of the world's leading producers of vaccines, the large majority of products are exported and do not benefit Indian citizens (Laxminarayan & Ganguly, 2011). Furthermore, the distribution of vaccines in India does not necessarily follow the distribution of people living in urban and rural regions. For various reasons, including transportation issues caused by poor road conditions and difficulty maintaining and storing vaccines properly in rural areas, there is often a lack of vaccines to distribute (Laxminarayan & Ganguly, 2011). Because vaccine distribution in rural India is not highly regulated, random time and context-dependent factors powerfully impair immunization coverage.

II. Shortage of and Unreliability of Personnel

Further, shortage and unreliability of trained healthcare personnel can deter people from pursuing vaccination services. The World Health Organization reported that, in 2006, India had 0.60 doctors, 0.80 nurses, 0.47 midwives, 0.06 dentists and 0.56 pharmacists per 1000 people (World Health Organization, 2006). If parents take time off of work to travel far distances to vaccination centers and there is no doctor or auxiliary nurse-midwife (ANM) to administer vaccines, positive vaccine behaviors will not be reinforced and parents will be less likely to pursue vaccination in the future. A 2006 survey found absenteeism among primary health providers in India to be the highest of several countries surveyed, at an astonishing rate of 40%. In part, this may be to the lack of sufficient monetary incentives and working guidelines for these health workers (Bhandari & Dutta, 2007). In addition to noting absenteeism and irregular

availability of community health workers, parents in India have complained of rude behavior and technical incompetence among such workers (Streefland et al., 1999b). Unfortunately, such comments are reported most frequently to researchers instead of being collected systematically by the healthcare system itself.

III. Availability of Information

Alongside the aforementioned issues with vaccine and personnel availability, lack of information and health education also stands as a barrier to higher vaccination rates. This ties back to issues with health workers not attending their posts regularly as well as a lack of general education among rural mothers. Similarly, perceptions of health workers as well as time allotted for vaccination sessions tend to be important. In 1999 in Pauri Gharwal, Streefland reported that health workers often did not have time to provide vaccination-related information during sessions. Also, because it was routine for them, the health workers did not always feel the need to explain to parents what was being done and why, particularly to those parents who had attended before. Likely as a direct result, many mothers reported not knowing the appropriate ages for different vaccinations (Streefland et al., 1999a). When parents are not properly advised about the purpose, benefits, and side effects of immunization, they are unable to invest in their children's health through informed decisions.

IV. Accessibility

Although the Indian government has specifically designed and implemented a healthcare network to serve the 70% of the population living in rural areas, many regions remain unreached. In effect, this necessitates that some people travel far distances to receive healthcare, sometimes on dangerous or rough roads and with limited transportation options. The majority of these people must walk distances ranging from a few kilometers up to tens of kilometers because of a

severe lack of public transportation and means of self-transportation (Streefland et al., 1999a). A 1999 evaluation regarding the quality of vaccination services in Uttar Pradesh revealed that because there was spotty public transportation and vaccination camps were designed for the health workers' convenience, camps were not held particularly regularly (Streefland et al., 1999a). One might predict, then, that the highest rates of partial or no immunization would be among the children of families who live the farthest from vaccination centers, contributing to the substantial inequities in health outcomes.

Social Demand for Immunization

Defined as "requesting the health services to provide immunization or to improve the quality of vaccination delivery", social demand impacts patterns in vaccine coverage (Streefland et al., 1999b). Though the Indian government expresses the willingness to address gaps in healthcare coverage among rural, underserved populations, there is an important role for local people to assess their own needs and demand appropriate services, for only they can understand the kind of interventions that will be most effective and sustainable in their own communities. Thus, it is paramount that parents in rural villages be able to identify deficits in health and vaccination facilities available to them and feel empowered to demand what they want or need. For example, a randomized control trial in rural Uttar Pradesh demonstrated that community meetings that promoted advocacy and informed resource-poor populations of their entitled health services increased immunization uptake (Pandey, Seghal, Riboud, Levine, & Goyal, 2007). This finding highlights the importance of active social demand and the impact that it can have on health-seeking behaviors.

Cultural and Community Beliefs

Globally, culture shapes the way people perceive the world around them and influences their actions and decisions, including health-seeking behaviors. Cultural and community health beliefs and practices become particularly important where there is a severe lack of health education and information. The phenomenon of vaccine refusal or hesitancy due to fear of negative side effects has been observed in various developing and developed countries, including the United States (Omer, Salmon, Orenstein, DeHart, & Halsey, 2009). For example, people have been reported to refuse polio vaccine because they perceived it as the local government's attempt to sterilize them and control the size of the population (Larson, 2014). Additionally, in some cases, it is difficult for vaccine education to surmount ambient community beliefs and cultural norms. A study on social demand for vaccination in Asia revealed that in Pauri Gharwal, India, many pregnant women did not receive their tetanus shots because it was considered taboo for them to be seen in public, especially by male village elders (Streefland et al., 1999a). At the same time that cultural and community beliefs serve as potential barriers to high immunization coverage in rural India, it is possible that they could be harnessed in a beneficial way to promote immunization awareness. Certain aspects of Indian culture lend themselves to potential health benefits. For example, because of the emphasis on the extended family in Indian society (Mullatti, 1995), influencing the head of a household to vaccinate can have a strong positive influence on health-seeking behaviors, even among distant relatives.

Vaccine Behavior

Even though improving and addressing logistical issues regarding vaccination remains an imminent issue, this alone is not enough to improve immunization rates in any significant way.

Banerjee and colleagues' study on incentives and immunization in Udaipur demonstrated that full immunization in a group with dal incentives and immunization camps (39% coverage) was much higher than camps that solely had immunization camps held (18% coverage) (Banerjee et al., 2012). However, it is neither feasible nor sustainable to provide incentives long-term – even assuming that all conditions are maintained perfectly (vaccines are always available and healthcare workers are always present), an increase in incentives is unlikely to translate into the same size increase in vaccine uptake over time (Das, 2010). From this perspective, improving supply alone is not enough - without demand from local people, vaccine uptake will not necessarily increase. Effectively, social demand and parents' attitudes toward vaccination are crucial determinants of whether a child will become fully immunized. Currently, there remains a spectrum of vaccine behaviors, from active demand to passive acceptance to absolute refusal, as well as everything in between. Even without logistical issues, vaccine hesitancy has been observed in places like the United States (Omer, 2009). The myriad of factors and social phenomena that influence these attitudes will be discussed in detail.

Passive Acceptance & Active Demand

Though they may result in the same health outcome – a child being immunized – there is an enormous difference between passive acceptance and active demand of vaccines. Primarily, if parents feel empowered to seek out health services for their child and actively demand vaccines, it is more likely that they will pursue future services and that their children will become fully immunized. Additionally, parents who actively demand vaccines may influence others in their community to adopt similar mindsets, creating more intense social demand for improved immunization services. Whether parents passively or actively accept vaccination depends on factors such as time made available to attend vaccination sessions, distance from vaccination

centers, and contact experiences with healthcare workers. Intermittently, parents must interrupt important daily activities such as housekeeping, childcare, and farming to travel to vaccination centers. Securing vaccination comes at a cost - which economists consider "opportunity cost" - in which families must sacrifice daily income and productivity in order to pursue basic healthcare services. "Vaccine complacency" occurs when immunization is not considered essential and the quality, reliability, and convenience of healthcare services is low (Kumar et al., 2016).

Non-Acceptance

Motivating factors behind vaccine behavior also vary on the other end of the spectrum. Three main modes of non-acceptance, or "vaccine hesitancy", have been observed, though certainly more exist (Larson, 2014). The first possibility is that parents are willing to go but cannot due to a heavy workload, sickness, funeral, poor weather conditions, or long distance to the vaccination center. Additionally, some parents simply do not attend camps and do not have strong opinions regarding vaccination – this is usually due to the malfunctioning of healthcare systems, such as the paucity of consistent immunization camps and reliable healthcare workers. Lastly, some parents strongly oppose vaccination and question its necessity. In some extreme cases, large-scale resistance has been observed – in the 70s, there was resistance in India against the smallpox vaccine because of a conspiracy theory that the government was trying to sterilize and control the size of the population (Larson, 2014). Just as positive attitudes toward vaccination can spread throughout communities, unfortunately, negative attitudes can spread just as quickly. Social contagion as well as prevailing local conditions highlight the importance of targeting the entire community and addressing the spectrum of vaccine behaviors and attitudes that exist.

Drivers of Vaccination and Perceptions

Vaccine behavior is strongly influenced by the way that individuals perceive vaccination. These perceptions can be broken down into different categories, such as perceptions of the vaccines themselves, as well as that of healthcare staff, specific programs, and the government as a whole. In this section, other crucial factors and theories regarding vaccine behavior will be addressed.

I. Perceptions of Vaccines and Vaccinators

The way that parents conceptualize vaccines remains very relevant to their health-seeking behaviors. If the perceived risk of vaccination itself is lower than the perceived risk of disease without immunization, parents are more likely to choose to vaccinate their children (Brewer et al., 2007). For this to happen, health education and immunization information must be more readily available via government services as well as non-governmental organizations. Any concerns regarding the safety of vaccines should be addressed and parents should understand exactly why it is important to vaccinate their children and to follow the recommended immunization schedule.

Similarly, parents' perceptions of healthcare workers such as government nurses and doctors have a strong impact on vaccine behavior. The personal characteristics of those performing vaccination services, including age, years of reliable service, behavior, physical appearance, caste, and social class may be important (Streefland et al., 1999a). If someone has favorable characteristics, is respected in the community, and has provided reliable service in the past, they are seen as more competent and a positive schema of vaccination will be reinforced. The observation that people are more likely to trust someone who is from their community or similar to them has been replicated in the design of rural healthcare in India in which ASHAs

(Accredited Social Health Activists) are chosen from a community as advocates of health who mediate communication between the government and local people (established by National Rural Health Mission).

II. The Power Dynamic & Social Inequity

Another factor regarding vaccine behavior is the motivation behind the choice to vaccinate. While people who feel empowered to invest in their own and their families' health are more likely to achieve full vaccination, others vaccinate for alternative reasons. In a stratified society where social inequities are particularly deep, such as in India, a power dynamic exists between the government and low-income rural populations (Kothari & Das, 2016). Some parents take their children to be vaccinated because of state regulation and public policies encouraging them to conform. For instance, in his research on vaccination in Indonesia, Scriotino found that "given local relations of power and dependency, the majority of poor villagers feel they must obey the requests to attend health activities" (Sciortino, 1992). When people vaccinate solely because of this power dynamic, they lose their agency, which does not advance future positive health-seeking behaviors. If parents do not feel empowered to demand and actively pursue vaccination, they are less likely to participate in the multiple visits that it takes to fully immunize their children.

III. Conforming to the "Norm"

The effect of social influence should be considered - in India, it is certainly possible that people comply with vaccination programs because it is the norm and they want to conform to the notion of what it means to be a "good parent". If community members share the view of immunizing their children as a social responsibility, this has the potential to drive an increase in vaccine uptake (Kumar et al., 2016). According to this notion, all vaccination users are

interdependent and are influenced by each other's health seeking behaviors. Even though this does not address the root of why mothers should be motivated to vaccinate, the positive impact of a social normative effect on vaccination coverage cannot be ignored.

IV. Media & Community

Media also plays a potential role in influencing vaccination coverage. Different forms of media, from newspapers to radio, can spread and reinforce community beliefs and attitudes (Streefland et al., 1999a). This can either have negative or positive impacts on vaccine-related and health-seeking behaviors. The SSIM project, which studied the association of child deaths with OPV in West Bengal in 1996, revealed that even though the events were likely unrelated, local press reported that vaccination caused death. As a result, parents refused vaccination, which demonstrated the importance of social community, press, and local politics in vaccine acceptance (Streefland et al., 1999b).

Framework and Hypotheses

Previous vaccination studies in Udaipur, India, such as baseline (2007) and midline (2009) surveys from Seva Mandir, have focused on overall population coverage, place and timing of immunization, and vaccine knowledge. Additionally, the Abdul Latif Jameel Poverty Action Lab's study (2003-2004) in collaboration with Seva Mandir demonstrated how vaccination coverage could be vastly improved by ensuring the regularity of services and encouraging local demand for immunization. Although these elements have been associated with increased vaccine uptake, overall coverage is quickly approaching a sort of "plateau". Each unit of improvement in services no longer translates to the same magnitude of benefit and increase in coverage. There was only a 1.5% increase in fully immunized children aged 12-23 months

between the two most recent National Family Health Surveys, from 1998-1999 and 2005-2006 (Patel & Nowak, 2010). In order to address this issue, it will be crucial to examine vaccination from a perspective that incorporates both individual agency and a humanistic perspective into policy and program development. This study will expand on previous evidence and theory by placing an emphasis on parents' perceptions of health and vaccine behaviors. The goal is to illuminate how these perceptions and behaviors, in addition to structural predictors of health, lead to gaps in vaccination coverage and ultimate inequities in health outcomes in rural Udaipur district.

In this study, overall vaccine coverage will be compared between "health intervention" or "HI" villages in which Seva Mandir has a vaccination or *balwadi* childcare program, "non-health intervention" or "NHI" villages in which Seva Mandir has non-health programs (e.g. agricultural or governance), and "non-intervention" or "NI" villages, where solely the government is working. As baseline and midline reports from Seva Mandir indicate, higher rates of immunization are expected in villages with vaccination camps or *balwadis*. Further, it is anticipated that developmental programs (e.g. gender training, education) in Seva Mandir non-health intervention villages will have a "spillover" effect. In theory, these non-health programs contribute to increased agency and demand for resources in the community, ultimately leading to higher vaccination rates than in non-intervention villages.

