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Acceptance Of Vaccine Against Influenza In Pregnant Women In Urban Slum Areas In Karachi, Pakistan

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Master of Public Health

Global Health

_____

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By

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Bachelor of Arts

Pomona College

2011

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An abstract of

A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of Master of Public Health in Global Health

2014

Abstract

Acceptance Of Vaccine Against Influenza In Pregnant Women In Urban Slum Areas In Karachi, Pakistan

By

Afshin Alaf Khan

Background: Very little is known about facilitators and barriers to Influenza vaccination programs amongst pregnant women in the developing world, particularly in South Asia. We assessed intention to accept Influenza vaccine amongst ethnically diverse low-income pregnant women in Pakistan.

Methods: Between May-August 2013, we conducted a cross-sectional survey of pregnant women who frequented 3 health centers in urban slum areas in Karachi, Pakistan. Our main outcome of interest, intention to accept Influenza vaccine, was assessed against variables including socio-demographic factors, vaccination history, vaccine recommendation sources and their reliability, and other facilitators and barriers to vaccine acceptance.

Results: A total of 283 pregnant women participated in our study. Ninety-seven percentage of the respondents intended to accept Influenza vaccine but none were vaccinated against Influenza. Except for 1, all pregnant women had heard about Influenza disease. Perceived vaccine safety, efficacy, and disease susceptibility were significantly associated with intention to accept Influenza vaccine ($p<0.001$). Only 50% of pregnant women received recommendation about any vaccines from physicians, whereas 95% of the participants rated healthcare providers as a highly reliable source of information ($p<0.01$, 95% Confidence Interval [CI] 2.95-36.31). Parents-in-law and husbands were named as the primary decision makers in the family by 88% of the respondents. The most often cited reason for accepting Influenza vaccine was if a physician recommended it ($p<0.01$) whereas, not getting permission from a family member was cited as an important reason to refuse vaccination.

Conclusion: Future maternal flu vaccination efforts should target decision makers in the family. Furthermore, healthcare providers should be encouraged to recommend Influenza vaccine as it may increase vaccine uptake.

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BACKGROUND

Overview

Influenza is one of the diseases with a significant global impact on morbidity and mortality. Pregnant women and infants under 6 months old are one of the vulnerable risk groups for developing Influenza. Fortunately, vaccines against Influenza are available in the market to combat the disease. Influenza is one of the two diseases where maternal immunization is strongly recommended to confer immunity to both the pregnant woman and her child. My literature review sheds light on the general disease characteristics, the trend of Influenza related morbidity and mortality over the years, and current available treatment options. Furthermore, it highlights some of the existing perceptions and misperceptions regarding maternal immunization. Currently, there is very little research conducted to assess vaccine acceptance in developing countries. My specific formative research tries to gain a better understanding of facilitators and barriers to maternal flu immunization in Pakistan.

Causes and Transmission

Influenza, commonly referred to as flu, is a contagious respiratory disease. Sneezing, coughing, and even talking creates aerosols that can cause Influenza. Even, tidal breathing can generate particles that can induce the disease. Additionally, fomite can spread Influenza where particles stay on surfaces anywhere from a few hours to a couple of days [1]. One can get infected by coming in contact with these virus-infected surfaces and then touching their nose, mouth, or eyes [2]. Indirect spread of Influenza also occurs via animal feces (bird droppings and avian flu) [3].

Influenza RNA viruses belong to *Orthomyxoviridae* family and are responsible for spreading Influenza [1]. There are 3 types of Influenza types namely A, B, C where A and B can cause epidemic human disease. There are two surface proteins on Influenza virus called hemagglutinin (HA) and neuraminidase (NA) that are major antigens. Type A Influenza virus is further divided into subtypes according to the combination of HA and NA proteins. This includes the H1N1 and H3N2, which are currently circulating as the seasonal Influenza virus subtypes. There are two type B viruses known as Victoria lineage and Yamagata lineage [4]. Type C Influenza is known to cause mild infections and sporadic outbreaks. Humans can also be infected with zoonotic or variant Influenza subtypes like avian Influenza A (H5N1) and A (N9N2) and swine Influenza virus subtypes A (H1N1) and (H3N2).

The Influenza virus is prone to genetic variation whereby reassortment between aquatic bird reservoir and human Influenza viruses can produce unique pandemic Influenza viruses in a process called antigenic shift. Another genetic variation is called antigenic drift whereby point mutations in virus can accumulate and help the virus escape routine surveillance and thus cause seasonal Influenza epidemics [5].

Signs and symptoms

Common signs and symptoms of Influenza include fever, cough, sore throat, runny or stuffy nose, muscle or body aches, headaches, fatigue, vomiting and diarrhea particularly in children [2]. Fever and body aches typically last three to five days whereas cough and lack of energy can last for two or more weeks.

Healthy adults are able to transmit the disease a day before symptoms develop and up to five to seven days after developing symptoms [2]. Some individuals, particularly young children and those with weakened immune systems are able to transmit the disease for a longer period of time.

Diagnosis

It is difficult to diagnose Influenza based on clinical symptoms alone as they resemble the symptoms caused by infectious agents like *Mycoplasma pneumoniae*, adenovirus, respiratory syncytial virus, rhinovirus, parainfluenza viruses, and *Legionella* spp [2]. There are numerous virus testing methods including the conventional viral cell culture, rapid cell culture, immunofluorescence assays, polymerase chain reaction assays, and rapid Influenza diagnostic tests (RIDT). Nasopharyngeal or nasal swab, and nasal wash or aspirate samples should be taken within the first four days of the illness. Viral cultures are able to give results within three to ten days whereas rapid diagnostic tests produce results within 15 minutes. Most RIDTs are 50-70% sensitive but more than 90% specific. Accurate and timely diagnosis of Influenza can help reduce the inappropriate use of antibiotics and encourage appropriate use of antiviral therapy.

Morbidity and Mortality

Influenza occurs worldwide during winter, resulting in 3 to 5 million severe cases and 250,000 to 500,000 deaths yearly [6]. The annual seasonal Influenza epidemic is 2-10% worldwide. About 20-30% of young children are affected by Influenza annually.

Pregnant women, young adults, children, and those with preexisting chronic medical illnesses are at a high risk of critical illness and subsequent hospital admissions [7]. During annual

epidemics and occasional epidemics, households are considered to be active contributors of spread of Influenza [8]. Influenza disproportionately affects the different age groups. For children under 5 years old, Influenza is the most common cause of outpatient care [9]. Modeling studies suggest that the rates of hospitalizations in children under two years of age are similar to those among older adults [10, 11]. Upwards of 90% of Influenza related deaths happen in the more than 65 years old age group [12]. Because of their high infectiousness, children increase the burden of the disease on all age groups [13].

Influenza can cause complications including bacterial pneumonia, ear infections, sinus infections, dehydration, and worsening of chronic medical conditions like congestive heart failure, pulmonary diseases, or diabetes [2].

Beyond Influenza related morbidity and mortality, Influenza has far reaching consequences. Influenza causes both clinical and socioeconomic burden as it contributes to missed days at work for parents and absenteeism from school for children. It is estimated that 15 million working days are lost each year due to flu in the United States alone [14] and the disease itself costs more than $2 billion in both direct and indirect costs [15].