Thereafter, this research will examine several social determinants of health in relation to individual and household immunization status. These include child gender, maternal age, maternal level of education, number of children in household, vaccine knowledge (purpose, vaccine and disease names), and household distance from nearest vaccination center. As mentioned previously, a preference for male children has been observed in rural and tribal

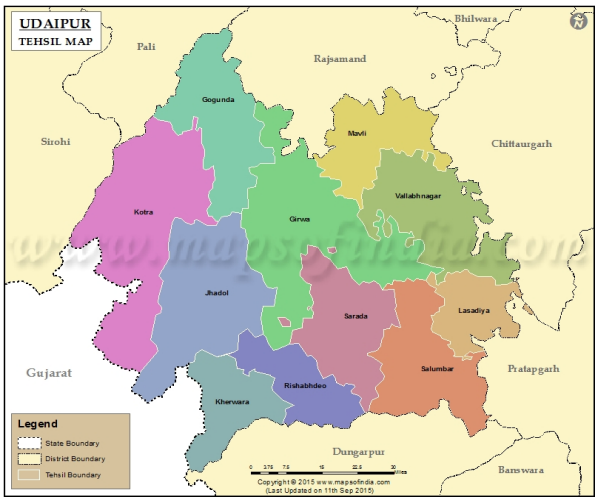
regions of India. Therefore, I hypothesized that female children will have received, on average, fewer vaccines than male children. Additionally, I predicted that the children of older, more educated women will have better vaccination statuses. This is because education and life experience may translate into higher health literacy and a strong sense of agency in health-related decisions. As a potential proxy for limited health knowledge and restricted access to family-planning resources, household size is hypothesized to be inversely correlated with the average number of vaccines received by children in each household. Respondents with more vaccine knowledge (as measured by knowledge of purpose, name of vaccines, and names of diseases) are expected to have a higher average number of vaccines for their children. Lastly, I tested the hypothesis that household distance from vaccination center, measured in kilometers, will be inversely correlated with average household number of vaccines per child. The farther a family lives, the less convenient it is to pursue vaccination services. Perceived benefit may not outweigh costs, such as loss of daily labor wage. Caste and religion will not be examined in the present study because in villages where the data was collected, each participant was Hindu and was from a scheduled caste or OBC.

Following the analysis of social determinants of health, the paper will focus on the current scope and major sources of vaccination information for parents in intervention and non-intervention villages as well as how this influences health-seeking behaviors. Local and personal factors regarding decisions to vaccinate or not vaccinate, particularly reasons for incomplete vaccination or dropout, will be addressed. The discussion will then turn to concerns of parents (e.g. side effects following vaccination events), community and cultural beliefs, and logistical issues such as availability and accessibility. I hypothesized that families in Seva Mandir health intervention villages will have a greater scope of vaccination knowledge and will display health-

seeking behaviors that align with "active demand", rather than passive demand or non-acceptance.

Methods

Site of Study[1]



Following Institutional Review Board (IRB) approval in June, 2016, the study was completed in two phases at separate locations. While initial data collection was carried out in Udaipur, India from July to August, 2016, data analysis and the writing process took place at Emory University in Atlanta, Georgia from August, 2016 to March, 2017. I conducted this study in conjunction with Seva Mandir, a nongovernmental organization serving rural and tribal communities of Udaipur through a variety of development programs, including health, self-governance, education, sustainable natural resources, women's empowerment, youth development, child care, and social enterprises. Within the health unit, vaccination services are provided via monthly immunization camps as well as *balwadi* child-care programs in which a

[1] "Tehsil Map of Udaipur", (2015)

balsakhi employee closely tracks child immunization. Five villages in which Seva Mandir worked (2 health intervention and 3 non-health intervention) were included in in the study.

While I interpreted and transcribed written notes from interviews at Seva Mandir headquarters, the primary study sites for data collection consisted of various rural and tribal villages in Jhadol, Kherwara, Kotra, Badgaon, and Girwa blocks of Udaipur district, Rajasthan, India. These villages (Table 1), both intervention and non-intervention, were randomly selected by Seva Mandir staff and local healthcare workers. Selection depended partially upon weather conditions (research was conducted during the rainy season) as well as where the organization was traveling for other programs on interview day. Additionally, we selected three non-intervention villages for the study – these sites also were randomly selected by Seva Mandir staff and were typically located within ten kilometers of an intervention village where Seva Mandir was working that day. The translator and I conducted semi-structured interviews in the homes of consenting respondents or their neighbors' homes. Questions were translated between English and Mewari, as well as various dialects of this local language in some households. Multiple modes of transportation, including Seva Mandir vehicles, public buses, and jeeps were used to travel to the study sites.

Seva Mandir and rural Udaipur were selected as the study sites for multiple reasons. Primarily, in order to establish a rapport with local families, it was necessary to work with a local well-established organization. At least within project villages, the large majority of parents were familiar with Seva Mandir and expressed either neutral or positive sentiments towards the organization and its employees. Additionally, the NGO had a particularly well-established and relatively successful health division – following the implementation of programs that increase supply as well as local demand, immunization rates have increased from 35 to 60% in some

project villages (Seva Mandir, 2016). Various individuals and institutions have collaborated with Seva Mandir in research efforts focused on the implementation of immunization programs and the current state of parental vaccine knowledge and pediatric coverage. The aim of this study was to contribute an anthropological perspective on vaccine-related perceptions and behaviors in order to shed a light on how the local government and the NGO can effectively increase vaccine uptake.

Furthermore, I specifically chose rural Udaipur because complete immunization rates are particularly low in this region. The third National Family Health Survey (NFHS-3) of India reported a 2005-2006 national average of 44% full immunization for children between the ages of one and two years; meanwhile, in rural Rajasthan, a full immunization rate of 22% was reported (Mathew 2012). The goal of the present study is to illuminate why coverage in this region is particularly low.

Study Population

The participant pool consisted of mothers in the community who had at least one child between nine months and five years of age and who were physically and mentally capable of consenting to and participating in the interview process. Interviewees and their families were mainly subsistence farmers, making a living from their own food production. In these particular communities, women play fundamental roles in their homes, as they are often responsible for childcare as well as the maintenance of crops and livestock. Oftentimes, multiple nuclear families, related by extension, occupy the same residence. In accordance with local patrilocal marriage practices, men live in their childhood home with their own nuclear family as well as their parents and brothers' families.

A Day in the Field

Each day of fieldwork roughly consisted of the same schedule. On most days, I left from Seva Mandir around 8 or 9:00 AM in a Jeep with Seva Mandir employees and a translator. Depending on the location, we traveled between two and three hours to reach the Seva Mandir zonal office nearest to the site of interest. Upon arriving at the office, the Jeep picked up a Seva Mandir zonal worker who could provide specific directions to intervention and non-intervention villages. From there, the translator and I traveled by foot or motorcycle to the selected villages. In one day, we would typically interview between four and six mothers in each village, across one to three villages. I recorded data manually in a notebook. After a day of data collection, the group left villages before dark (around 4 or 5:00 PM) to travel back to Seva Mandir main campus.

Table 1 Study site characteristics

Village	Block	Zone	Intervention Status	Respondents (Mothers)	Number of Children
Chikla	Kotra		Health Intervention (HI)	4	6
Bori Milan	Girwa	Patiya	Non-Intervention (NI)	3	5
Patiya	Girwa	Patiya	Intervention, Non-Health (NHI)	2	4
Adol	Jhadol		Non-Intervention (NI)	4	6
Upali Subari	Kotra	Kotra	Intervention, Non-Health (NHI)	4	8
Kojon Ka Gurha	Girwa		Intervention, Non-Health (NHI)	6	9
Pareda	Kherwara	Pareda	Health Intervention (HI)	4	6
Badgunda	Badgaon		Non-Intervention (NI)	6	8
			Total	33	52

Data Collection: Semi-Structured Interviews

The translator and I conducted semi-structured interviews with thirty-three mothers, near or inside their homes. It was necessary to obtain oral consent, as the large majority of respondents had received little to no education and were unable to sign written documents. The following basic script was translated into Mewari by the translator and utilized throughout the interview process:

> "Hello, I am an American student working with Seva Mandir. I am studying immunization coverage and health services in this area so that health outcomes in this area may be improved. May I interview you about your child(ren)'s vaccination history and your beliefs about immunization?"

Prior to each interview, I assigned a study identification number to individual children and families, so as to protect their identities and private health information. Respondents were asked questions about basic demographics, their children's vaccination statuses, their perceptions and knowledge of immunization, their experiences with current health services, and shared community attitudes (Survey Questions, Appendix A). Seva Mandir employees, including local students (part-time) and full-time health unit workers, assisted with the translation between English and Mewari, the local language spoken by most of the villagers. Throughout the process, three male students between twenty-one and twenty-three years of age provided the majority of translation assistance. However, because respondents spoke alternative dialects in some villages, local healthcare workers, like auxiliary nurse-midwives (ANMs), assisted with translation between Mewari and the local dialect. Throughout the interview process, the translator continuously referred to vaccines as "*tika*" in Mewari. When translated into English, *tika* (*"tilak*" in Sanskrit) literally means "dot" or "spot". In order to maximize data collection efficacy,

interview questions were often repeated or phrased in various forms. Additionally, if the respondent mentioned something of interest that was related to the study but not included in the questionnaire, I asked follow-up questions.

Following this initial data collection process, I cleaned and transcribed interviews into a Microsoft Word document so that they could be reorganized into a logical, thematic format. Because the semi-structured interviews were more representative of casual conversations, topics were sometimes addressed at random. Thereafter, I coded the data into a Microsoft Excel document - for each variable, such as village intervention status or location of vaccination event, each response was assigned a specific numerical value. For example, Seva Mandir "health intervention" villages were coded as "0", while "non-health intervention" villages were "1" and "non-intervention" villages were "2". The variables extrapolated from interviews included the following: village intervention status, maternal age, maternal highest level of education received, child gender, child age, number of children in household, number of vaccines received by child, mother's reasons for pursuing or not pursuing immunization services, location of vaccination event, mother's knowledge of purpose, knowledge of vaccine names, knowledge of diseases targeted by vaccinations, source of health information, and household distance from nearest vaccination site.

Quantitative Data Analysis

Following the editing and cleaning process, the data were analyzed using both SPSS v23.0 and STATA v14.2 software. Primarily, I used SPSS to explore the descriptive statistics, such as average, standard error of the mean, mode, standard deviance, and range for different variables for the study population. This included information about the basic demographics of

the population, such as child age and mother's level of education. Because I hypothesized that maternal education and household distance from nearest vaccination center would be two of the most vital predictors of vaccination, various statistical methods were used to determine whether these variables significantly differed between villages by intervention status. Primarily, chi-squared testing in STATA was used to illuminate the nature of the relationship between intervention status and maternal education level, which was coded into two groups: "low/no literacy" and "6th standard pass or higher". Further, because distance from nearest vaccination center is a continuous variable, I used ANOVA testing in STATA to evaluate whether there was a significant relationship between intervention status and distance, followed by post hoc Tukey testing to differentiate between specific intervention groups.

I then analyzed current state of coverage, both overall and by village intervention status. Because the number of vaccines received per child was not normally distributed, chi-squared testing in STATA was used to examine the relationship between intervention status and number of vaccines, which was coded into three categories: "few to none" (0-2 vaccines), "moderate" (3-5 vaccines), or "substantial to complete" (6 or more vaccines). Knowledge of the purpose of immunization and names of vaccines and vaccine-preventable diseases were also compared between intervention groups. Primarily, knowledge of purpose was categorized into the following groups: "knows purpose", "limited knowledge", and "no knowledge", while knowledge of vaccine and disease names were categorized into "none" and "one or more".[2] The aforementioned codes were used consistently throughout the study, unless otherwise stated.

[2] "Knows purpose" meant the respondent could explain that vaccines prevent diseases, "Limited knowledge" meant that they only generally knew that it was beneficial for their children's health, while "No knowledge" meant that they knew nothing about vaccination.

Given the categorical nature of these data, I analyzed these relationships between intervention status and vaccine knowledge using chi-squared testing in STATA.

Furthermore, various social determinants of health represented by the variables in the study were examined in relation to vaccine coverage (defined by number of vaccines received) and to vaccine knowledge (defined by knowledge of purpose and number of vaccine or disease names known by mother). For the purpose of this study, the World Health Organization's definition of "social determinants of health" will be used:

> "The conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies, and political systems" ("Social determinants", 2017).

Additionally, I sorted the data according to the type of analysis employed. For example, an analysis that involved solely individual characteristics of a child (such as the relationship between a child's gender and the number of vaccines they have received), did not require sorting by family. However, because most mothers in the study had multiple children, analyses that involved information about the mother's demographics or health-seeking behaviors required treatment of the household as one unit and calculation of the average number of vaccines per household (rather than using an individual child's immunization status).

Using SPSS, I calculated a two-tailed Pearson's correlation to determine the relationship between the following continuous variables and vaccine coverage (coded as "few to none", "moderate", or "substantial to complete"): child age, number of children in family, and household distance from nearest vaccination center. For categorical variables, such as child gender, maternal education level (coded as "low/no literacy" or "6th standard pass or higher"),

and maternal age (coded as “25 years or younger” or “older than 25 years”). Chi-squared tests in STATA were utilized to determine each variable’s relationship with vaccine coverage (coded as “few to none”, “moderate”, or “substantial to complete”). I also analyzed the relationship between vaccine knowledge (as measured by number of vaccine and disease names known) and both maternal age and education through chi-squared tests in STATA. Similarly, chi-squared tests were used to examine the relationship between vaccine knowledge and household distance to nearest vaccination center; in order to do this, respondents’ answers were coded either as knowing no diseases and vaccines or knowing one or more, while distance from nearest vaccination center was coded as “less than 1 km” or “1 km or more”. In order to better understand the mechanism by which health education may translate into health-seeking behaviors like vaccine uptake, I analyzed the relationship between various indicators of vaccine knowledge and vaccine coverage through extended chi-squared testing in STATA.

Thereafter, in order to explore statistically significant associations between social determinants of health, vaccine coverage, and markers of knowledge, various binomial logistic regressions were run in STATA. Though it is not feasible to control for every real world variable, the regression aimed to identify factors that may confound individual relationships. Because average household number of vaccines was used as a dependent variable in the regressions (and therefore was required to be binary), I coded vaccine coverage into one of two categories (“0-4 vaccines” or “4 or more vaccines”) rather than its initial three categories (“few to none”, “moderate”, and “substantial to complete”).