Epidemics and Pandemics

In the 20th century, there were 3 Influenza pandemics that occurred in 1918, 1957, and 1968. Each pandemic was different with regards to its epidemiology, disease severity, and etiology. The Influenza subtype responsible for the 1918 pandemic was H1N1, whereas H2N2, and H3N2 subtypes were present in the pandemics of 1957 and 1968 respectively [16]. The sites of origin for the 3 pandemics were Spain, Asia, and Hong Kong respectively. “Spanish” Influenza,

being the mother of all pandemics, caused approximately 50 million deaths worldwide [17]. The Asian Influenza pandemic killed more than a million people whereas the Hong Kong Influenza pandemic killed 1-3 million people [16]. Most recently, H1N1 Influenza virus was detected and caused a pandemic in 2009-2010 affecting 43-89 million and killing 8,870 - 18,300 people [9].

Treatment

Antiviral drugs are prescribed for individuals who are affected with Influenza. However, the first line of defense is vaccinations. According to Kilbourne ED, we can prepare for Influenza pandemics by vaccinating everyone as 'no amount of hand washing, hand wringing, public education, or gauze masks will do the trick' [18].

Vaccination

There are two types of vaccines available for Influenza: the Trivalent Influenza Vaccine (TIV) and the Live Attenuated Influenza Vaccine (LAIV). Both TIV and LAIV vaccines contain two type A Influenza strains (H1N1 and H3N2) and one type B Influenza strain [1]. Since the virus is prone to genetic variations, the exact composition of Influenza vaccine is determined based on the likelihood of circulating Influenza strain as determined by the World Health Organization [19].

Several studies have suggested that Influenza vaccines are efficacious in preventing the incidence of Influenza [20]. Since 2010, the Centers for Disease Control and Prevention (CDC) and the Advisory Committee on Immunization Practices (ACIP) have recommended routine Influenza vaccines for all persons 6 months and older who do not have any contraindications [20]. Antiviral chemoprophylaxis is not allowed for children under one year old as it does not lead to a sufficient immune response that can protect infants [21]. Influenza vaccines reduce the risk of getting

Influenza or developing Influenza-related complication, visits to the physician, subsequent hospitalization, and death in healthy and high-risk individuals [20, 21]. Furthermore, vaccination could also decrease the transmission of Influenza viruses in the community (hence controlling epidemics and pandemics) through herd immunity [22].

A study by Pedro Plans-Rubió (2012) estimated the level of vaccination coverage required to confer herd immunity, which depends on a variety of factors including virus strain, seasonal attack rates, effectiveness of the vaccine, and the epidemic year. The study suggested that a higher vaccination coverage would be required for viruses that have R_o[1] ≥ 2 as long as the vaccine has effectiveness of > 60% but only a 50% coverage is needed for viruses with R_o ≤ 1.5 that has a vaccine effectiveness of > 60% [23].

For children more than 2 years old, both LAIV and inactivated vaccines have similar effectiveness in preventing Influenza (33 and 36% respectively) but for children younger than 2 years old, the inactivated vaccine was no more effective than placebo [24]. Another study conducted in the US in 2003-2004 season showed that 2 doses of inactivated vaccine reduced the ILI visits of 6-21 months old children by 69% [25].

It is also important to note that Influenza vaccine has been associated with a few side effects including fever and myalgia, and pain and swelling at the site of vaccine administration.

[1] R_o, otherwise called the Basic Reproductive Number, is the average number of secondary cases that arise from an average primary case in a completely susceptible population

These effects are mild and temporary. However, febrile convulsion [26, 27] and narcolepsy [24] are also reported to be associated with certain vaccine brands.

Pregnant Women

Pregnant women are at particularly high risk of Influenza related complications, owing to the physiological and biological changes during pregnancy. Even the deadly pandemic of 1957 was disproportionately deadlier for pregnant women. It is estimated that 50% of childbearing age women who were pregnant were killed by Influenza [28] and 10% of the Influenza-associated deaths were amongst pregnant women [29]. Pregnant women make up 1% of the US population yet they contributed to 5% of the deaths due to Influenza during the 2009 Influenza epidemic [30]. Changes in the immune, respiratory, and cardiac systems are associated with the increased risk of Influenza in pregnant women [31, 32]. These physiologic changes include an increase in heart and stroke volume, a decrease in lung capacity, and an attenuation of cell-mediated immune responses [33, 34]. The risk of hospitalization, ICU admission, and death associated with Influenza increases with gestational age [30, 35-37]. In developed countries, the odds of hospitalization due to Influenza are higher for pregnant women as compared to non-pregnant women [38, 39].

Since pregnant women are at high risk of Influenza related complications and hospitalizations, the ACIP and the American College of Obstetricians and Gynecologists have recommended pregnant women to get the annual seasonal flu vaccine. This helps protect both the infant and the mother against Influenza [40-42]. Currently, Influenza vaccines are recommended to children 6-23 months of age. The flu vaccine is unable to mount a sufficient

immune response in children under 6 months of age and is thus not recommended for this age group [43, 44]. Passive immunity via maternal immunization is the best strategy to protect neonates [45, 46].

Studies have shown that antibodies (immunoglobulin G) cross the placenta through active transport [47, 48], specifically during final weeks of pregnancy while immunoglobulin A are transferred during breast milk [49]. A study conducted by Zaman *et. al* showed that in a randomized controlled clinical trial in Bangladesh, pregnant women with inactivated Influenza vaccine had 63% effectiveness in reducing laboratory-confirmed Influenza in their infants compared to those mothers who had received a conjugate pneumococcal vaccine in their pregnancies [50]. A similar study looked into the effectiveness of the vaccine administered during pregnancy and found that the Influenza vaccine was 91.5% effective in preventing hospitalization in infants <6 months old [51].

Challenges to Vaccine Acceptance

Despite the recommendations, vaccine acceptance has been low. In most developed countries, vaccine uptake rates amongst pregnant women are very low ranging from 1.7% to 76.4% [52-60]. In the United States, during the 2006-2007 Influenza season, vaccine uptake was as low as 13% [61]. According to Healthy People 2020, the Influenza vaccine uptake for pregnant women should be at least 80% but during the 2011-2012 Influenza season, only 36.5% of pregnant women were vaccinated against Influenza [62]. This estimate, clearly, lies far below the intended target.

A systematic review by Nguyen et al (2011) [63] shows that certain factors need to be considered for vaccination efforts. These include personal risk perceptions, severity of Influenza illness, and likelihood of being infected with Influenza virus, risk of severity of Influenza illness when infected, and risk from the Influenza vaccine itself.

A psycho-behavioral Health Belief Model (HBM) is employed in understanding and predicting health related behaviors [64]. This theory is often utilized in comprehending the uptake of immunizations and is determined by perceived susceptibility to a given disease, perceived severity of the disease, perceived benefits of vaccination, perceived barriers to vaccination, cues to action (any internal or external stimulus that impacts one to get vaccinated), and self-efficacy (one's confidence in his or her ability to successfully get vaccinated). Contextually speaking, the model predicts that the likelihood of taking a preventive health action, in this instance, immunization is affected by interplay of these 6 constructs. Modifying factors like demographic (age, sex) and socio-psychological factors (personality, social class) can impact perceived severity and susceptibility to a given disease, which manifests itself in the form of a perceived threat of the given disease. This is further affected by cues to action like mass media campaigns, advice from others, illness of friend or family member, and healthcare provider's explanation or recommendation. The aforementioned modifying factors could also impact the likelihood of action whereby one assesses the perceived benefits and barriers, and together with the perceived threat of a disease affects the likelihood of the health behavior.

Studies have used the Health Belief Model to explain vaccination acceptance in different populations. The results of one such study that focused on assessing the parental acceptance of

H1N1 vaccine revealed that cues to action like intrapersonal communication including friends, family members and mass communication including media and modeling by the Obama family were better predictors of vaccine acceptance [65]. Interestingly enough, perceived risk of H1N1 was not associated with vaccine uptake. The authors thus emphasized on cues to action to support the normalization and modeling of vaccination as opposed to emphasizing on the perceived risks of a disease.

In another study conducted to assess the acceptance of Influenza vaccines by pregnant women in Massachusetts during the 2009-2010 flu season, women were more likely to accept vaccines if their provider recommended the shots. Some of the top reasons for not opting for vaccines include safety fears for the mother and the baby, especially with regards to H1N1 vaccine [66]. Other studies have shown that low vaccine acceptance is associated with fear of needles and cultural beliefs [42, 67, 68].

Another study that assessed the knowledge and attitudes of post-partum Hispanic women towards immunization revealed that recommendations by the healthcare providers had the greatest impact on the acceptance of vaccines by pregnant and postpartum women [69]. The same study identified insufficient knowledge about vaccines, cost, lack of transportation, work commitment, and fear of needles as possible barriers to vaccination. Healthcare providers' recommendations not only increase the uptake of vaccine but it also helps pregnant women in overcoming fears about the safety of the vaccine for the child [57].

One survey among OB-GYN showed that vaccinated providers were more likely to recommend flu vaccine as compared to unvaccinated providers ($p<0.0001$) [70]. These

healthcare providers were also more likely to recommend Influenza vaccines if they believed that the vaccine protected neonates and if they believed that women were at an increased risk of developing Influenza during pregnancy. However, 12% of the surveyed providers were of the opinion that all vaccines should be avoided during pregnancy. Provider knowledge also plays an essential role in vaccine acceptance. Those who were abreast with current knowledge and vaccine recommendation regarding Influenza were more likely to initiate discussions with their patients [70].

Besides healthcare providers, there are other factors at play as well. Several studies have suggested that during pregnancy, a mother often places the health of her child above hers and thus shows concerns about the safety of the vaccine for her child. To increase the uptake of vaccination in pregnant women, appropriate message framing is important. One such study conducted on African American pregnant women revealed that mothers were likely to pay more attention to the messages if they talked about how Influenza vaccines would affect their child and would likely influence their decision to get vaccinated. Additionally, they were more likely to listen to a positively framed message that emphasized on the infant's health as opposed to a negatively framed message that focused on risks in case vaccine is not administered during pregnancy [71].

A study by Wray et al showed that African Americans were less likely to accept Influenza vaccines on the ground that they feared getting Influenza from the vaccine itself or did not trust the vaccine and the health care system [72, 73]. Another study showed similar findings where compared to the Blacks and Hispanics, Whites were even less likely to trust the government [74].

This study by Freimuth et. Al further explored different aspects of trust where healthcare providers, in general, were considered more trustworthy than religious leaders.

Vaccine Acceptance in Pakistan

Though there is little data on the disease burden of Influenza in developing countries, it is anticipated that the risk of severe Influenza amongst pregnant women and young children is higher than those in developed countries. Thus, the need for vaccines in such settings is ever so high. However, Influenza vaccines are not used frequently in resource-limited countries for a variety of reasons including misconception that Influenza is not a problem, the high costs associated with vaccination, challenges with program implementation, vaccine availability, and vaccine expiry dates, etc. [75].

Pakistan is amongst one of six countries that contribute to half of the global mortality in children less than five years of age [76]. One in every eleven children dies before the age of five years old [77]. Approximately a third of these deaths are attributed to vaccine preventable diseases. There is very little information regarding Influenza related morbidity and mortality in Pakistan. Since 1980s, there has been sporadic Influenza surveillance reported at the National Institute of Health, Islamabad. However, beginning 2008, sentinel lab-based surveillance network was set up with collaboration from the Centers of Diseases Control and Prevention (CDC). During the period 2008-2011, all Influenza types and subtypes were detected including A/H1N1, A/H3N2, Influenza B and the novel A/(H1N1) pdm09 [78].

To date, there is very little information on attack rates and case fatality rates due to Influenza. A recent study by Ali et. al (2013) showed that 3.3% of admitted children at Aga Khan

University and Hospital (AKUH) were tested positive for Pandemic H1N1 virus during 2009-2011. Those tested positive for the pandemic strain were 5 times more likely to be admitted to the hospital or get transferred to the Intensive Care Unit, 5.5 times more likely be intubated, and were 12.9% more likely to die because of Influenza as compared to those tested negative for the strain [79]. The vaccine uptake during this pandemic cycle was very low primarily because of inadequate information on the burden of disease and seasonality in addition to poor access to vaccines.

Currently Fluarix, a trivalent, inactivated vaccine against Influenza types H1N1, H3N2, and Influenza B, is licensed for use in Pakistan [80]. There is no existing protocol for maternal or children immunization for Influenza in Pakistan. The Expanded Programme on Immunization (EPI) Pakistan immunizes children against tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, measles, hepatitis B (Hep B) and *Haemophilus influenzae* type B (Hib) [81]. Thus, a child in Pakistan has to make five visits to a health center in the first year of his or her life and only one visit during the second year to gain protection against eight deadly diseases. EPI also vaccinates pregnant women against tetanus only so as to protect the infant from tetanus toxoid. However, no Influenza vaccines are administered or included in the immunization schedule for pregnant women or children.

Despite the provision of free vaccination services to children by the EPI Pakistan, vaccination coverage in children 12-23 months is only 59-73% [82, 83]. In the context of developing countries, several reasons are cited for poor immunization coverage. Some of these include poor parental knowledge about the importance of vaccination or immunization schedule, residence in rural areas, lower socioeconomic status, poor access to healthcare services, and

inadequate supervision by healthcare providers [84-92]. A study by Owais et. Al (2011) showed that simple educational interventions targeting mothers improved immunization by 39% [51]. Recently, the Global Alliance of Vaccine and Immunization (GAVI) is considering modifying its investment priorities by facilitating access to Influenza vaccines in developing countries. With the routine recommendation of Influenza vaccine by the WHO and provision of vaccines by GAVI, it becomes important to investigate potential barriers and facilitators for introduction of this vaccine amongst pregnant women in Pakistan.

Summary

Immunization is one of the most cost-effective methods to tackle the global spread of Influenza to save lives and prevent disease. Maternal immunization has been proven to have double advantage in that it confers immunity to pregnant women but also reduces the risk of complications and disease in infants under 6 months old who are too young to receive the vaccines themselves. However, despite the availability of vaccines against Influenza and recommendation from the ACIP and WHO, flu vaccine uptake is considerably below the acceptable levels. Several factors including socio-demographic, knowledge, perceptions of vaccine safety and efficacy have been known to affect vaccine acceptance in the developed world. In the developing world, however, other factors such as cultural and religious reasons may also impact vaccine acceptance.

Pakistan is currently battling to win the fight against Polio but widespread misperceptions about the polio vaccine make it difficult to achieve its goal of elimination. Even for other immunization including maternal tetanus toxoid vaccines, Pakistan has been unable to reach the

desired vaccination coverage. With a recent move towards considering a roll out of Influenza vaccines in low-income countries by the GAVI Alliance, it becomes pertinent to get a better understanding of vaccine acceptance amongst pregnant women if maternal flu vaccine were to be introduced in the community. Future studies should also explore the viewpoints of healthcare providers and other staff in vaccination programs to get an up-close understanding of the barriers and facilitators to vaccination programs in the country and investigate what lessons may be applicable to flu immunization.