Primarily, binomial logistic regressions were used to explore the effect of the following variables on average number of vaccines per household: village intervention status (health intervention vs. non-health intervention) and household distance from nearest vaccination center

(km), household distance from nearest vaccination center and disease knowledge, and village intervention status and disease knowledge. Other potential models included the effect of household distance from center and knowledge of purpose on vaccine coverage, the effect of village intervention status and knowledge of purpose on vaccine coverage, and mother's education and village intervention status on the number of vaccines known. I used further chi-squared testing in STATA to explore the relationships with multiple levels. This was done by dividing a predetermined "comparison variable" into two categories and comparing the two chi-squared tests for the relationship between the independent and dependent variables. The following summarizes the relationships that were evaluated:

Test	"Comparison" Variable	Independent Variable	Dependent Variable
1	Distance from center (km)	Knowledge of purpose	Vaccine coverage
2	Village intervention status	Knowledge of purpose	Vaccine coverage
3	Village intervention status	Mother's education	Vaccine coverage
4	Distance from center (km)	Knowledge of diseases	Vaccine coverage
5	Village intervention status	Distance from center (km)	Vaccine coverage
6	Village intervention status	Knowledge of diseases	Vaccine coverage

Qualitative Data Analysis

In order to integrate a more holistic approach into the study, I used qualitative analyses to supplement the aforementioned quantitative testing. These results were collected from semi-structured interviews with mothers of children between the ages of nine months and five years, across villages of all intervention statuses. Primarily, site of vaccination event and source of vaccine information were examined; these results were compared between villages by

intervention status. In order to gain a better understanding of how respondents' experiences with vaccination may influence their health-seeking behaviors, I asked specific questions about individual and community beliefs and attitudes surrounding immunization. Along the same lines, I evaluated the spectrum of vaccine behavior, ranging from non-acceptance to active demand.

Thereafter, perceptions of vaccination were examined within the context of Indian culture; though difficult to pin down any particular "mainstream" Indian culture, broad concepts extrapolated from literature and conversations with local people were applied. The word for vaccine, *tika,* and what it symbolizes within a larger framework of local culture was evaluated. Follow-up questions for source of information and vaccines provided invaluable insight into the relationship between healthcare providers and local families, particularly the mother. In order to consider the nature of this relationship, I considered the cultural power dynamic, the rural/urban divide, and gender dynamics.

Results

Study Site and Population Descriptive Statistics

The study was conducted in conjunction with Seva Mandir, a nongovernmental organization with a wide range of developmental programs. The main headquarters is located in Udaipur city, though the non-governmental organization has zonal and block offices in rural and tribal villages in Jhadol, Kherwara, Kotra, Badgaon, and Girwa blocks of Udaipur district. These offices employ local community members as well as staff from the main headquarters. Interviews with respondents in the various health intervention and non-health intervention communities indicated that many people are aware and respectful of Seva Mandir's presence.

In these villages, all respondents were housewives who engaged in subsistence farming, which was the main occupation across households. The only exception was that some younger men traveled to Udaipur city to work as day laborers. A typical household comprised one or two nuclear families (married brothers lived in their childhood home) living in a home with a kitchen and two or three multipurpose rooms. The majority of families lived in modest homes consisting of a variety of materials (such as mud and tin); a few lived in concrete homes with more modern amenities. Every household owned a small plot of land for basic crops and at least a few livestock animals. The majority of families were Hindu, low-income, and from scheduled, tribal or other "backwards"-designated castes; specific details could not be analyzed due to sensitivity and privacy issues. Women are a pillar in the household because they are typically responsible for substantial agricultural and pastoral duties as well as organizing the household including child and healthcare. In some households, the mother appeared shy and deferential, while in others she appeared to be assertive.

Analysis of overall descriptive statistics through SPSS revealed that the average child age was about three years, the average household size was about three children, and the average age for mothers was almost twenty-seven years. The average number of children per family was smaller than expected, given the fact that there is often limited access to healthcare and family planning resources in these villages. Additionally, the average age of mothers was higher than anticipated, given that child marriage is relatively common in various rural parts of India. Further examination of these descriptive statistics indicated diversity both within and across villages. The standard deviation and range were relatively small for child age and household size, but were much larger for maternal age, indicating variation in child-bearing age across women (Table 2).

Table 2 Overall descriptive statistics: Child age, household size, and mother age

	Child Age	***Household Size***	***Mother Age***
Average	3.08	2.90	26.55
Mode	5.00	3.00	30.00
Standard Deviation	1.46	1.45	4.26
Range	4.25	6.00	15.00

Furthermore, variables representing social determinants of health differed among villages with different intervention statuses. While 57% of mothers in health intervention (HI) villages had completed at least the 6th standard or higher, only 8% of mothers in non-health intervention (NHI) villages and 31% of mothers in non-intervention (NI) villages had received such an education (Table 3). As a potential proxy for women's status, earning potential, and health literacy, this educational disparity suggests that the non-health intervention group had the most difficult living conditions. Chi-squared tests in STATA revealed that there was a statistically significant difference in highest level of education attained by mothers across intervention groups (p-value < 0.05). When I compared each intervention group pair by pair, statistical significance only remained in the comparison between HI and NHI villages.

Table 3 Mother highest level of education attained, by intervention status

	Health Intervention	***Non-Health Intervention***	***Non-Intervention***	***Total***
Low to no literacy	2	11	9	22
6th standard pass or higher	4	1	4	6
Total	6	12	13	28
Percentage	57%	8.0%	31%	29%

"Educated"				

Pearson chi2(2) = 6.64 Pr = 0.036*

As another crucial social determinant of health and health-seeking behaviors, household distance from nearest vaccination center was also compared between intervention groups through descriptive statistics in SPSS and ANOVA testing in STATA. Primarily, the shortest average distances that mothers traveled were HI villages, 0.68 km and NI villages, 1.07 km; on the other hand, mothers in NHI villages were required, on average, to travel the farthest distance – 4.64 km. The NHI group had the highest standard deviation, variance, and range, indicating that there were intra-village or inter-village disparities in distance from nearest vaccination center (Table 4). There was a statistically significant difference between all intervention groups (p-value < 0.01). Post hoc Tukey testing indicated that the disparities between HI and NHI groups were significant (p-value < 0.01) (Table 5). Overall, households in Seva Mandir villages without health interventions had significantly fewer educated mothers and were substantially farther from the nearest vaccination center, in comparison with villages where Seva Mandir had health interventions or no interventions at all.

Table 4 Descriptive statistics: Distance to vaccination center (km), by intervention status

	Overall	***Health Int.***	***Non-Health Int.***	***Non-Int.***
Average	2.36	0.68	4.64	1.07
Mode	6.00	0.50	6.00	0.30
Standard Dev.	2.96	0.22	3.49	1.79
Range	9.98	0.50	9.98	5.95

Table 5 Post hoc (Tukey): Distance to nearest vaccination center (km), by intervention status

	Standard Error	***t***	***P-value***	***95% CI*** *(Lower Bound)*	***95% CI*** *(Upper Bound)*
Health Int. *vs.* Non-Health Int.	0.98	-2.98	0.007**	-4.96	-0.90
Health Int. *vs.* Non-Int.	0.96	-1.20	0.243	-3.13	0.83
Non-Health Int. *vs.* Non-Int.	0.93	1.91	0.068	-0.14	3.69

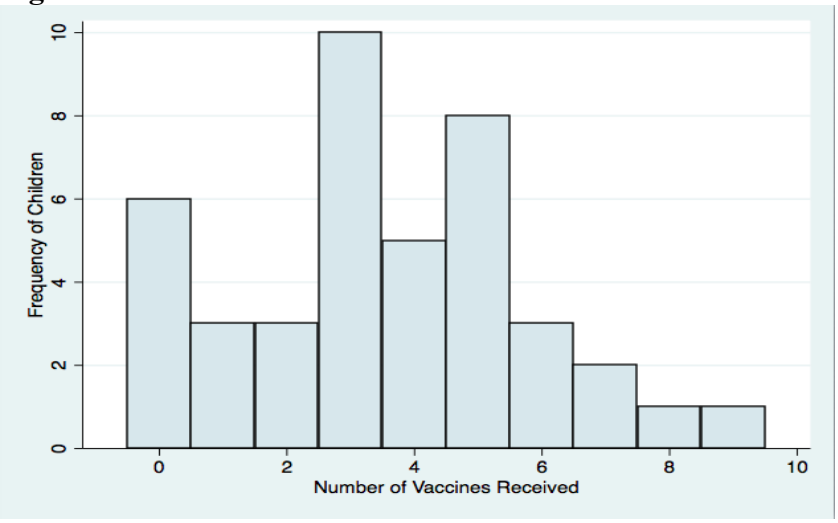
Vaccine Knowledge and Coverage, by Intervention Status

In addition to the aforementioned variables that represent social determinants of health, I analyzed vaccine coverage (number of vaccines received) and knowledge of immunization purpose, vaccines, and vaccine-preventable diseases across villages by intervention status. It was initially predicted that both Seva Mandir HI and NHI villages would display higher coverage and more in-depth know4uledge of immunization. Even though NHI villages did not have vaccination camps sponsored by Seva Mandir, I predicted that because of other developmental intervention programs, people in the community would have a stronger sense of agency, which would positively influence vaccine uptake.

Regarding the overall distribution of vaccine coverage (measured as number of vaccines received per child), very few children received more than 5 vaccines. The majority of children had received between 0 and 3 vaccines (Figure 1). Because the overall distribution was not normal, I utilized chi-squared testing to compare coverage (coded as “few to none” or 0-2

vaccines, “moderate” or 3-5 vaccines, and “substantial to complete” or 6+ vaccines) across intervention groups.

Figure 1: Overall distribution of number of vaccines received



Descriptive statistics revealed that the HI villages had much higher immunization coverage, on average, than the NHI and NI villages. Although the HI group boasted an average of about 5 vaccines per child, it was most common in NHI households to have received no vaccines. However, vaccine coverage was comparable between NHI and NI villages, at about 2 and 3 vaccines, respectively. Furthermore, the NHI group fared more poorly than was originally speculated, refuting the notion that non-health programs would inspire positive health-seeking behaviors in the villages. The standard deviation in the NHI group was relatively high, suggesting intra-village disparities in coverage (Table 6).

Table 6 Descriptive statistics of vaccine coverage[1], by intervention group

	Overall	***Health Intervention***	***Non-Health Intervention***	***Non-Intervention***
Mean	3.52	4.83	2.07	2.79
Mode	3.00	5.00	0.00	2.00

Standard Dev.	2.29	0.39	2.49	0.89
Lowest Value	0.00	3.00	0.00	2.00
Highest Value	9.00	9.00	7.00	8.00
Range	9.00	6.00	7.00	6.00

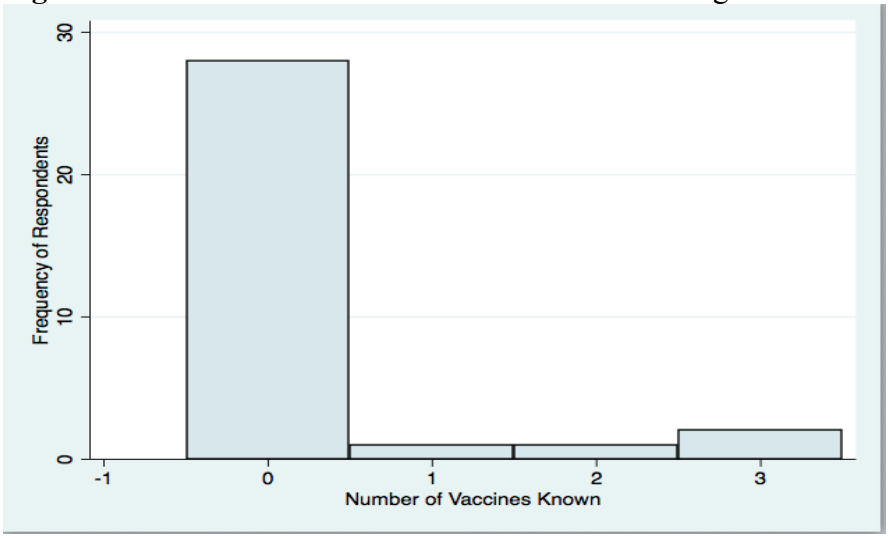
[1] Defined as "number of vaccines that each child has received"

In a chi-squared test, a statistically significant difference in vaccine coverage emerged between intervention villages (p-value < 0.01) (Table 7). Pairwise comparisons between intervention groups were employed through further chi-squared testing in order to determine from where this relationship stemmed. HI and NHI villages had significantly different levels of vaccine coverage (p-value < 0.05), the HI group having much better coverage (Table 7). The average number of vaccines received per child, a direct measure of vaccine coverage, was supplemented by chi-squared testing for vaccine knowledge, measured by knowledge of purpose, number of vaccines known, and number of vaccine-preventable diseases known.

I coded participants' knowledge of the purpose of immunization into one of three categories: "knows purpose", "limited knowledge", and "doesn't know purpose". The large majority of respondents across all villages either knew the purpose of vaccination or generally knew that it was beneficial for their children's health (categorized as "limited knowledge") – very few people indicated that they did not know the purpose. Though the raw numbers indicate that slightly more respondents in HI and NI groups fully knew the purpose of immunization, there was no statistically significant difference between intervention villages (Table 8). Overall, a relatively high proportion of mothers knew the purpose of vaccination (56% of respondents) or at least knew that it was generally positive for their children's health (31% of respondents). On the other hand, there was a significant relationship between village intervention status and the

number of vaccines known by respondents. It should be noted, however, that very few respondents in any villages could name any vaccines (Figure 2). Follow-up chi-squared testing revealed a significant difference (p-value < 0.05) in vaccine knowledge between HI and NHI villages, adding to the increasingly observed stratification between these two categories of intervention villages (Table 9).

Figure 2 Overall distribution of vaccine name knowledge



For knowledge of vaccine and disease names, respondents in the NHI groups could name the fewest vaccines, while respondents in the HI group could name the most vaccines and respondents in the NI group could name the most diseases prevented by immunization (Tables 9 & 10). Once again, very few respondents across all villages could name any diseases (Figure 3); the most commonly mentioned diseases were "*kasra*" or TB, tetanus, and polio. I observed the best indicators of health literacy via disease knowledge in the HI and NI groups, as more people could name vaccine-preventable diseases in these groups. Initial chi-squared testing in STATA revealed a statistically significant disparity between intervention groups, while further testing

revealed a difference between HI and NHI groups (p-value < 0.01) and NHI and NI groups (p-value < 0.05) (Table 10).

Figure 3 Overall distribution of disease knowledge

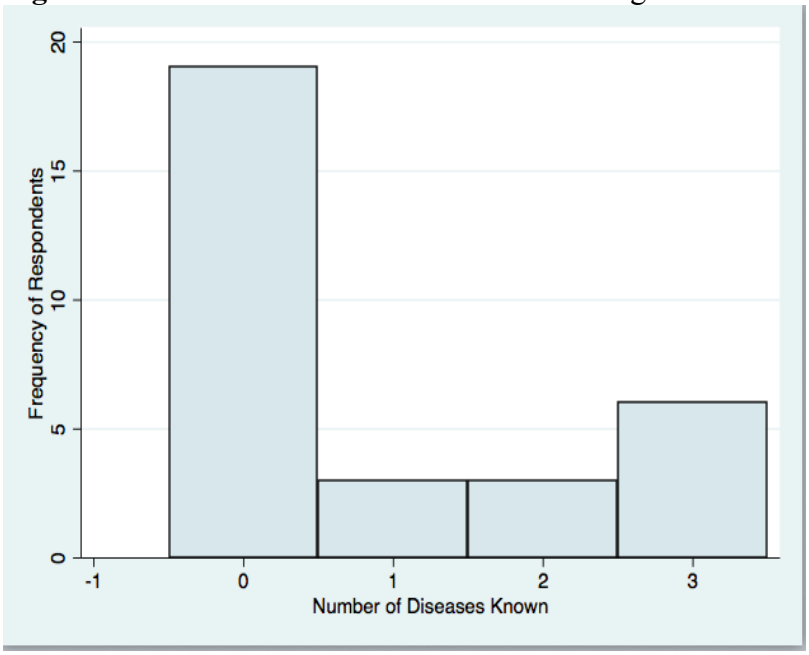


Table 7: Vaccine coverage in relation to social determinants of health: intervention status, child gender, child age, maternal age, maternal level of education, size of household, and household distance from nearest vaccination center (km)

	Subcategory	**Average Number of Vaccines in Household[1]**			**Chi-squared**	**P-value**
		Few	*Moderate*	*High*		
Village Intervention Status	*Health Intervention*	0	10	2	Chi2(4) = 13.84	<0.01**
	Non-Health Intervention	9	4	2		
	Non-Intervention	3	8	4		
Child Gender	*Female*	6	14	4	Chi2(2) = 0.38	0.83
	Male	6	9	3		
Child Age	*9 months – 2 years*	4	7	3	N/A[2]	0.85
	3 – 5 years	8	16	3		
Maternal Age	*25 years or younger*	1	7	3	Chi2(2) = 1.16	0.56
	Older than 25 years	3	7	2		
Maternal Education	*Low/no literacy*	7	6	4	Chi2(2) = 3.52	0.17
	6th standard or higher	1	6	1		

Size of Household	*0-2 children*	3	3	2	N/A[2]	0.10
	3-5 children	5	7	0		
	6+ children	3	2	0		
Distance from center (km)	*Less than 1 km*	3	5	2	N/A [2]	<0.01**
	1 km or more	4	7	2		

[1] "Few" vaccines indicates 0-2 vaccines received on average, "Moderate" indicates 3-5 vaccines, and "High" indicates 6 or more
[2] Used Pearson's two-tailed correlation test

Table 8: Knowledge of vaccine purpose in relation to social determinants of health: intervention status, maternal age, maternal level of education, and household distance from nearest vaccination center (km)

	Subcategory	**Respondents' vaccine purpose knowledge**			**Chi-squared**	**P-value**
		Knows	*Limited*	*None*		
Village Intervention Status	*Health Intervention*	6	1	0	Chi2(4) = 3.52	0.23
	Non-Health Intervention	4	6	2		
	Non-Intervention	8	3	2		
Maternal Age	*25 years or younger*	10	2	1	Chi2(2) = 1.71	0.43
	Older than 25 years	8	5	2		
Maternal Education	*Low/no literacy*	10	8	4	Chi2(2) = 4.90	0.11
	6th standard or higher	7	1	0		
Distance from center (km)	*Less than 1 km*	9	4	0	Chi2(2) = 2.52	0.28
	1 km or more	7	6	2		

Table 9: Knowledge of vaccine names in relation to social determinants of health: intervention status, maternal age, maternal level of education, and household distance from nearest vaccination center (km)

	Subcategory	**Vaccine Names Known**		**Chi-squared**	**P-value**
		None	*1+*		
Village Intervention Status	*Health Intervention*	4	3	Chi2(2) = 7.89	0.02*
	Non-Health Intervention	12	0		
	Non-Intervention	12	1		
Maternal Age	*25 years or younger*	7	8	Chi2(1) = 0.18	0.67
	Older than 25 years	1	2		
Maternal Education	*Low/no literacy*	21	1	Chi2(1) = 5.51	0.02*
	6th standard or higher	5	3		
Distance from center (km)	*Less than 1 km*	4	11	Chi2(1) = 1.80	0.18
	1 km or more	2	1		

Table 10: Knowledge of disease names in relation to social determinants of health: intervention status, maternal age, maternal level of education, and household distance from nearest vaccination center (km)

	Subcategory	**Disease Names Known**		**Chi-squared**	**P-value**
		None	*1+*		
Village Intervention Status	*Health Intervention*	2	4	Chi2(2) = 7.90	0.02*
	Non-Health Intervention	11	1		
	Non-Intervention	6	7		
Maternal Age	*25 years or younger*	7	5	Chi2(1) = 0.01	0.93
	Older than 25 years	9	6		
Maternal Education	*Low/no literacy*	15	7	Chi2(1) = 2.30	0.13
	6th standard or higher	3	5		
Distance from center (km)	*Less than 1 km*	7	4	Chi2(1) =0.01	0.95
	1 km or more	10	6		

Relationship between Vaccine Coverage and Social Determinants of Health

In order to identify crucial predictors of vaccine uptake, I examined various social determinants of health in relation to vaccine coverage. Primarily, the relationship between child age and number of vaccines received was explored. Theoretically, an older child would receive more vaccines and a positive correlation should exist between these two continuous variables. Even though there was a slight positive correlation in a two-tailed Pearson's correlation, the relationship was not statistically significant (p-value = 0.71) (Table 7). Along the same lines, I examined child gender in relation to the number of vaccines received per child. It was hypothesized that because of a culturally-rooted preference for male children that exists in many rural regions of India, female children would receive fewer vaccines. Descriptive statistics demonstrate that the average number of vaccines, about 3-4, as well as standard deviation were nearly identical for male and female children (Table 11). Because the number of vaccines per child was not normally distributed in the population, a chi-squared test was run for a sample of 42 children from all villages to examine the relationship between child gender and vaccine coverage. There was no statistically significant difference in coverage (p-value = 0.85) across gender and this hypothesis was invalidated (Table 7).

Table 11 Descriptive statistics of vaccine coverage[1], by child gender

	Overall	***Male***	***Female***
Mean	3.52	3.44	3.58
Mode	3.00	3.00	3.00
Standard Deviation	2.29	2.38	2.26

[1] Defined as "number of vaccines that each child has received"

Other than variables specific to the children, I predicted that household and maternal characteristics would affect the number of vaccines that they received. For example, the number of children in each household, measured as "size of household" was considered. As a potential proxy for limited access to health and family planning resources, number of children in the household was predicted to be inversely associated with number of vaccines received. Although the two-tailed Pearson's correlation yielded an association of -0.34, the relationship was not statistically significant (p-value = 0.10) (Table 7).

Given that the mother in each household is primarily responsible for childcare and health-related decisions, it seems likely that a mother's personal characteristics would significantly influence child immunization status. I anticipated that older and more highly educated mothers would have children with higher coverage. Descriptive statistics reveal that, on average, the children of mothers who have been educated until at least the 6th standard received more vaccines – the results demonstrate about 4 vaccines for the children of educated mothers and about 3 vaccines for "low/no literacy" mothers. There was also much larger range in the "low/no literacy" group, indicating intra-group disparities (Table 12). Chi-squared tests used to compare vaccine coverage between the more and less educated groups yielded no significant difference (p-value = 0.17) (Table 7).

Table 12 Descriptive statistics of vaccine coverage[1], by mother's level of education

	Overall	***Illiterate***	***6th Standard Pass or Higher***
Mean	3.52	3.33	4.05
Mode	3.00	0.00	3.00
Standard Deviation	2.29	2.83	1.19
Variance	5.23	7.47	1.41

Range	9.00	9.00	3.50

[1]Average number of vaccines that children of respondent have received

Lastly, I examined the relationship between household distance to nearest vaccination center and average number of vaccines received by children in each household. Households were coded either as "less than 1 km" away or "1 km or more" away. It was predicted that households farther away would have significantly lower vaccine coverage. A two-tailed Pearson's correlation revealed a statistically significant correlation of -0.64 (p-value < 0.01), indicating that, indeed, lower coverage was associated with longer distance traveled (Table 7).

Relationship between Vaccine Knowledge and Social Determinants of Health

Further, vaccine knowledge, used as a proxy for health-seeking behaviors and vaccine uptake, was also evaluated in relation to various of social determinants of health. In this study, I considered maternal age, maternal education, and household distance to vaccination center. Once again, respondents' vaccine knowledge was measured through knowledge of purpose as well as ability to name specific vaccines and vaccine-preventable diseases. These analyses were run in order to gain a better understanding of how structural factors both directly and indirectly impact health literacy across rural communities in Udaipur.

Primarily, I evaluated the relationship between maternal educational level and vaccine knowledge. The expectation was that women who are literate and have spent more time in school would have more exposure to general health-related information, including immunization. Therefore, I hypothesized that older, more educated mothers would demonstrate significantly greater knowledge regarding the purpose of immunization as well as relevant vaccine and disease names. In chi-squared testing on a sample of 30 mothers from all villages, each variable

was split into categorical groups – maternal age was stratified as "25 years or younger" and "older than 25 years" and maternal level of education was coded as "low/no literacy" or "6th standard pass or higher". Testing revealed that there was no significant difference in knowledge of purpose between age groups (p-value = 0.43); a similar effect was observed for maternal level of education (p-value = 0.11) (Table 8). On the other hand, even though there was no statistically significant disparity in knowledge of vaccine names between maternal age groups (p-value = 0.67), there was a significant difference between less and more educated mothers (p-value = 0.02) (Table 9). Lastly, neither maternal age nor maternal education level had significant intra-group disparities for the number of vaccine-preventable diseases known (p-value = 0.93 and 0.13, respectively) (Table 10).

Additionally, I observed the relationship between vaccine knowledge and household distance from the nearest vaccination center through further chi-squared testing. For each household, distance was categorized as either "less than 1 km" or "1 km or more". I predicted that the group of households farther from vaccination centers would have poorer vaccine knowledge, thus resulting in disparities between households stratified by distance. Ultimately, between the two distance groups, there was no significant or detectable difference in knowledge of vaccine purpose (p-value = 0.28) or knowledge of vaccine names (p-value = 0.18) (Tables 8 & 9). Conversely, there was a statistically significant difference in the mean number of diseases known for households stratified by distance (p-value < 0.01) (Table 10).

The Translation of Vaccine Knowledge to Coverage

Vaccine knowledge is also expected to be an important correlate of health-seeking behaviors. In theory, greater vaccine knowledge, with positive motivation as a catalyst, should

translate to higher vaccine uptake and increased coverage. In order to investigate how this relationship is manifested in reality, I utilized chi-squared testing to examine the relationship between vaccine knowledge and coverage. Different levels of knowledge of immunization purpose were associated with differences in vaccine coverage (p-value < 0.01). Similarly, there was significantly greater vaccine coverage for the children of respondents who could name at least one disease compared to those who knew none (p-value = 0.02) (Table 13). This implies that both a mother's knowledge of the purpose of immunization and her knowledge of vaccine-preventable diseases impact her health-seeking behaviors and ultimately the number of vaccines that her children receive. There was no variation in vaccine coverage for groups of respondents stratified by knowledge of vaccine names (p-value = 0.18) (Table 13).

Table 13: Vaccine coverage in relation to markers of vaccine knowledge: knowledge of immunization purpose, knowledge of vaccine names, and knowledge of disease names[1]

	Sub-category	Vaccine Coverage			Chi Squared	P-value
		Few	*Moderate*	*High*		
Knowledge of Purpose	*Knows purpose*	0	12	3	Chi2(4) = 17.78	<0.01**
	Limited	6	2	0		
	Does not know	2	0	1		
Knowledge of Vaccine Names	*No names*	8	10	5	Chi2(2) = 3.39	0.18
	1+ names	0	3	0		
Knowledge of Disease Names	*No names*	8	3	3	Chi2(2) = 7.67	0.02*
	1+ names	1	8	2		

[1] "Few" vaccines indicates 0-2 vaccines received on average, "Moderate" indicates 3-5 vaccines, and "High" indicates 6 or more

Logistic Regression Models

Following the establishment of these primary individual relationships between vaccine knowledge, immunization coverage, and social determinants of health, I employed further testing to understand how these patterns fit into a larger network of health-seeking behaviors, more representative of the real world. Several logistic regression models were built in order to determine whether there was confounding in any relationships or observations. Primarily, a binomial logistic regression was run to probe the effects that village intervention status (HI vs. NHI) and household distance from vaccination center had on the average number of vaccines per household. The following question was asked: "when we consider that there are disparities in household distance from vaccination center between intervention groups, can we still observe the same significant relationship between distance and vaccine coverage?" While distance was a continuous variable in the model in STATA, village intervention status was considered categorical. Ultimately, when both variables were considered in the model, neither had a statistically significant association (p-values 0.30 and 0.31, respectively), suggesting that neither distance from center nor intervention status can predict vaccine coverage independently. This is likely because nearly all of the NHI households were 1 km or farther from the nearest immunization center (seven out of eight). Though this is not perfect confounding, it is difficult to tease out distance and intervention status while examining their impact on vaccine coverage. Previously, I observed a statistically significant difference in household distance from nearest vaccination center between HI and HNI villages (p-value < 0.01).

An additional binomial logistic regression was utilized to illuminate the impact of disease knowledge and household distance from nearest vaccination center on the average number of vaccines per household. The following question was asked: "when we consider that distance may

influence whether a mother chooses to travel to the vaccination center or not, can disease knowledge still predict vaccine coverage in a household?" Distance was a continuous variable and knowledge of diseases ("knows none" or "knows 1+") was categorical. Neither distance nor knowledge had a significant independent association with vaccine coverage (p-values were 0.20 and 0.18, respectively). However, the notion of collinearity in this model was not supported by earlier chi-squared testing, which demonstrated that there was no significant difference in disease knowledge between groups stratified by distance from center (Table 10). A similar percentage of respondents could name at least one VPD in households both closer and farther than 1 km from the nearest immunization center (50% and 39%, respectively).