CHAPTER 2: MANUSCRIPT

INTRODUCTION

Pregnant women have a high risk of severe complications and death from Influenza. Children under 6 months old are another group with the highest rate of Influenza-related hospitalizations. Vaccination is one of the most effective measure to prevent Influenza related morbidity and mortality. Currently, no Influenza vaccine has been licensed for use in children under 6 months old. The World Health Organization's Strategic Advisory Group of Experts on Immunization (SAGE) has declared pregnant women in any trimester to be the highest priority group for vaccination [93]. Since 2004, the Advisory Committee on Immunization Practices (ACIP) and the American College of Obstetricians and Gynecologists have recommended pregnant women to get vaccinated annually [20]. There is compelling evidence to support that Influenza vaccine significantly reduces risk of severe disease in pregnant women and offers secondary protection to infants for at least the first 6 months of their lives [94].

Despite being the sixth most populous country in the world with 35% of its population under 15 years of age, Pakistan has not included vaccines against Influenza in the Expanded Program on Immunization (EPI) schedule for pregnant women and children. There are no official estimates of Influenza related morbidity and mortality in Pakistan. However, lower respiratory infection is the number one killer in the country and contributes to 12% of deaths. Globally, Pakistan ranks third in having the highest number of acute respiratory infections (9.8 million cases) in children less than 5 years old [95]. The infant mortality is also high at 74 deaths per 1000 [96].

Even though, free vaccines are available through the Pakistan EPI, only 59% of pregnant women have received one or more tetanus toxoid vaccine during their last pregnancy [96]. There is a need to better understand low vaccine uptake, and the various facilitators and barriers to maternal flu vaccination in Pakistan. To our knowledge, no study has been conducted on acceptance of vaccine against Influenza amongst pregnant women in South Asia. Our study aimed at assessing intention to accept Influenza vaccine amongst pregnant women seeking care at local health centers in a multi ethnic population in Karachi, Pakistan in 2013. The findings will play an important role in shaping future vaccine programs in Pakistan.

MATERIALS AND METHODS

Study location

Three health centers located in Bilal Colony, Ibrahim Haideri, and Ali Akbar Shah in Korangi Industrial area in Karachi, Pakistan were selected to participate in our study. These health centers serve a low income urban population which is also ethnically diverse including the Bengalis and Pashtuns who have the lowest DTP3 vaccination coverage (48% and 67% respectively) [97].

Study Design

This is a cross sectional observational study where we used a 51 items questionnaire to assess the knowledge and practices of pregnant women with regards to accepting vaccine against Influenza. Subjects were enrolled in the study from May to August 2013. Any woman, in the age range of 18-49 years old inclusive, who frequented the participating health clinics and was in any

trimester of pregnancy as assessed by a doctor was included in the study. We recruited pregnant women when they were either waiting for their prenatal checkup or vaccination for themselves or their children at the health center. Subjects were approached by trained members of the study team who provided adequate details of what the study entails, its objectives, associated risks, and potential benefits. Once verbal consent was granted, each participant's name and signature was included on the consent form. In case where a woman was unable to read and write, a third person who was not affiliated with the study verified the informed consent form and helped record the subject's thumb print as proof of consent. Because a majority of the study participants were unable to read and write, questions were read out by the study staff and answers were noted down on paper version of the questionnaire. Based on feasibility and logistical considerations, we aimed to interview at least 250 pregnant women. However, we were able to interview a total of 283 individuals.

Outcome measures

The main outcome of interest was whether pregnant women would accept vaccine against Influenza if offered to them during pregnancy. Questions were aimed at collecting general demographic information including age, education, marital status, employment status, language spoken at home, self-described regional heritage, ownership of house to assess socioeconomic status, total number of pregnancies, number of children, and whether any of the children died of any illness. We also inquired about the month of pregnancy and if, when and where did the pregnant woman seek antenatal care during the current pregnancy. We asked about general health problems that the participant may be facing and whether she has been hospitalized in the current pregnancy.

With regards to vaccines, we asked the pregnant women whether they were advised about vaccination during the current pregnancy, what the recommendation source was, and what vaccines were recommended. Furthermore, we were interested in knowing whether our study participants had already received vaccines in the current pregnancy and if so, what were these vaccines. Regardless of whether she had been vaccinated, we asked if she had any intention to get vaccinated against any disease in the current pregnancy. We also asked pregnant women to assess the reliability of information about vaccines from a variety of different sources including healthcare staff members, religious leaders, ministry of health, etc. Additionally, we asked which family member makes healthcare decisions in the household.

We were also interested in recording information about the participant's vaccination status in childhood and previous pregnancy, and whether she faced any complications and was hospitalized as a result of the vaccine use. Where possible, the information was verified against vaccination cards but in most cases, answers were recorded based on a subject's ability to recall.

Another set of questions was designed solely to record pregnant women's perceptions about Influenza. We asked questions about whether the subject had ever heard about Influenza, whether she thinks that pregnant women in general should get vaccinated against Influenza, and if she herself would get vaccinated if the decision maker in the household left the decision up to her. Questions also asked about some of the aspects of health belief model including whether a non-vaccinated pregnant woman would be susceptible to contracting Influenza, whether a vaccinated pregnant woman would be susceptible to contracting Influenza, if she would consider it safe for herself to get the vaccine against Influenza, if the subject thought it was likely for a

baby to contract Influenza, and whether an infant can be protected against pertussis if the mother was vaccinated against the disease. Lastly, an optional, open-ended question was asked to identify reasons why pregnant women would accept or reject vaccines against Influenza during pregnancy.

Statistical Analyses

SAS 9.3 (SAS Institute Inc., Cary, NC) was used to analyze the data that was manually entered into Microsoft Excel 2011 (Microsoft Redmond, Washington). 'Don't know' responses were merged with 'No' responses. Age (based on median), education, employment status, and socioeconomic status variables were dichotomized. Number of children variable was categorized into one, two, three, or more levels.

Descriptive statistics were calculated for all study variables in the dataset. To identify strong correlations between the different socio-behavioral and demographic variables and vaccine acceptance, bivariate analysis was conducted. Simple logistic regression was used to examine unadjusted associations between each study variable and intention to accept Influenza vaccine. Significance, using alpha of 0.05, was assessed using Mantel-Haenszel Chi-Square.

Ethical consideration and financial disclosures

The Institutional Review Board at Emory University and the Ethical Review Committee at The Aga Khan University in Karachi approved our study. The researchers declare no conflict of interest in the study. None of the participants received any financial or other incentives.

RESULTS

Demographics

We intended to capture all pregnant women who presented during the study period at the three health centers in Ibrahim Haideri, Ali Akbar Shah, and Bilal Colony in Korangi Industrial area in Karachi, Pakistan (n=286). Three of them were younger than 18 years and were subsequently excluded from the study. Of the 283 participants, 274 pregnant women expressed interest in either rejecting or accepting Influenza vaccine and were thus included in further analysis (response rate: 96.8%).

The median age of this group was 25 years (range: 18-43). Ninety five percent of the pregnant women had a below secondary education where a majority were unable to read and write (53%). Eighty five percent of them were housewives and forty four percent of them had a low socioeconomic status, as determined by their inability to own the house in the urban slum community. Except for 1 separated woman, all participants were married at the time of the study. We managed to capture an ethnically diverse population where all major ethnicities were almost equally represented (range of number of pregnant women per ethnicity group: 31-56). Seventy one percent of the women were in their third trimester of the pregnancy and 73% of them reported seeking antenatal care during the current pregnancy. Eighty nine percent of the pregnant women who reported seeking antenatal care sought care from healthcare staff including physicians and nurses. Forty five percent of the pregnant women reported having general health problems including diabetes, hypertension, and urinary tract infections during the current pregnancy but only 4% (n=11) of these pregnant women were hospitalized during the current pregnancy.