A third binomial logistic regression was run to understand the effects of disease knowledge and village intervention status on the average number of vaccines per household. The following question was asked: "when we consider that households in various intervention villages may differ in levels of disease knowledge, can disease knowledge still predict vaccine coverage across households?" Both intervention status (HI and NHI) and knowledge of diseases ("knows none" or "knows 1+") were considered categorical. Further, I found that neither variable was found to have a significant independent association with vaccine coverage (p-values 0.24 and 0.55, respectively). Though I did not exactly observe perfect confounding, nearly all respondents in HI villages could name at least one VPD (six out of seven), while almost no respondents in NHI villages could name any (one out of eleven). The association between disease knowledge and village intervention status made it difficult to tease out how these two variables can predict vaccine coverage.

Multi-Level Chi-Squared Tests

Because of the underlying associations and factors that became an imminent issue in binomial logistic regression models, I utilized multi-level chi-squared tests to identify potential confounding in the study. In order to do this, an identified variable of interest was stratified into one of two categories and the results of two chi-squared tests for these categories were compared. Primarily, the effect of household distance from nearest center ("less than 1 km" or "1 km or more") and knowledge of vaccine purpose ("knows purpose", "limited knowledge", or "no knowledge") on vaccine coverage ("few", "moderate", or "substantial to complete") was observed. I ran two chi-squared tests to compare how vaccine coverage differs between groups of respondents that are stratified by level of knowledge of purpose – one test was for households closer than 1 km and the other was for households 1 km or farther from the vaccination center. While there was a significant difference in vaccine coverage based on knowledge of purpose for households closer than 1 km (p-value < 0.01), there was no significance for households 1 km or farther (p-value $= 0.14$). In practice, this suggests that even though knowledge of purpose may be an important predictor of child immunization status in households that are closer to vaccination centers, knowing the purpose of immunization is not as influential on respondents' health-seeking behaviors for households that are farther away.

Similar testing was completed to determine the effect of village intervention status (HI vs. NHI villages) and knowledge of purpose on vaccine coverage. For both HI and NHI groups, it appeared that there was no significant difference in vaccine coverage between groups stratified by knowledge of purpose (p-values were 0.66 and 0.17, respectively). This reveals that intervention status does not seem to confound the relationship – or lack thereof – between knowledge of purpose and vaccine coverage. I observed a similar effect in chi-squared testing

meant to determine the effect of distance from center and knowledge of diseases on vaccine coverage. Testing for households both closer and farther than 1 km to a vaccination center revealed no significant difference in coverage based on disease knowledge (p-values were 0.72 and 0.16, respectively). Ultimately, this finding could mean either that distance does not confound the relationship between disease knowledge and vaccine coverage or that there are issues with the sample size.

In addition, the population was stratified by village intervention status in an attempt to understand the combined effect that intervention status and maternal education have on vaccine name knowledge. However, because no respondents knew any vaccine names in the NHI villages, this could not truly be tested. A chi-squared test for the HI villages showed that there was no significant difference in coverage based on knowledge of purpose (p-value = 0.71) – however, this is almost certainly due to a limited sample size and a very low degrees of freedom.

Next, the population was again stratified by intervention village status in order to determine whether the relationship between knowledge of diseases and vaccine coverage is the same for HI compared to NHI villages. For the NHI groups, I could not employ a full analysis because none of the respondents could name any diseases. On the other hand, in the HI group, vaccine coverage did not differ significantly between groups stratified by knowledge of diseases ("knows none" or "knows 1+") (p-value = 0.54). Even though analysis could not be completed for NHI households here and in the test mentioned before, it is important to acknowledge why this occurred, namely that no respondents could name a single vaccine or disease.

Lastly, I used testing to determine whether intervention status influences the relationship between distance from nearest vaccination site and average number of vaccines received in that particular household. Comparison of two chi-squared tests revealed that for NHI villages,

distance mattered more. While for the HI villages, each distance group had the same coverage (p-value = 1.00), for the NHI group, there was a significant difference in vaccine coverage between households that were closer and those that were farther (p-value < 0.05). So while distance is an important predictor of vaccine coverage in NHI villages, it is not as relevant in HI villages.

Location of Vaccination

Across all villages, the large majority of mothers pursued immunization services for their children at the local *anganwadi* – thirty-two out of forty-seven children included in this study were vaccinated at this category of vaccination center. As mentioned previously, this type of health center, which compliments the formal three-tier system (sub-center, primary care center, and community health center) was established by the government in 1975 in accordance with the Integrated Child Development Service scheme. Interestingly, only two families in Pareda village (Kherwara block) reported immunizing their children at a government sub-centre. It was reported that four children were vaccinated at the nearest government hospital. Even in health intervention villages where Seva Mandir provides regular immunization camps, only three children were vaccinated at Seva Mandir sites (either *balwadi* or vaccination camp). Overwhelmingly, mothers chose to vaccinate their children at *anganwadi* centers, regardless of whether Seva Mandir had health interventions present. There were no large differences in where mothers chose to vaccinate based on village intervention status.

Additionally, some children were vaccinated at less traditional sites. One child was immunized at school without parental consent. In this case, it was reported that government healthcare workers visited the school, lined up children, and administered one vaccine to each

child without asking for or providing any information. Other interviewees who did not have children eligible for the study reported the same event and that there were no follow-up vaccination services provided by the government. On the other hand, some healthcare workers offered in-home immunization services, as evidenced by the four children who were vaccinated at home. However, it is clear that these services were offered very sporadically and are unsustainable – it is not necessarily feasible for local healthcare workers to travel to every home in the communities that they serve.

Source and Extent of Information

In addition to questions pertaining to vaccine knowledge, I asked respondents about their sources of vaccine information. Several respondents reported receiving information from multiple sources, but typically no more than two. The primary source of immunization information across all communities was government healthcare workers, including doctors, nurses, and other healthcare providers (twenty-four respondents). In HI villages, all respondents who provided an answer reported learning about vaccination from Seva Mandir (six respondents). Other sources of health information included friends and family (four respondents) and school or media (three respondents). In one case, a mother had read about vaccination in the newspaper and learned about it in school; another had learned about vaccination while watching television. Only two of the thirty-two respondents reported that they had not received information from any source. Though Seva Mandir is an important and reliable source of health information in intervention villages, the government is still actively working in these villages.

From a public health perspective, the government has been successful with regards to disseminating very basic vaccine information, like knowledge of purpose, as well as general

awareness in these communities. Several respondents reported that *anganwadi* workers travel directly to homes on a regular basis; however, respondents within the very same communities reported that they had never been visited, indicating that coverage may not be thorough in some villages. Interviews also revealed that the extent of knowledge was quite limited. As was previously mentioned, very few respondents could name any vaccines or diseases prevented by immunization. In a typical visit, the physician or nurse would ask the mother the age of her children, tell her that immunization is "compulsory", and then vaccinate the children, without providing further information. In some cases, the healthcare worker would tell the mother to come back in a specified amount of time.

Table 14 Location of vaccination and source of immunization information

Location of Vaccination	*Number of Children Vaccinated*	**Source of Information**	*Number of Respondents*
Anganwadi center	32	Government workers	24
Seva Mandir site	3	Seva Mandir	6
School	1	Friends & family	4
Home	4	School or media	3
Hospital	4	None	2
Sub-centre	2		

The Spectrum of Vaccine-Related Behaviors and Underlying Factors

Vaccine-related behaviors and perspectives varied widely within and across villages. This spectrum ranged from "non-acceptance" to "passive acceptance" to "active demand", as well as everything in between. In order to understand factors that contribute to mothers' perceptions of immunization as well as how these perceptions translate into health-seeking behaviors, I asked respondents why they chose to vaccinate or not to vaccinate. Some mothers indicated multiple

reasons, but no more than two. When asked about their primary reasons to vaccinate their children, most respondents reported that an authority figure, like a government nurse or physician, informed them that it was mandatory (ten out of sixteen respondents). On the other hand, five respondents revealed that they chose to vaccinate in order to pursue better health outcomes for their children. While the former aligns with passive acceptance (willing to vaccinate, but unlikely to actively seek out services), the latter is more representative of active acceptance (will seek out immunization services on an individual basis). One mother claimed that she vaccinated her children because she observed others in the community doing so; in this case, it is likely that her perception of what it means to be a "good" mother was modeled after others in the community. There was no clear relationship between reasons to vaccinate and village intervention status.

Equally as important are the reasons for incomplete immunization – many of the same mothers who had children with partial immunization status described why they initially chose to vaccinate, but also why their children had not completed the full regimen. Once more, some respondents indicated more than one factor that contributed to drop-out. Out of eighteen families with children who either had never been vaccinated or had received only a few vaccines, the large majority reported either time or transportation issues (eight respondents), or they indicated that they did not understand why it is important (thirteen respondents). One household indicated that their children's interruption in immunization was due to seasonal migration (they were originally from Gujarat, but had migrated to Udaipur for work). Active resistance to vaccination was almost non-existent in these communities and there were no observed cultural or religious beliefs that inhibited vaccine uptake. Only one mother was actively opposed to vaccinating her children, indicative of non-acceptance. She believed that because her children had been relatively

healthy thus far, it was completely unnecessary for them to receive any vaccines. Though the literature suggests that perceived harmful side effects of immunization may inhibit vaccine uptake, only one household reported halting immunization because the oldest boy had a serious side effect with an abscess and swelling.

The above results indicate that most mothers were passive acceptors of vaccination, rather than active actors, as it pertains to their health-seeking behaviors. Many people did not seem to perceive vaccination as being fundamental for health, which corroborates with the previously reported lack of information being provided by healthcare workers. Very few mothers across all villages could name any vaccines or diseases. Some mothers reported that their children had been fully vaccinated even though they had only received 2-3 vaccines, indicating a gap in knowledge as well as communication between healthcare workers and local people. Along the same lines, it was common to have incomplete immunization because of transportation or timing issues – all families in the study were subsistence farmers. Therefore, it makes sense that mothers would be hesitant to leave their work in order to vaccinate their children, if they do not perceive the benefit of immunization as outweighing the cost of losing that day's food or wages.

Though concerns about vaccine safety and logistical issues did not seem to be an imminent issue in this particular context, they were considered. Two households reported concerns about immunization side effects – while one mother reported concerns about post-immunization fevers, the other was concerned about abscesses and swelling. Additionally, two respondents mentioned that older people in the community were more hesitant towards immunizing their children because of side effects and children crying. These results indicate that current outreach programs have been quite successful in educating parents about potential side effects. Furthermore, a wide range of logistical issues, from limited availability of vaccines to

lack of staff at immunization sites, have been reported in the literature. However, when asked about these potential issues, no respondents reported anything within this realm. The most prominent issue seemed to be that not many people were willing to travel more than 1 km to vaccinate, as most mothers (twenty-six respondents) reported that they would pursue vaccination services if provided within a reasonable distance from their home (5 km or less). While one mother claimed that she would travel a far distance to vaccinate her children (more than 5 km), three mothers reported that they would only vaccinate their children if the resources were brought directly to their homes.

Local Perspectives and the Healthcare Provider-Patient Relationship

In order to develop a more cohesive comprehension of vaccine-related behaviors, it is useful to consider the relationship between government and Seva Mandir health workers and local people receiving vaccination services. Semi-structured interviews with study respondents and translators provided insight into these dynamics. First and foremost, even though I observed that the government was reported to provide limited information, all but one household reported being satisfied with the government and Seva Mandir's work. It is important to note that there is potential bias because of my "otherness". Even though it was communicated that I was a student working with Seva Mandir, it is possible that as a foreigner, the community members thought I was working with the government.

Though no interviews were conducted directly with government or Seva Mandir workers, information was extrapolated from the way that translators and healthcare workers described residents. Specifically, these workers frequently mentioned that people in tribal areas were "wild and dangerous" and expressed hesitancy about visiting these areas, particularly after dark. There

seems to be a sort of stigma, which aligns with the literature that suggests a significant rural/urban divide.

Lastly, it should be noted that women were the main caretakers of children and as such were the main stakeholders in decisions related to their children's health. Initially, the intention of the study was to interview both parents – however, only mothers were able to provide health-related information about their children. This role configuration must be examined in relation to other gender roles and gender dynamics within a larger context of rural Indian culture.

Discussion

Overall Coverage and the Intervention Effect

Overall, the study population exhibited mixed markers of quality of life and well-being – while maternal education status was consistently low, most mothers bore children in their early to mid-twenties. This likely indicates a low prevalence of child marriage and that women are able to have children at a later age than has been observed in other rural communities in Rajasthan. Though outlawed by the Child Marriage Restraint Act in 1978, rural Rajasthan has been infamous for persistently high rates of child marriage. The Women's International Network News reported that in 1993, 56% of women were married at 18 years of age or younger (Women's International Network News, 1998) – clearly, the age at which women are getting married and having children has increased in these study communities. Further, family size was relatively low – about three children per mother, which is only slightly higher than the 2014 national average of 2.4 (World Bank, 2016), though these women were far from completing their reproductive careers. Nevertheless, data suggest that women may have better access to healthcare and family planning resources than other remote rural areas.

Contrary to the initial hypothesis that NHI villages would have better health outcomes than NI villages due to a "spillover" effect, indicators of health and well-being consistently fared the worst in NHI villages. While 57% of mothers were educated in HI villages, only 8% were in NHI villages and 31% in NI villages. Similarly, NHI households were, on average, much farther (4.64 km) from the nearest vaccination center than were HI and NI households (0.68 and 1.07 km, respectively). It should be noted that the standard deviation and range in the NHI group were both high, suggesting intra-group diversity or potential outliers. I observed similar results with regard to immunization coverage and knowledge – descriptive statistics revealed that, as predicted, HI villages had the highest coverage, an average of 5 vaccines per child. Unexpectedly, NHI villages had the lowest coverage, 2 vaccines per child, while NI villages averaged 3 vaccines. The only statistically significant difference in coverage was between HI and NHI villages. Although there was no statistically significant difference among intervention villages for knowledge of immunization purpose, HI and NHI villages differed significantly in number of vaccines and vaccine-preventable diseases known.