Bengalis were the only ethnic group that showed a significant association with intention to accept Influenza vaccine in our unadjusted bivariate analysis (OR=0.18, 95% CI: 0.03-0.94). No other significant differences were seen for any demographic or clinical characteristics between women who intended to accept and those who did not intend to accept Influenza vaccine.

Health Belief Model

Eighty nine percent of the respondents (n=241) agreed that women should be vaccinated against any disease during their pregnancy. This was significantly associated with intention to accept Influenza in our unadjusted analysis (**Table 3**). All health belief model related questions included in the study were found to be significantly associated with intention to accept Influenza vaccine (**Table 3**). Perceived disease susceptibility was associated with intention to accept Influenza vaccine (OR: 3.58, 95% CI: 1.17-10.96). Similarly, perceived vaccine efficacy was significantly associated with intention to accept Influenza vaccine (OR: 11.62, 95% CI: 4.26-31.69). Seventy four percent of the pregnant women (n=195) were aware that it is safe for pregnant women to receive Influenza vaccine and were more likely to accept Influenza vaccine (OR: 15.92, 95% CI: 5.13-49.37). Seventy five percent of the women also agreed that an infant is prone to contracting Influenza and the odds of these women accepting flu vaccine were 4.79 times higher than those who did not think that infants could contract Influenza (95% CI: 1.92-11.96). Eighty one percent of the pregnant women also agreed that if a pregnant woman received vaccine against Influenza, her infant would be protected against the disease. This health belief model variable was also positively associated with intention to accept Influenza vaccine (95% CI: 3.5-23.24).

Influenza Disease Knowledge and Vaccine Administration History

Except for 1, all pregnant women had heard about Influenza and 252 of these women intended to accept Influenza vaccine (89%) as compared to 21 who refused to get vaccinated despite knowing about the disease. There was, however, no significant association between disease knowledge and vaccine acceptance.

Prior vaccination status against tetanus toxoid (TT) during the current pregnancy was significantly associated with intention to accept Influenza vaccine in our unadjusted analysis as those pregnant women who were already vaccinated against were 3.32 times more likely to intend to accept Influenza vaccine as compared to pregnant women with no history of prior vaccination during current pregnancy (95% CI: 1.24-8.84). Similarly, women with positive vaccination history for DPT during childhood or adolescence were 2.33 times more likely to intend to accept Influenza vaccine as compared to those with no DPT vaccination history during childhood or adolescence (**Table 2**). Only 2 pregnant women reported having any complications after receiving TT vaccine and only 1 reported being hospitalized due to these vaccine related complications. Not surprisingly, the odds of pregnant women who intended to get vaccinated in the current pregnancy were 4.68 times higher as opposed to those who were not planning to get vaccinated ($p<0.01$).

Vaccine Recommendation and information sources

A substantial majority (78%) of the study population was recommended to get any vaccine during the current pregnancy. Though statistically insignificant, these women were 1.88 times more likely to intend to accept Influenza vaccine compared to those who were not

recommended (**Table 2**). 50% of the pregnant women were recommended by physicians to get vaccinated against any disease. Those recommended by physicians were 2.15 times more likely to intend to accept Influenza vaccine as compared to the pregnant women who were not recommended by physicians (**Graph 1**). The next highest recommendation source was social workers including community health workers hired by The Aga Khan University (**Graph 1**). Eighty eight percent of the study population reported their parents-in-law and husbands as ones who decide about seeking healthcare for any family member (**Table 2**). As with vaccine recommendation sources, 95% of the study population ranked the doctors and nurses group as reliable with regards to the information provided about vaccines. Pregnant women who were recommended by doctors were 10.36 times more likely to intend to accept Influenza vaccine compared to those who were not recommended by doctors ($p<0.01$). Non-medical friends or relatives were the next most reliable source of information (n=151, 58%), however this was not found to be significantly associated with intention to accept Influenza vaccine (**Graph 2**).

Facilitators and Barriers to Vaccine Administration

In an optional, open-ended question, doctor recommendation was significantly associated with intention to accept Influenza vaccine ($p<0.01$). Respondents who thought that a pregnant woman should accept Influenza vaccine if recommended by a doctor were 5.8 times more likely to intend to accept Influenza vaccine (**Table 3**). Though statistically insignificant, 19% of the respondents thought that a pregnant woman should accept Influenza vaccine if a friend or relative recommended it. No other reasons were significantly associated with Influenza vaccine acceptance.

Among reasons to refuse Influenza vaccine, 31% of pregnant women (n=85) would not accept the vaccine if her husband or household member did not grant her permission. 17% of the respondents (n=47) refused vaccination on the ground that it may cause harm to her. Other reasons for refusal included pregnant women fearing that the vaccine would cause harm to the unborn child (n=42, 15%) or if they thought that the vaccine could weaken their immune response (n=30, 11%).

DISCUSSION

In our study, a majority of the pregnant women expressed their intention to accept Influenza vaccine if vaccination is introduced in this community. Approximately 90% of the study population sought antenatal care from healthcare providers but only half received vaccine recommendation from them. Amongst the different sources of vaccine recommendation, doctors and nurses were considered as the most reliable source of information. Recommendation by any physician was strongly associated with intention to accept Influenza vaccine. Close to 90% of the respondents cited their parents in law and husbands as important decision makers in the family.

Our study showed high acceptance of maternal flu vaccines if a potential vaccine program was to roll out. Contrary to the common reasons cited for refusing polio vaccines in the context of Pakistan that include sterility fears, having little faith in vaccination program and other religious reasons [98], the reasons for Influenza vaccine refusal in this study were different. In an optional open-ended question, many pregnant women reported their fears that the vaccine

could be harmful for themselves or their unborn children. Furthermore, 31% of the study population that answered the question also reported that they would refuse the vaccine if they do not receive permission from their decision makers in the family. This is an important point to note as culturally, Pakistani women may have to rely on the approval and or knowledge of her elders to take such important health decisions for herself or her infant.

Our study affirms the findings of several other studies that highlight the importance of healthcare providers in increasing vaccine acceptance amongst pregnant women [99-102]. Together with perceived fears about Influenza vaccines and the positive association seen between physician recommendation and high vaccine acceptance, it is paramount to encourage doctors about relaying the importance of Influenza vaccination to their patients.

There are a few potential limitations of the study. We recruited women from health centers, which may have impacted our generalizability. However, towards the end of the study period, we were beginning to see the same pregnant women who had been interviewed before. Furthermore, sending out research assistants as a precautionary measure to search for pregnant women who did not seek antennal care during the study period ended up recruiting the remaining pregnant women who were eligible to take part in the study. Our analysis further showed that our study had recruited an ethnically diverse population whose viewpoints and experiences may better reflect the general population. It is also worth pointing out that the health centers are well-established primary care facilities in the community. As opposed to tertiary healthcare facilities where patient's disease status or accessibility issues may affect their health seeking behavior, this cannot be said about the primary health care facilities in our study

as they are accessible by community members who regularly seek their routine healthcare and immunization at these health clinics.

There is another limitation that may have impacted our study results. Because all interviews were conducted at the health centers, social desirability bias may be a problem in the recorded responses. The outcome for the study was intention to accept Influenza vaccine, which may not be a strong correlate for acceptance of vaccine in real life.

The study was also conducted in a predominantly uneducated population and the views reflected in the study may not resonate with a population that is more educated. However, the findings may help to shape vaccination policies in low-income, low education settings.

Overall, our study has highlighted the importance of the role played by both healthcare providers and family members, specifically the decision makers in the family. Recommendation by healthcare staff and permission by decision makers is a strong determinant of high vaccine acceptance. Future vaccine programs should target both sets of groups to increase vaccine uptake in the target population.

TABLES

Table 1: Demographic And Clinical Characteristics Of Pregnant Women By Intention To Accept Vaccine Against Influenza At 3 Health Centers In Korangi, Karachi, Pakistan (May-Aug 2013)

Variable	Sample (%) n=274	Intention to Accept Vaccine Yes (%) n=253	No (%) n=21	*P*	OR[a]	95% CI
Age (n=272)						
≥25 years[c]	149 (55%)	135 (54%)	14 (67%)		1	
<25 years	123 (45%)	116 (46%)	7 (33%)	0.26	1.72	0.67-4.40
Education (n=274)						
Below Secondary[c]	260 (95%)	239 (94%)	21 (100%)		1	
Secondary or Above	14 (5%)	14 (6%)	0 (0%)	0.27	2.6	0.15-45.16
Employment Status (n=259)						
Housewife[c]	219 (85%)	199 (84%)	20 (95%)		1	
Employed	40 (15%)	39 (16%)	1 (5%)	0.16	3.92	0.51-30.07
Socioeconomic Status[b] (n=272)						
Low[c]	121 (44%)	114 (45%)	7 (33%)		1	
Moderate	151 (56%)	137 (55%)	14 (67%)	0.29	0.6	0.23-1.54
Marital Status (n=273)						
Single or Divorced[c]	1 (0.4%)	1 (0.4%)	0 (0%)		1	
Married	272 (99.6%)	252 (99.6%)	20 (100%)	0.78	0.24	0.01-6.17
Ethnicity (n=272)						
Urdu[c]	56 (21%)	54 (22%)	2 (10%)		1	
Bengali	35 (13%)	29 (11%)	6 (29%)	0.03	0.18	0.03-0.94
Pashtun	48 (18%)	44 (18%)	4 (19%)	0.3	0.41	0.07-2.33
Sindhi	55 (20%)	51 (20%)	4 (19%)	0.39	0.47	0.08-2.69
Punjabi	31 (11%)	31 (11%)	0 (0%)	0.29	2.89	0.13-62.12
Other[d]	47 (17%)	42 (17%)	5 (24%)	0.16	0.31	0.06-1.68
First time Pregnancy (n=274)	50 (18%)	47 (19%)	3 (14%)	0.63	1.37	0.39-4.84
No. of children (n=207)						
One[c]	47 (23%)	46 (24%)	1 (6%)		1	
Two	49 (24%)	44 (23%)	5 (29%)	0.1	0.19	0.02-1.70
Three	34 (16%)	33 (17%)	1 (6%)	0.82	0.72	0.04-11.89
More	77 (37%)	67 (35%)	10 (60%)	0.04	0.15	0.02-1.18
Children Died of Illness (n=274)						
First pregnancy[c]	50 (18%)	47 (19%)	3 (14%)	0.44	1.54	0.43-5.61
Yes	68 (25%)	64 (25%)	4 (19%)	0.43	1.58	0.50-4.98
Trimester of Current Pregnancy (n=269)						
First or Second [c]	79 (29%)	76 (31%)	3 (15%)		1	
Third	190 (71%)	173 (69%)	17 (85%)	0.14	0.4	0.11-1.41

Table 1 continued on next page…

Table 1: Demographic And Clinical Characteristics Of Pregnant Women By Intention To Accept Vaccine Against Influenza At 3 Health Centers In Korangi, Karachi, Pakistan (May-Aug 2013)

Variable	Sample (%) n=274	Intention to Accept Vaccine		*P*	OR[a]	95% CI
		Yes (%) n=253	No (%) n=21			
Sought Antenatal Care During Current Pregnancy (n=262)	190 (73%)	178 (74%)	12 (60%)	0.19	1.85	0.72-4.74
Trimester When Antenatal Care First Sought (n=178)						
First[c]	62 (35%)	57 (34%)	5 (45%)		1	
Second	65 (37%)	61 (37%)	4 (36%)	0.68	1.34	0.34-5.23
Third	51 (29%)	49 (29%)	2 (18%)	0.37	2.15	0.40-11.57
Source of Antenatal Care (n=225)						
None[c]	20 (9%)	19 (9%)	1 (7%)		1	
Healthcare Staff	202 (89%)	188 (90%)	14 (93%)	0.74	0.71	0.09-5.67
Home	3 (1%)	3 (1%)	0 (0%)	0.7	0.54	0.02-16.08
General Health Problems in Current Pregnancy (n=265)	119 (45%)	110 (45%)	9 (45%)	0.99	1	0.40-2.49
Hospitalized During Current Pregnancy (n=261)	11 (4%)	10 (4%)	1 (5%)	0.9	0.87	0.11-7.14

[a] Unadjusted odds ratio comparing odds of pregnant women's intention to accept Influenza vaccine versus intending to not accept influence vaccine

[b] Determined based on ownership of house in the study area whereby low socioeconomic status corresponds to an inability to buy one's house whereas moderate socioeconomic status is determined by one's ability to own the house that she is currently living in

[c] Reference Group

[d] Other ethnicities include Burmese, Hindko, Brahui, Siraiki

Table 2: Vaccine Recommendation, Administration, And Influenza Disease Knowledge By Intention To Accept Vaccine Against Influenza Amongst Pregnant Women In Korangi, Karachi, Pakistan During May-Aug 2013

Variable	Sample (%) n=274	Intention to Accept Vaccine Yes (%) n=253	No (%) n=21	*P*	OR[a]	95% CI
Any vaccine recommended during current pregnancy (n=259)	202 (78%)	188 (79%)	14 (67%)	0.19	1.88	0.72-4.91
Tetanus vaccine recommended during current pregnancy (n=274)	127 (46%)	119 (47%)	8 (38%)	0.43	1.44	0.58-3.60
Received any vaccine during current pregnancy (n=263)	144 (55%)	138 (57%)	6 (29%)	0.01	3.32	1.24-8.84
Received tetanus vaccine during current pregnancy (n=274)	121 (44%)	114 (45%)	7 (33%)	0.30	1.64	0.64-4.20
Received DPT vaccine as a child or adolescent (n=272)	127 (47%)	121 (48%)	6 (29%)	0.08	2.33	0.87-6.19
Received any vaccine during previous pregnancy/ies (n=266)	38 (14%)	36 (15%)	2 (10%)	0.26	2.41	0.51-11.45
This is the first pregnancy	135 (51%)	127 (52%)	8 (38%)	0.11	2.13	0.82-5.52
Receive tetanus vaccine in any previous pregnancy/ies (n=132)	119 (90%)	112 (90%)	7 (100%)	0.37	0.56	0.03-10.28
Complication/s after receiving any vaccine in the past (n=137)	2 (1%)	2 (2%)	0 (0%)	0.72	0.33	0.01-7.51
Ever hospitalized for complications due to any vaccine (n=137)	1 (1%)	1 (1%)	0 (0%)	0.80	0.20	0.01-5.25
Planning to get any vaccines during current pregnancy (n=267)	224 (84%)	212 (86%)	12 (57%)	<0.01	4.68	1.83-11.94
Respondents who have ever heard of Influenza (n=274)	273 (99.6%)	252 (99.6%)	21 (100%)	0.77	3.91	0.15-99.03
Person who decides about seeking healthcare for family members (n=258)						
In Laws including husband[b]	228 (88%)	213 (89%)	15 (79%)		1.00	
Myself	17 (7%)	14 (6%)	3 (16%)	0.09	0.33	0.09-1.27
Family	8 (3%)	8 (3%)	0 (0%)	0.45	1.23	0.07-22.39
Both Husband and Wife	5 (2%)	4 (2%)	1 (5%)	0.24	0.28	0.03-2.68