These results indicate that the NHI villages selected at random had the worst indicators of wellbeing, connectedness to their health system (farthest from center), as well as overall immunization knowledge and coverage. It is also possible that the remoteness of these villages limits their access to other services, the schooling system, or benefits of market integration, which could indirectly impact utilization of health services. However, it is unlikely that this is related to their "non-health intervention" status, as Seva Mandir is very active in these intervention communities, regardless of whether there is a specific health intervention or not. It is more likely that these villages randomly had the worst pre-intervention outcomes, that Seva Mandir is relatively new to the community and has not had time to become established, or that

there were issues related to sample size. It is interesting that the only factor that does not differ significantly among intervention villages is knowledge of purpose - this is likely due to limited variation. The large majority of respondents across all villages knew the purpose of immunization, regardless of their education status – in HI villages, 85.7% of respondents knew the purpose of immunization, compared to 61.5% in NI villages and 25% in NHI villages. This indicates that from a public health perspective, the local government and Seva Mandir have been successful in at least spreading general awareness of immunization in HI and NI villages.

Ultimately, vaccine coverage and knowledge were highest in HI villages, as was initially hypothesized. However, there were no statistically significant differences in measures of vaccine knowledge and coverage between HI and NI villages. Therefore, total benefits that HI mothers receive over those who are not in Seva Mandir villages may be limited or not captured by this particular study. This finding indicates several possibilities: 1) pre-intervention levels of immunization knowledge and coverage were relatively low in HI Seva Mandir villages compared to NI villages, 2) the government has had relatively successful interventions in these communities, at least compared to Seva Mandir, 3) issues with sample size. Observed differences likely were due to a combination of these factors.

Additionally, I initially predicted that there would be a positive association between child age and the number of vaccines received. Theoretically, an older child has had more time and therefore more opportunities to become vaccinated. According to the immunization schedule suggested by the World Health Organization, by twelve months, a child should have received one dose of BCG, three doses of DPT, three doses of OPV, and one dose of measles vaccine. Though exact vaccine names were unavailable, I observed that the large majority of children included in the study had not received this full immunization package, even by the age of five

years – out of forty-two children whose immunization status was known, only two had received 8 or more vaccines (potentially full immunization). Furthermore, a formal test identified no association between child age and number of vaccines received. Alongside the previously mentioned data, this finding suggests that the large majority of children are not being immunized in a timely manner, according the recommended schedule. Because the first few years of life are so crucial for the development of a child's immune system, delayed immunization opportunities can have a large impact on early morbidity and mortality, with potential effects later in life as well (Centers for Disease Control and Prevention, 2016). In future immunization campaigns, the importance of timeliness merits emphasis alongside spreading general awareness.

Education, Health Literacy, and Vaccine Coverage

Numerous studies in similar rural settings in India have reported a strong association between maternal education and awareness and knowledge of vaccines. In a study in rural Ahmedabad, researchers stratified the population by level of education and compared the knowledge of vaccine-preventable diseases between groups, finding that more educated mothers (those who had achieved secondary or post-secondary education) demonstrated more thorough vaccine knowledge (Kapoor & Vyas, 2010). In contrast to the majority of findings reported in previous literature, in this study, older mothers with a higher level of education did not have more comprehensive vaccine knowledge. While there was no significant difference in knowledge of purpose and vaccine-preventable diseases, there was a significant difference for knowledge of vaccine names. However, the former two markers of vaccine knowledge are generally considered to be more important indicators of a mother's health literacy with regards to immunization.

The discrepancy between current evidence and the results from the study must be evaluated from multiple perspectives. In Kapoor and Vyas's study and others, a common methodological practice has been to rank maternal education into categories, such as "illiterate", "primary", "secondary", or "post-secondary", rather than creating a binary variable. The broader range of education in other studies both reflects the poor status of women's education in the communities targeted by this research as well as the potential limitations of sample size. Overall, few respondents had received any sort of general education that they deemed appropriate to report. On average, 25% of mothers in the study population were literate, while the 2011 Indian Census reported a literacy rate of 45% for women in rural Rajasthan (Directorate of Census Operations, 2011). The distinction between health literacy and literacy in its most common conception is dysfunctional here because both measures are so low in the population.

Global health literature largely identifies a well-established relationship between maternal education and pediatric immunization coverage. In 2005, in Udaipur, researchers observed that higher maternal education consistently translated to better health outcomes for children (Mathew, 2012). Various pathways may mediate this "well-established" relationship between maternal education and vaccine coverage, including increased human, social, and cultural capitals as well as more autonomy for mothers in the household. Human capital (health knowledge or experience viewed as valuable to others) and cultural capital (communication skills and high cultural knowledge that leads to social advantage) have been reported as the two most important mechanisms by which maternal education translates to health outcomes in the context of pediatric immunization (Vikram et al., 2012). In other words, mothers who have achieved more years of schooling are likely to have better health literacy.

Contrary to this literature, maternal level of education was not found to be a significant predictor of vaccine coverage in this set of study villages, whereas knowledge of purpose was. There was no significant difference in knowledge of purpose between intervention groups. This challenges the established view that improved health literacy translates directly to improved health outcomes for children. For the present study population, knowledge of immunization purpose and vaccine-preventable diseases, independent from maternal education, were associated with increased vaccine uptake. A "dispersion effect" that cannot be shown in single-level or fixed-effect models could explain why the results from this study depart from previous findings. Even if just a few mothers in the population are educated, they may spread vaccine knowledge to other women in their social network (Parashar, 2005). Because these few women may have a high social status due to their educational background, it is more likely that others would mirror their behavior.

The lack of association between maternal education and vaccine coverage in this study also contradicts the notion that higher maternal education increases women's autonomy regarding health-seeking behaviors. Theoretically, educated women maintain a higher status within their communities and should feel more empowered to pursue immunization services than others. Levine and colleagues (2001) argue that schooling is advantageous in oral communication with the health bureaucracy and may influence mothers to utilize health services more often. Because maternal education was not an important predictor of vaccine knowledge or coverage, it is possible, then that there are alternative ways through which women become self-empowered in these communities, which have been excluded from consideration in previous studies.

The *Anganwadi*

When asked about where they chose to vaccinate their children, the large majority of mothers across all villages reported going to the local *anganwadi* (for thirty-two out of forty-seven children). Interestingly, even in Seva Mandir health intervention villages where the NGO offered monthly immunization camps, most mothers still traveled to the *anganwadi*. A few mothers mentioned that they were motivated by dal incentives provided as mid-day meals for their children. As mentioned previously, these centers are also mandated to offer informal pre-school educational services (Arora, Bharti, & Mahajan, 2006). Clearly the *angwanwadi* plays an integral role in the health outcomes and education of young children in rural Udaipur. However, despite the immunization services that these centers provide, attendance and immunization uptake is relatively low in rural Udaipur district. This is partially due to the fact that many *anganwadi*s in the area are very sub-standard. Seva Mandir (2016) reported that prior to intervention in 2015, the *anganwadi*s in project villages were only open 50% of the time, only offered dal incentives sporadically, did not offer preschool activities, and had very low children's attendance. Correspondingly, in Rajasthan, the 2000-2002 ICDS III/ ICDS II endline survey reported that, on average, only 20% of children 5 years and younger attended an *anganwadi* at least once per month (Gragnolati, Bredenkamp, Shekar, Gupta, & Lee, 2006).

In future policymaking, it will be essential to consider the fact that mothers mainly choose to vaccinate their children at immunization centers. Therefore, specifically targeting the *anganwadi* as a channel for health services has the potential to significantly increase overall immunization coverage in these communities in rural Udaipur. For example, the constant provision of dal incentives, more reliable services, and engaging mothers in community events at the *anganwadi* may encourage a higher attendance. Rather than creating new government

schemes and programs, emphasizing the importance of the *anganwadi* will likely be enormously effective with regards to healthcare policy in rural Udaipur.

Accessibility

As a universally important social determinant of health (Solar & Irwin, 2007), accessibility of healthcare resources was analyzed in relation to maternal vaccine knowledge and pediatric immunization coverage. In this study, I measured accessibility via household distance to the nearest health center or immunization camp site. Previous studies regarding immunization coverage in low-income, rural communities have highlighted the importance of considering accessibility. In rural Assam, India, the immunization status of children was significantly higher for households reporting that the nearest health center was less than 2 km away, compared to 5 km or more (p-value = 0.02); compared to households that were 5 km away, children in households 0-2 km away were 1.84 times (95% CI, 1.16-2.91) more likely to be immunized (Phukan, Barman, & Mahanta, 2009). Correspondingly, in rural Kabul, Afghanistan, close proximity to a health facility was positively associated with children being fully immunized (OR = 1.92; 95% CI, 1.08-3.39) after adjusting for demography, socio-economic factors, participation in health education, and experiences in hardship (Hemat, Takano, Kizuki, & Mashal, 2009). Note that while these studies examined completeness of immunization status, the present study focuses rather on the raw number of vaccines that each child has received (because so few children were fully immunized). However, in the larger context of maternal health-seeking behaviors, I observed the same effect of household distance to health center on vaccine uptake.

Ultimately, data analysis revealed that although distance was a good predictor of vaccine coverage (correlation of -0.64, p-value < 0.01), it had an insignificant relationship with vaccine

knowledge. Formal testing revealed a statistically significant difference in the number of vaccine-preventable diseases known for households stratified by distance (p-value < 0.01), but identified no detectable difference in knowledge of immunization purpose or vaccine names for these groups (p-values were 0.284 and 0.18, respectively). Further testing among households stratified by distance did find significant differences in knowledge of immunization purpose (p-value < 0.01) and disease knowledge (p-value < 0.05); there was no significant difference for vaccine name knowledge (p-value = 0.18). The latter may be attributed to overall limited knowledge of vaccine names. In light of the strong relationship between vaccine knowledge and vaccine coverage, this is an interesting finding. In order to explore the relationship further, I applied a logistic regression model to determine the effect that knowledge of vaccine-preventable diseases and distance from nearest vaccination center had on vaccine coverage. When these two variables were considered, neither had a significant independent association with coverage (p-values were 0.20 and 0.18, respectively). Because there is no relationship between knowledge of vaccine-preventable diseases and household distance from center, it is unlikely that this is due to collinearity in the model. There is a gap in the literature regarding the association between immunization knowledge and distance from nearest health center. However, in this particular context, it is possible that household distance from vaccination center is such an important determinant of health-seeking behavior that it "overrides" the impact of vaccine knowledge. Otherwise, because vaccine knowledge was so low in this population, there may have been issues with sample size.

Further, chi-squared testing revealed that for distances shorter than 1 km, knowledge of purpose was a more significant predictor of vaccine knowledge; for distances longer than 1 km, knowledge of purpose was not as crucial. The finding suggests that although knowledge of

purpose may be a good motivator for vaccine uptake, it may not be enough to offset the barrier of traveling a far distance. Qualitative data extrapolated from respondent interviews corroborated the notion that household distance from the nearest vaccination center was a key factor in determining vaccine uptake. When asked why their children were not fully vaccinated, eight out of eighteen respondents indicated that they had issues with transportation or timing. Moreover, some mothers do not perceive the benefit of pediatric immunization as outweighing the cost of losing a day's harvest or wages. Particularly in communities plagued by severe poverty, hunger and risk of starvation are more immediate concerns than potential future diseases (Roalkvam, McNeill, & Blume, 2013). Evidently, the more pertinent focus is on immediate survival rather than long-term wellbeing. On the other hand, women in rural India often have limited transportation and ability to leave the home. In rural Rajasthan, where traditional cultural gender norms have been preserved, women – particularly married women – live behind "closed doors" (Nath & Nayar, 2001). Though they may interact with close neighbors, married women rarely venture far from the home without the accompaniment of a male family member.

In this study, one household reported that their children had not been fully immunized because they were seasonal labor migrants from Gujarat. Upon arriving in Udaipur and staying with family, they did not pursue immunization services, but indicated that they would continue immunizing their children after they returned to Gujarat in a few months. This is important, as traveling for work is relatively common in India. A study of rural to urban migrant women workers in New Delhi revealed that the immunization coverage rates of children were lower among migrants than among the general population, and lowest among recent migrants (Kusuma, Kumari, Pandav, & Gupta, 2010). It is essential that in creating policy and rural healthcare outreach programs, the government as well as private sector organization address the needs of

seasonally migrating populations. These families may be socially isolated upon arriving in a new community and therefore may be less aware of immunization services.

Local Perceptions of Vaccination

Furthermore, perceptions of vaccines and the process of immunization are important to examine in the context of patterns of vaccine uptake. How people conceptualize immunization has a strong impact on their motivation and overall health-seeking behaviors. Even though there is very little literature regarding the direct meaning of immunization in rural India, perceptions can be examined from multiple perspectives. Primarily, throughout the data collection process, study translators consistently referred to vaccines as *tika* in Mewari, the local language. Interestingly, this term departs from the literal translation of "needle", which is "*suee*" in Hindi. One translator revealed that *tika* ("*tilak*" in Sanskrit) literally means "spot" or "dot" and has a few common uses within Indian culture: it can be worn on the forehead by ladies on a daily basis, can be applied during a *puja*, or can be worn by priests and other religious figures. However, it is important to note that this is not necessarily the word that rural mothers would have selected. Rather, the term *tika* was initially introduced by government health authorities to designate vaccines; in Rajasthan, black marks on the face of newborn babies, also called *tika* are meant to protect children from the "evil eye" (Roalkvam et al., 2013). Upon the introduction of widespread immunization programs in India, health workers likely intended to take advantage of the perceived protective quality of such a mark, hoping parents would associate the process of immunization with its protective effect.

Additionally, previous studies in similar rural, low-income settings have frequently encountered resistance to vaccination due to perceived harmful side effects. In a meta-analysis of

concerns about immunization in low-income countries, Cobos Muñoz and colleagues (2015) identified various reports of safety concerns in India: for unimmunized children, parents believed that immunization was not good for their children's health, while for all categories of immunization status, parents reported a fear of side effects like fever. Some parents believed that repeated vaccination could lead to over-dosage. Despite these reported concerns, in the present study, only two out of thirty-three households reported any concerns about side effects such as fever. No active resistance to immunization was reported by the study population and concern about harmful effects apparently did not affect maternal health-seeking behaviors in this particular context. This discrepancy between the previous literature and the present study could indicate that government outreach programs and NGOs like Seva Mandir have improved their ability to alleviate fear of potential side effects; it is also possible that mothers' responses were biased because healthcare workers were often present throughout the interview process.