[a] Unadjusted odds ratio comparing odds of pregnant women intending to accept vaccine against Influenza versus intending to not accept vaccine against Influenza

[b] Reference Group

Table 3. A set of Health Belief Model Dimensions in relation to Influenza vaccine acceptance in Pregnant Women in Korangi, Karachi, Pakistan

Respondents Who Thought That…	Sample (%) n=274	Intention to Accept Vaccine: Yes (%) n=253	Intention to Accept Vaccine: No (%) n=21	*P*	OR[a]	95% CI
A pregnant woman should be vaccinated against Influenza (n=271)	241 (89%)	232 (93%)	9 (43%)	<0.01	17.19	6.39-46.17
A pregnant woman should accept Influenza Vaccine because... (n=274)						
Doctor recommended it	168 (61%)	163 (64%)	5 (24%)	<0.01	5.8	2.06-16.34
Friend or relative recommended it	53 (19%)	50 (20%)	3 (14%)	0.54	1.48	0.42-5.21
If another Pregnant woman recommended it	21 (8%)	21 (8%)	0 (0%)	0.17	3.98	0.23-67.95
If there is an Influenza case in the country	18 (7%)	17 (7%)	1 (5%)	0.73	1.44	0.18-11.39
If there is an Influenza case in the neighborhood	17 (6%)	16 (6%)	1 (5%)	0.78	1.33	0.19-9.53
If there is an Influenza case in the city or province	17 (6%)	16 (6%)	1 (5%)	0.78	1.35	0.17-10.71
Any healthcare professional recommended it	1 (0.4%)	1 (0.40%)	0 (0%)	0.77	0.26	0.01-6.46
Pakistan Ministry of Health recommended it	1 (0.4%)	1 (0.40%)	0 (0%)	0.77	0.26	0.01-6.46
International Organization (e.g. WHO) recommended it	1 (0.4%)	1 (0.40%)	0 (0%)	0.77	0.26	0.01-6.46
If NGOs recommended it	0 (0%)	0 (0%)	0 (0%)			
If none of the above recommended it	1 (0.4%)	1 (0.4%)	0 (0%)	0.77	0.26	0.01-6.46
Other reasons[b]	22 (8%)	17 (7%)	5 (24%)	<0.01	0.23	0.08-0.71
A pregnant woman should refuse Influenza Vaccine because... (n=274)						
If her husband or household member does not authorize her to get the vaccine	85 (31%)	75 (30%)	10 (48%)	0.09	0.46	0.19-1.14
If she had concerns that the vaccine might cause harm to the pregnant women	47 (17%)	46 (18%)	1 (5%)	0.12	4.44	0.58-33.96
If she had concerns that the vaccine could be dangerous for the baby	42 (15%)	42 (17%)	0 (0%)	0.04	8.64	0.51-145.52
If she had concerns that the vaccine weakens the immune system	30 (11%)	30 (12%)	0 (0%)	0.1	5.87	0.35-99.36
If she believed that Influenza is not dangerous for herself	20 (7%)	20 (8%)	0 (0%)	0.18	3.78	0.22-64.61
If she believed that Influenza is not dangerous for the baby	20 (7%)	20 (8%)	0 (0%)	0.18	3.78	0.22-64.61
If she believed that the vaccine is not effective	17 (6%)	17 (7%)	0 (0%)	0.22	3.18	0.18-54.76
If she believed that it is better to suffer from natural disease than vaccination	2 (1%)	2 (1%)	0 (0%)	0.68	0.43	0.02-9.19
For ethnical or moral reasons	0 (0%)	0 (0%)	0 (0%)			
For religious beliefs	0 (0%)	0 (0%)	0 (0%)			
None of the above	3 (1%)	3 (1%)	0 (0%)	0.62	0.6	0.03-12.02
Other reasons[c]	45 (16%)	42 (17%)	3 (14%)	0.78	1.19	0.34-4.24

Table 3 continued on next page…

Table 3. A set of Health Belief Model Dimensions in relation to Influenza vaccine acceptance in Pregnant Women in Korangi, Karachi, Pakistan

Respondents Who Thought That…	Intention to Accept Vaccine					
	Sample (%) n=274	Yes (%) n=253	No (%) n=21	*P*	OR[a]	95% CI
It is likely for an unvaccinated pregnant woman to contract Influenza (n=268)	117 (44%)	113 (46%)	4 (19%)	0.02	3.58	1.17-10.96
A pregnant woman protected if she is vaccinated against Influenza (n=264)	206 (78%)	200 (82%)	6 (29%)	<0.01	11.63	4.26-31.69
It is safe for a pregnant woman to receive Influenza vaccine (n=263)	195 (74%)	191 (79%)	4 (19%)	<0.01	15.92	5.13-49.37
It is likely for a baby to acquire Influenza? (n=269)	203 (75%)	194 (78%)	9 (43%)	<0.01	4.79	1.92-11.96
A baby is protected if his/her mother received an Influenza vaccine during pregnancy (n=270)	219 (81%)	211 (85%)	8 (38%)	<0.01	9.02	3.50-23.24

[a] Unadjusted odds ratio comparing odds of pregnant women intending to accept vaccine against Influenza versus intending to not accept vaccine against Influenza

[b] Recommendation: For me and my child's safety (1), If doctor prefers (1), family/husband gives permission (13), if she is sick (1), if vaccine is not harmful (2). If she is satisfied and not afraid of the vaccine (1)

[c] Objection: Fear injection pain (1), if vaccine is not harmful (14), if injection is harmful (1), if place is too far (1), afraid of vaccination (10)