Even though vaccination was not necessarily considered a threat to health in these communities in rural Udaipur, it was also not commonly perceived as being necessary for good health. In Mangalore, India, a study on the knowledge, attitudes, and perceptions of immunization found that only 56% of mothers in rural areas felt that pediatric immunization was important; furthermore, when asked about whether it was important to follow a vaccination schedule, only 39% of rural mothers felt that it was needed (Mahalingam et al., 2014). Similarly, in semi-urban Pilani, Rajasthan, a 2003 cross-sectional study demonstrated that mothers knew very little specific information about vaccination or the importance of completing the schedule on time (Majunath & Pareek, 2003). Along the same lines, in the present study, one of the main reasons for incomplete immunization was that most mothers did not understand why it was important (13 respondents). The lack of a relationship between child age and vaccine coverage

indicates that most children in these communities did not receive vaccines according to the WHO-recommended schedule. In fact, no mother could properly name the vaccines that are needed during a child's first year of life. Even though many mothers reported that they chose to vaccinate because it was beneficial for their children's health (five out of sixteen respondents), many mothers did not perceive vaccination as completely necessary, nor did they understand that a strict schedule needed to be followed in order to claim the full protective effect of immunization. Rather, most mothers perceived immunization as a supplementary health practice, which is consistent with the concept of "vaccine complacency"; in the mother's schema of immunization, each vaccine unit is beneficial for child health. Because they did not know many vaccine-preventable diseases, it was impossible for these mothers to differentiate the unique purpose of each vaccine. As a result, they did not understand that the entire series is needed to protect from all potential diseases or that it is essential to complete a series of shots (i.e. DPT1, DPT2, DPT3).

The Patient-Provider Relationship

All study participants were relatively familiar with the concept of immunization and 56% of respondents fully understood the purpose, indicating that the local government and Seva Mandir have been quite successful in spreading at least general vaccine awareness across villages. Despite awareness among the majority of mothers and a positive association between knowledge of purpose and vaccine coverage, only seven out of forty-two children were found to have "substantial to complete" immunization status (6-8 vaccines). Even though understanding the purpose of immunization may influence parents to begin vaccination, drop-out and incomplete immunization rates are high.

From a public health perspective, although local organizations have spread general awareness, other gaps on a clinical level may play a role, such as the provider-patient relationship. When asked about their experiences with local healthcare providers, mothers in all villages revealed that they had been provided very few specifics about the process of immunization, the names of the vaccines, or why it was so important. In most cases, a government nurse or doctor had asked the child's age, administered the vaccine, and claimed that immunization was "mandatory". Moreover, very few mothers could name any vaccines (four of thirty-two) or vaccine-preventable diseases (twelve out of thirty-one). When asked about why their children had not been fully immunized, thirteen out of eighteen mothers responded that they did not understand why vaccination was important because it had never been fully explained to them by a healthcare provider. Additionally, two families reported that their children had been immunized at school without parental consent. As part of an immunization program, government health workers randomly lined children up at school, administered one vaccine each, and sent the children home without providing any information or follow-up services. Evidently, there is a large gap in health communication between the government and families in these rural villages.

Such a gap in communication is best understood within the context of the patient-provider relationship in India, particularly in rural regions. When asked about their interpretation of a good, ethical patient-provider relationship, obstetricians studied in Mumbai and Navi Mumbai highlighted the importance of communication, but admitted that they could not engage in effective communication with patients. They attributed their inability to communicate effectively to overcrowding in the hospital, an extreme workload, and the illiteracy of their patients (Ghoshal et al., 2013). Follow-up interviews revealed that, upon clarification of what improved communication actually meant, physicians really desired the ability to more clearly

map out what the patients should do in a detailed way, rather than truly engage with them in decision-making (Ghoshal et al., 2013).

Physicians' lack of interest in patient partnership regarding healthcare decisions also must be examined within the context of provider perceptions of rural dwellers and the nature of the patient-provider relationship in rural India. Interviews with local healthcare providers in rural Madhya Pradesh revealed that most physicians adopted an authoritarian, paternalistic approach in their patient interactions. In many situations, the doctors perceived patients as ignorant, defiant, uneducated, and incapable of understanding the information that they needed to provide (Fohcsen, Deshpande, & Thorson, 2006). A common theme of power imbalance emerges. This is largely exacerbated by the social and gender divides. Physicians also have reported that they are not linked to patients in any way because they come from different social strata (Fohcsen et al., 2006). An important element of this dynamic is physicians' attitudes toward lower-income, lower-caste women in India. Uskul and Ahmad (2003) found that male gynecologists were more likely to have negative attitudes, to show neglect, and to provide less information to lower-income women. In Rajasthan, workers in the health system have been known to refer to rural dwellers as "bad citizens" or "dirty people", particularly Muslim and tribal populations (Roalkvam et al., 2013). Ultimately, these unfavorable perceptions of rural villagers color the way that healthcare providers interact with patients. The provision of limited information as well as negative patient-provider interactions likely have a drastic adverse impact on mothers' health-seeking behaviors with regards to child immunization.

It is a human right for mothers to be informed to the best of their ability with regards to health-related decisions. However, the current healthcare structure and culture around patient-provider relationships inhibits this. While a large part of the gap in communication between

mothers and healthcare providers can be attributed to gender, social, and educational disparities, a lack of incentives for physicians plays an important role as well. Because of a shortage of physicians in rural areas under the current healthcare system, the central health ministry and state governments have attempted to bring doctors to rural areas through mandatory rural posting, linking rural postings to admission into postgraduate courses, and offering monetary incentives (Sharma, 2015). However, many physicians do not feel as though they are compensated enough and are wary that it will be difficult to eventually return to the city. Understanding that physicians do not feel fulfilled in their rural postings better frames their perceptions of rural dwellers and their responsibilities in rural communities.

Interestingly, when asked about their perceptions of healthcare providers and the current system, all respondents except one in the present study reported that they were satisfied with the current health and immunization services provided by the government. Ultimately, this observation is likely due to the combination of two factors. First, mothers may have perceived that I was working with the government because of my obvious appearance as an outsider. Second, people may be satisfied with current services because they are not fully aware of the services that they could or should be receiving.

Future studies in rural Udaipur are needed to gain a better understanding of how patient-provider interactions on a clinical level directly affect mothers' health-seeking behaviors. Additionally, it must be considered that oftentimes, *anganwadi* nurses or doctors administer vaccines, so future studies on the relationship between government nurses and patients would help to further illuminate the importance of patient-provider relationships. Distinct from physicians, *anganwadi* nurses are village level female workers (Sharma, Webster, & Bhattacharya, 2015) from the local community and are responsible for providing services such as

immunization, nutrition, health education, growth monitoring, and the promotion of family welfare services (Sandharayani & Rao, 2013). Ultimately, the communication gaps on a clinical level are part of larger social issues, such as the rural/urban divide and discriminatory perceptions of rural villagers. Though difficult to tackle directly, these barriers can be addressed through better incentives for physicians to work in rural areas, improved mid-level health service provision, and policy that focuses on the promotion of equality and altered medical school and other health care curricula that emphasize the specific significance and challenges of serving the rural poor.

Gender and Vaccination

Over the years, studies on vaccine coverage consistently have indicated large gender disparities in many rural, low-income parts of India. This can be attributed to the patriarchal cultural climate in which health decisions are made. For instance, female children are often discriminated against in rural India through various channels such as health and education (Stroope, 2015). A study in the Narmada district of rural Gujarat revealed that child gender was significantly associated with immunization uptake, which heavily favored male children (OR = 3.76) (Chandwani & Pandor, 2015). Data also suggest that this gender disparity is particularly pronounced in rural regions compared to urban areas in Rajasthan, which is reported to have the most significant rural/urban disparity in full immunization rates (Pande & Yazbeck, 2003). Contrary to findings from previous studies and what was initially hypothesized, there was no gender disparity in the average number of vaccines received by each child (p-value = 0.83). Across the sample, the average number of vaccines received by each gender was nearly identical – while the average was 2.4 vaccines for males, it was 2.3 for females.

These findings may depart from previous research in Rajasthan for a variety of reasons. Primarily, the study population was more homogenous, particularly in relation to religious affiliation and caste (all study participants were Hindu and OBC or "scheduled" caste). Prusty and Kumar (2014) assert that there is more of a pronounced gender disparity in immunization rates for Muslim populations than for all other religious groups. Other literature suggests that these gaps may be declining in specific regions of the country – the gender disparity ratio for full immunization in Rajasthan was 127 in 1992, but dropped to 99 in 2006, indicating a lower level of disparity (Prusty & Kumar, 2014). Additionally, the 2011 Indian Census reported that while the sex ratio for children aged 0-6 years was 888 female children per 1,000 male children in Rajasthan overall, Udaipur district reported a ratio of 924 female children per 1,000 male children (Directorate of Census Operations, 2011).

Ultimately, degree of gender equality in immunization appears to be very region-specific to these particular communities in rural Udaipur. Seva Mandir currently runs "gender training" programs in intervention villages, aimed to alter more traditional, rigid perceptions of what it means to be a woman in rural India. This may discourage discriminatory attitudes toward female children, ultimately impacting parents' health-seeking behaviors and vaccine uptake in intervention villages. Otherwise, there may be a social desirability effect in which respondents know that health care providers promote gender equality of care and respond accordingly. Future studies should be employed in order to gain a better understanding of the exact social structures and attitudes that have contributed to this phenomenon unique to rural Udaipur.

Even though gender was not identified as a significant predictor of immunization coverage for children, it was important in another context. The initial intention concerning study methods was to interview both parents about their family health-seeking behaviors. However,

upon initiating the data collection process, it quickly became clear that the mother was the main stakeholder in children's health and that fathers typically knew very little about the immunization status of their children. Similarly, the Caldwells (1993) assert that in developing countries, the person with the greatest interest and time invested in children's health and survival is the mother. In the Indian context, this can be attributed to both gender roles and family dynamics. Maternal health-seeking behaviors must be examined in the context of the social role and responsibilities of young mothers in India. In New Delhi, Weaver (2014) found that women with type II diabetes (a disease that necessitates a large amount of self-care) frequently neglected their own physical health to serve others in the household (such as their children), which is a large part of their social identity. Typically, the care of others is a mother's central focus, so it makes sense that she would be at least partially responsible for vaccination decisions.

Furthermore, a young mothers' social and familial relations must be considered in this analysis. In rural Indian society, a young woman typically moves in with her husband's family and in-laws, sometimes very far from her original home. Young mothers often closely care for their young children because they can improve her status within the family (Caldwell & Caldwell, 1993). Traditional gender roles and expectations from a strict mother-in-law likely enforce the system in which mothers are responsible for health-related decisions. However, these decisions often are made under the eagle eye of the mother-in-law, who tends to have a dominating presence in the Indian household. A mother's mobility outside of the household and ability to travel to the nearest immunization center may even depend on permission from the mother-in-law. In the strongly patrilineal communities in India, the presence and influence of the mother-in-law has been observed to have a powerful impact on household activities as well as fertility decisions of young parents in Madhya Pradesh (Char, Saavala, & Kulmala, 2010). In this

study, older generations were more likely to express hesitation towards vaccination, claiming that it was dangerous (because of side effects) or unnecessary (because they themselves were not vaccinated and were mostly healthy). In future research, the impact of mothers-in-law on health-seeking behaviors of mothers as well as how this translates to health outcomes merits investigation.

Given the patriarchal context in which this study was completed, it is also interesting to consider the relatively high level of decision-making power that women wielded regarding child and family health. Because mothers are primarily responsible for pursuing health services for their children, lack of resources and limited self-confidence or self-efficacy will negatively affect their children's health (Caldwell & Caldwell, 1993). A study on maternal health-seeking behaviors in rural Andhra Pradesh revealed that infants of more autonomous mothers who had greater participation in household decision-making had significantly better nutrition statuses (less underweight and less wasting) (Shroff et al., 2011). Similarly, a meta-analysis of literature regarding women's empowerment and immunization suggests that low immunization rates often are associated with a lack of decision-making agency among mothers, mainly in India and Nigeria (Thorpe, VanderEnde, Peters, Bardin, & Yount, 2016). When mothers have little autonomy, child health suffers directly. However, very little literature focuses on how the gendered nature of immunization decisions could be harnessed to improve current coverage. These findings suggest that in future policymaking, it will be helpful to recognize that women are responsible for health-making decisions in communities like rural Udaipur. The implementation of programs that promote gender equality and women's autonomy, such as those that Seva Mandir currently runs, will be essential for increasing vaccine uptake and improving overall immunization coverage.

Agency, Autonomy, and Formation of Health-Seeking Behaviors

The formation of maternal health-seeking behaviors related to vaccine uptake is a complex phenomenon. Primarily, vaccine uptake has been framed as translation of vaccine knowledge to coverage. Across all study villages, different levels of knowledge of immunization purpose were associated with degree of vaccine coverage (p-value < 0.01), where immunization coverage was greater among the children of mothers who could name at least one disease compared to those who knew none (p-value = 0.02). Ultimately, this observation suggests that a greater level of vaccine knowledge translates to increased vaccine uptake. Past studies focused on the association between immunization knowledge and coverage support the notion that low coverage is often attributable to low levels of parental vaccine knowledge. In Bangladesh, Rahman and colleagues (1995) found a strong association between lack of mother's knowledge of vaccine-preventable diseases and partial or unimmunized status of children (OR = 16.7; 95% CI, 15.65-17.8), after controlling for the effects of maternal illiteracy and low socio-economic status. They suggest that even in an environment with limited educational resources, educating mothers about vaccine-preventable diseases may be highly effective in increasing vaccine uptake.

The intersection of maternal immunization knowledge and motivation in the formation of health-seeking behaviors merits consideration. In Orissa, India, it has been observed that people feel pressured to comply with vaccination because the state prescribes it and most people view the state as a benevolent entity (Roalkvam et al., 2013). Similarly, in the present study, most mothers reported that they vaccinated their children because a government or Seva Mandir health worker had instructed them to (ten out of sixteen respondents), while only a few mothers vaccinated for health-related reasons. This result aligns with the aforementioned imbalance in the

paternalistic patient-provider relationship that the literature suggests. Consequently, many parents chose to vaccinate their children not because of perceived benefit, but because they were informed that it was mandatory by a trusted or powerful authority figure. In some cases, mothers reported that children were vaccinated at school without any form of parental consent – intervention practices like this can do more harm than good, as they inhibit parents' agency in health-related decisions and further the divide between families and the local government. When parents perceive their role in their children's health as being limited, they will feel less engaged with the local health system and are less likely to pursue health resources in the future. This became evident through the interview process, as several mothers indicated that they would only vaccinate their children if the services came directly to their home.

Several other factors aside from maternal vaccine knowledge and personal motivation influence health-seeking behaviors. It is important to consider, in this context, that the decision to vaccinate is not just the mother's – in a pluralistic society such as India, numerous people have a role in vaccination decisions, including mothers-in-law, spouses, neighbors, priests and prophets, local healers, and "doctors" of varying legality and education (Roalkvam et al., 2013). Assuming a mother is motivated to pursue health services, several conditions must be in place for vaccine uptake. These include household awareness of immunization availability and the belief that it is important for child survival, financial resources for productive time lost in seeking services and the cost of transportation, and physical access to and some sort of trust in a healthcare provider (Yazbeck, 2009). In the present study, some of these elements are existent. However, as mentioned previously, mothers do not seem to be aware of how critical vaccination is and are more concerned about financial loss through loss of productive time.

Lastly, vaccine-related behaviors span a wide spectrum, ranging from active community demand to passive acceptance to active refusal. While passive acceptance is marked by compliance and yielding to recommendations from authority figures, active demand is denoted by adhering to vaccination schedules and actively choosing to pursue immunization. Nichter (1995) posits that, in the absence of active community demand, high coverage is neither sustainable nor attainable. Ultimately, although there was little vaccine hesitancy in the present study, the large majority of mothers demonstrated passive acceptance with respect to child immunization. So how can the government and NGOs like Seva Mandir increase social demand and active acceptance in these communities? Current measures of measuring local perceptions and knowledge regarding immunization use household surveys, which tend to be a quite passive form of communication. Yazbeck (2009) argues that this must be supplemented with more active forms, such as qualitative data collection including semi-structured interviews, ethnographic inquiry, and participant observation.

Limitations

Linguistic and Cultural Barriers

A major limitation in the study was the language barrier. This was anticipated, as I spoke neither Hindi nor Mewari, the local language. With the help of translators, most often local students, the original interview questions were translated into Mewari and respondents' answers were translated back into English. Because the two languages are so different, it is very possible that some of the specifics as well as subtleties on both sides were lost in translation. Effectively, a particular phrase or idiom may be difficult to translate from one language to the other. Further, in a few communities, the respondents spoke only a more specific, local dialect; in these cases, it

was necessary to employ the help of another local person who spoke both Mewari and the local language. Ultimately, this strained the process of translation even more and increased the risk of meanings being lost, not to mention the impact of social desirability and other dynamics from additional interlocutors. Throughout the process, some questions were repeated multiple times and were phrased in different ways so that respondents could properly interpret what was being asked. As a result, some interviews lasted almost an hour, which certainly constrained the number of interviews and quality of information that could be achieved in the limited time that I was able to spend in these villages.

Furthermore, it is crucial to address the potential limitations inherent to the gender and age of the translators. In the present study, the three translators were all males between the ages of twenty-two and twenty-three. It is possible that mothers' responses were slightly altered because they did not feel comfortable providing personal information to a male stranger. Unfortunately, there were no female translators available and willing to travel to rural Udaipur during my time at Seva Mandir. All three translators were university students or taking entrance exams for government jobs, thus they were highly educated. Likely related to the social divide between educated and uneducated people, the translators would sometimes tell me that the mothers did not know what they were talking about because they were so uneducated. When these situations arose, I often repeated the question and convinced the translator to provide the exact answer of the mother, regardless of the content.

Similarly, issues regarding cultural differences were inherent to the nature of the study. Though I aimed to adopt a lens of cultural relativism, it is nevertheless the case that some cultural concepts do not smoothly translate from one culture to another. Furthermore, there was a potential suspicion of motives among some villagers. Because of my "otherness" and obvious

appearance as a foreigner, it is possible that some respondents were wary of my presence, which could lead to potential bias in interviews. For example, although I explained that I was a student conducting research for Seva Mandir in the initial consent portion of the interview, some mothers may have thought that I was working with the government. Regardless, it is quite understandable that people may not want to share personal information with someone who is not from their community and does not share their same language or culture. For the most part, people were very willing to participate, but in some cases, mothers walked away mid-interview or refused altogether. Because some responses were unclear and some questions were skipped, complete data were not collected for every study participant. Accurate recall is a real concern: some mothers did not recall or know the number of vaccines that their children had received, and some mothers who did report number of vaccines may not have done so accurately. Additionally, some questions could not be asked because of their sensitive nature, such as family's caste or income.

Limited Sample Size

One of the most common issues with regards to quantitative data analysis was the limited sample size. This was due to several issues, the first of which is the short study period. I was only able to stay with Seva Mandir in Udaipur for six weeks; once I arrived, it took time to become established with the health unit and to begin the research process. Because of communication difficulties in the beginning stages, the first successful day of fieldwork was not completed until the second week. For the first few trips, I relied on Seva Mandir for transportation and traveled near whichever sites employees were randomly visiting. Thereafter, I was able to use public transportation, such as buses and jeeps, to travel to study sites

accompanied by a translator. Throughout the process, the limited availability of translators also determined when it was possible to conduct interviews and collect data.

Also, because it was monsoon season during the study period (July to August), it was difficult or impossible to travel on some planned fieldwork days. Flooded roads sometimes caused cancelled trips or added to travel time, taking away from the time allotted for interviews. To compensate, I sometimes traveled to villages that were not originally planned for inclusion. Along the same lines, the difficult nature of rural fieldwork was another limiting factor. Many of the villages were quite far away (2 – 3.5 hours by automobile), so one-day trips (there was often nowhere for me to stay overnight) offered a very narrow window of time in which interviews could be conducted. Oftentimes, the translator and I attempted to leave before dark, particularly in or near tribal areas, which translators perceived as being "dangerous". Because most of the villages were not near paved roads, it was necessary to walk long distances, which also limited available time.

Potential Bias and Confounding

Throughout the study, several factors may have contributed to sampling error or bias. Primarily, because I relied on Seva Mandir for transportation, some selected villages were within 10 or 15 kilometers of some sort of Seva Mandir office and roads that cars could travel on. Because of this, it is possible that some of the most remote areas were not surveyed. Additionally, there were issues with nearly perfect confounding between variables like household distance from nearest vaccination center and knowledge of vaccine-preventable diseases. It was initially difficult to predict that there would be nearly perfect confounding between any of these variables. In future research, this could be corrected for through the

identification of villages that have more variety within variables other than intervention status (there was a relatively equal portion of NHI, HI, and NI villages in the study) – for example, purposeful inclusion of households that differ in household distance from nearest vaccination center.

Study Ethics

It was of the utmost important to maintain ethics and standards set forth by the Institutional Review Board throughout the study. Primarily, it was important to establish my position as a student working with Seva Mandir – at several points throughout the research, the translator referred to me as "*doctor ki baccha*" or "pediatrician", which I consistently needed to correct. Additionally, there were issues with cross-cultural consent. A few times, it was difficult to understand if a mother consented to the study because she would not respond verbally, but nodded her head and muttered something. It was necessary for me to use my best judgement and to trust the discretion of the translator and other Seva Mandir workers, if present. As noted, some mothers left part-way through the interview or refused to answer particular questions, which was respected and also suggests that mothers felt free to terminate the interview if they wished to do so.

Conclusion

The initial aim of the present study was to probe reasons for low pediatric immunization rates and the "plateau" in coverage that currently exists in rural Udaipur, India, taking into account local immunization-related perceptions and behaviors. Ultimately, the goal was to illuminate how these perceptions and behaviors, in combination with a variety of social

determinants of health, lead to disparities in vaccination coverage and ultimate health outcomes. This was done by comparing social determinants and vaccine knowledge and coverage in health intervention villages and non-health interventions of Seva Mandir, as well as non-intervention villages where solely the government was working. Both qualitative analysis and quantitative testing via SPSS and STATA software were employed in this analysis.

The study produced results that both supported and contradicted initial hypotheses. Contrary to the "spillover" hypothesis, in which non-health developmental programs in NHI villages would positively impact immunization uptake, NHI villages displayed the worst overall markers of wellbeing and vaccine knowledge and coverage. Additionally, formal testing revealed a lack of relationship between child age and number of vaccines received, which largely suggests that children are not receiving their immunizations in a timely manner, as recommended by the World Health Organization. One of the most surprising findings, which departs from previous literature, was that there was no relationship between maternal level of education and vaccine knowledge and coverage.

Overall, though respondents were relatively aware of the general purpose of immunization across all villages, very few mothers could name a single vaccine or vaccine-preventable disease. This reflects gaps on a clinical level that were further confirmed through conversations with local people and translators. The patient-provider relationship in rural India is predominantly paternalistic, with a large gap in communication between rural villagers and providers. This is supported by the result that most mothers reported vaccinating their children because an authority figure instructed them to do so, but also largely declaring that their children had not received the full immunization schedule because they did not understand why it was so important. Distance also seemed to be an important limiting factor, as mothers had issues with

limited transportation. In this study population, there were no reported concerns about side effects or community beliefs that inhibited vaccine uptake – the larger issue is that people in the community perceive vaccination as being good for health, but not essential. Ultimately, the health-seeking behaviors of mothers in these rural communities was strongly indicative of passive acceptance (rather than active demand), which makes it nearly impossible to both attain and sustain high levels of full immunization.

In future immunization campaigns, the importance of timeliness merits emphasis alongside spreading general awareness. The missing link between maternal education and vaccine coverage potentially indicates either issues with sample size in the study or that education may not be mandatory for women to understand vital aspects of immunization. In order to further examine the formation of maternal health-seeking behaviors, future study should also address the impact that mothers-in-law, as influential figures in the household, have on immunization decisions.

Furthermore, future studies in rural Udaipur are needed to gain a better understanding of how patient-provider interactions on a clinical level directly affect maternal health-seeking behaviors – specifically, Seva Mandir employees and *anganwadi* workers should be interviewed in addition to other government health workers such as nurses and physicians. Though it is difficult to tackle these larger social issues, such as the rural/urban divide and discriminatory perceptions of rural villagers, these barriers may also be addressed through improved incentives for physicians to work in rural areas, improved mid-level health service provision, policy that focuses on the promotion of equality, and altered medical school and other healthcare curricula that emphasize serving the rural poor.

Lastly, the location where mothers choose to vaccinate their children has important implications for future policy and programs. In the present study, almost all mothers reported immunizing their children at the local *anganwadi*. Focusing on increasing attendance and improving current services at the *anganwadi* will be advantageous because mothers clearly already associate child health with this type of center. As mentioned previously, the *anganwadi* is meant to offer basic health services for young children and expecting mothers as well as mid-day meals and a non-formal pre-school education for children. However, surveys have demonstrated that centers in rural Udaipur often are closed, understaffed, or do not provide all of these programs, which likely discourages mothers from attending. If mothers perceive the *anganwadi* as a reliable, multi-disciplined center for their children, this may offset the perceived cost of traveling to the center and losing a day's work. Ultimately, focus on the *anganwadi,* rather than introducing more programs and interventions is likely to be most effective in increasing the uptake of immunization and other health services in rural Udaipur.

Appendices

A. Survey Questions

1) What is your name and your age?
2) What is the highest level of education that you have received?
3) How many and which vaccines have your children received? At which age did they receive these vaccines?
4) Where did they receive these vaccines and who administered them?
5) How did you learn about vaccination and who informs you about camps?
6) What do you think the purpose of immunization is? Which diseases do the vaccines prevent?
7) How many visits has your child had to the immunization center so far?
8) What are the benefits and dangers of vaccinating your children?
9) Why did you choose to vaccinate or not to vaccinate your children?
10) How far do you live from the nearest vaccination camp or healthcare center?
11) Did you have any problems with receiving vaccines?
12) How do you think your community (friends and family) views vaccination?

B. Excel Spreadsheet Formating and Coding

- Family ID and Individual ID
- Status as intervention village
  - 0 = "health intervention"
  - 1 = "non-health intervention"
  - 2 = "non-intervention"
- Age of mother
  - 0 = "25 years or younger"
  - 1 = "older than 25 years"
- Level of education of mother
  - 0 = "illiterate"
  - 1 = "6^{th} standard pass or higher"
- Occupation of mother
  - 0 = "homemaker"
  - 1 = "other"
- Child gender
  - 0 = "female"
  - 1 = "male"
- Child age (represented as continuous variable)
- Number of vaccines received
  - 0 = "few to none" or 0-2 vaccines
  - 1 = "moderate" or 3-5 vaccines
  - 2 = "substantial to complete" or 6+ vaccines
- Number of visits for vaccination (represented as continuous variable)
- If children vaccinated, why?

    - 0 = “don’t know”
    - 1 = “positive health for children”
    - 2 = “local authority directed”
    - 3 = “other”
- If children not vaccinated, why?
    - 0 = “don’t know”
    - 1 = “did not have time”
    - 2 = “do not understand why it is important”
    - 3 = “does not want to vaccinate children”
    - 4 = “resources/opportunity not available”
    - 5 = “other”
- Location of vaccination
    - 1 = “*anganwadi* center”
    - 2 = “Seva Mandir site”
    - 3 = “school”
    - 4 = “home”
    - 5 = “hospital”
    - 6 = “other”
- Know purpose of vaccination
    - 0 = “yes”
    - 1 = “limited knowledge”
    - 2 = “no knowledge”
- Concerns about vaccination
    - 0 = “none”
    - 1 = “fever”
    - 2 = “other side effects”
- Motivation level to vaccinate
    - 0 = “will not vaccinate children”
    - 1 = “will vaccinate children if resources brought to home”
    - 2 = “will travel reasonable distance to vaccinate children (a few hundred meters to 5 km)”
    - 3 = “will travel any distance to vaccinate (over 5 km)”
- Number of vaccines known
    - 0 = “none”
    - 1 = “1+ vaccines”
- Number of diseases known
    - 0 = “none”
    - 1 = “1+ vaccines”
- Source of vaccination information
    - 0 = “no one”
    - 1 = “government nurse/doctor/worker”
    - 2 = “Seva Mandir worker”
    - 3 = “local community leader”
    - 4 = “friends and family”
- Community views of vaccination
    - 0 = “neutral”

    - 1 = “positive”
    - 2 = “negative”
- Distance from nearest vaccination center
    - 0 = “less than 1 km”
    - 1 = “1 km or more”

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