FIGURES

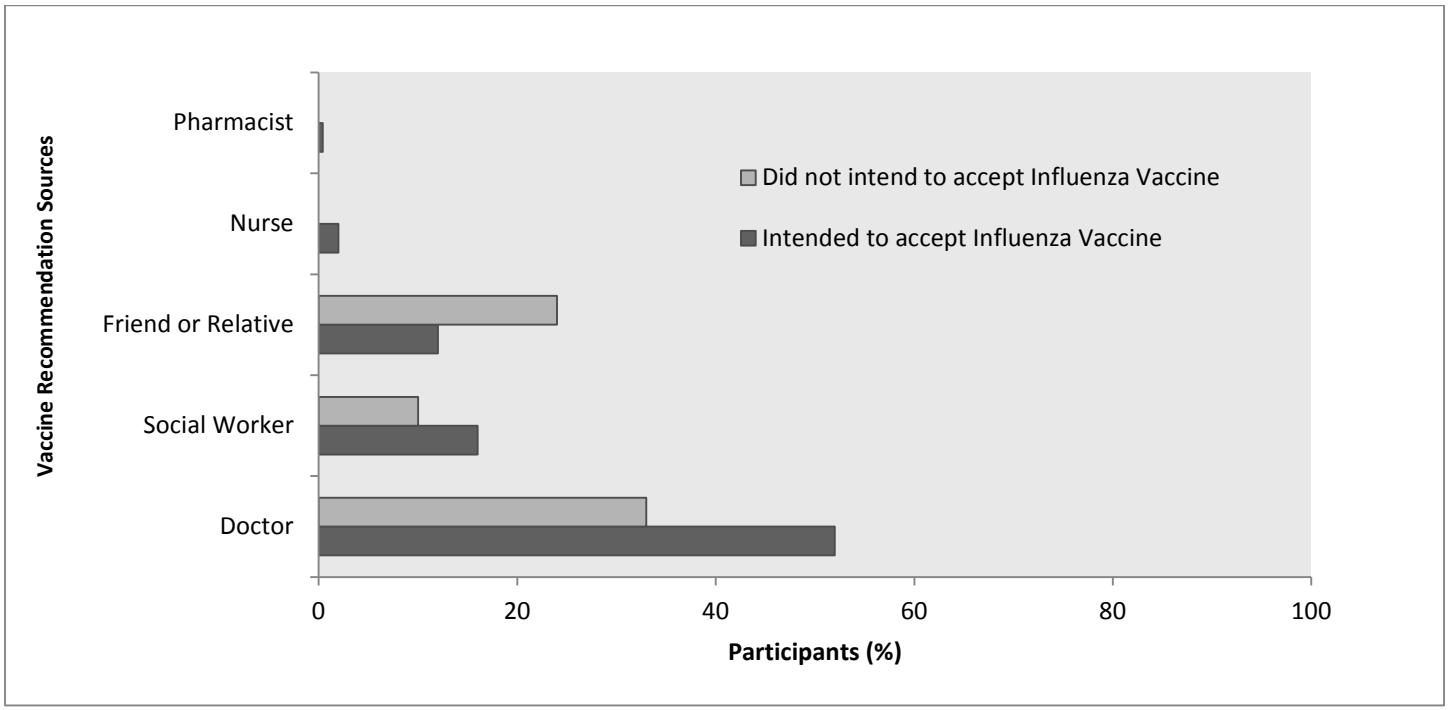

Figure 1 Different Vaccine Recommendation Sources for Pregnant Women in Korangi Industrial Area in Karachi, Pakistan during May-Aug 2013

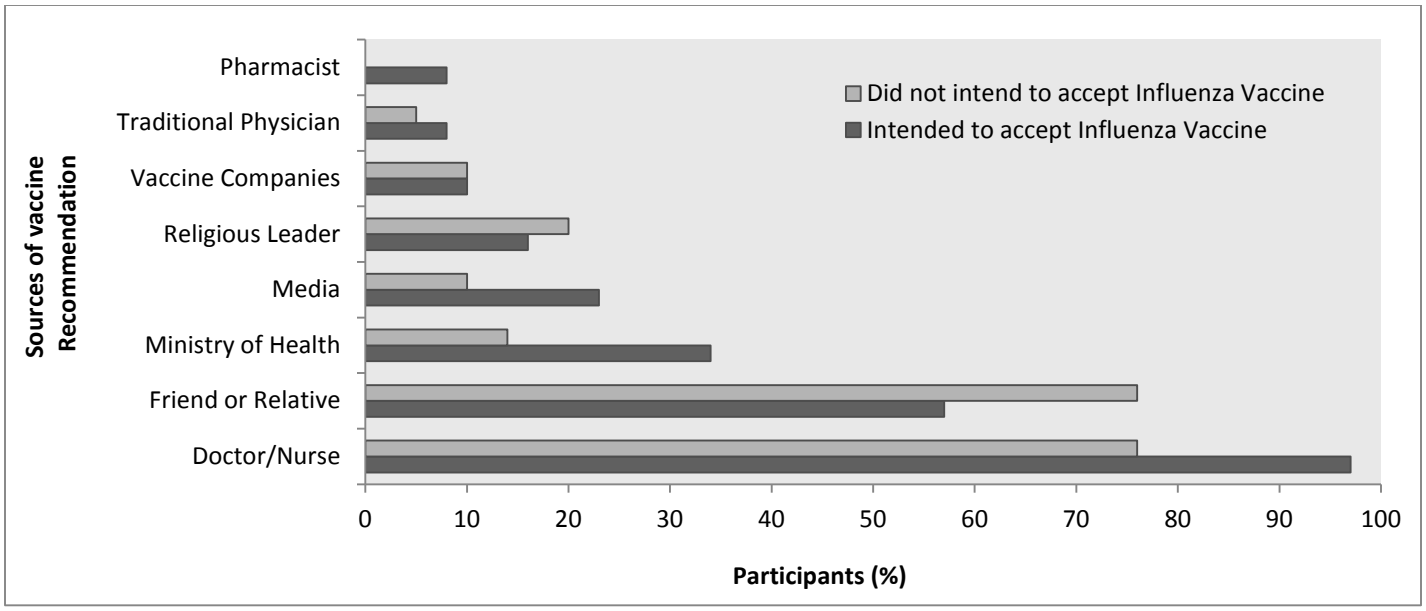

Figure 2 Reliability of Sources of Vaccine Recommendation as ranked by the pregnant women in Korangi Industrial Area, Pakistan during May-Aug 2013

CHAPTER 3: PUBLIC HEALTH IMPLICATIONS

Given the magnitude of the impact of Influenza related morbidity and mortality, it is pertinent to explore effective strategies to tackle the problem that includes vaccination. Our study highlights the importance of working with healthcare providers to increase vaccine acceptance. Pregnant women look favorably upon physicians including OB-GYN, pediatricians, etc. and trust their recommendation with regards to vaccination more than any other recommendation source. Healthcare providers can also play an important role in dispelling any myths or fears that pregnant women may have about the Influenza vaccine. Though pregnant women in our study had high perceived vaccine safety and efficacy, a sizeable minority also shared their fears about the vaccines and its perceived harmful effects for their infants or themselves during pregnancy. Our study thus goes far and beyond potential vaccine acceptance and opens avenues for vaccine program planners where they may be able to intervene and strengthen such programs. Healthcare providers are one such option for public health professionals. There is a need to educate healthcare providers about Influenza vaccines, their potential side effects, and the benefits associated with vaccination. This increased knowledge on the part of healthcare providers can be utilized to deal with any misperceptions that pregnant women and their families may have about vaccinations.

In addition to healthcare providers, future vaccine acceptance efforts should target decision makers in the family including parents-in-law and husbands, where possible. In a majority of the respondent's homes, adults including parents-in-law and husbands take decisions regarding healthcare. Their permission determines much of the healthcare seeking behavior in pregnant women. It is thus important to educate these key decision makers in vaccine awareness programs. Without proper education and guidance, we will not be able to mold their attitudes

regarding vaccinations and hence, our vaccine programs that solely target pregnant women may not garner as much success.

While quantitative study can only gather so much information regarding facilitators and barriers to future vaccination programs, future research should include focus group discussions and in-depth interviews with both healthcare providers and pregnant women. This would help in shedding light on the complicated nature of what goes into deciding between different factors about vaccination. Discussion with healthcare providers would tap into their knowledge based on their experience with existing vaccinations and their personal attitudes including their perceived facilitators and barriers to Influenza vaccination programs.

The findings of our study sheds light on the importance of different factors that need to be incorporated in future vaccine programs. Permission from family members and recommendation from healthcare providers are two important limiting factors in vaccine acceptance. We, in the field of public health, need to pay attention to the reality on the ground and work with the existing norms. Instead of revamping the entire system, we need to work with the existing hierarchical family structures and talk to the decision makers and work on changing their attitudes towards immunization. The framing of messages is vital in this regard. Earlier studies have emphasized on positive messages to influence attitudes. The benefit of high vaccine uptake in pregnant women is two-fold in that it protects both the women and their infants against potentially deadly diseases. Since both pregnant women and infants are high risk groups for influenza related morbidity and mortality, much of the suffering and death can be eliminated with vaccination. Our formative research may help GAVI and other organizations for a stronger

push towards maternal immunization and incorporating effective strategies to enhance vaccine acceptance.

REFERENCES

1. Widdowson, M.-A., *<Lecture 9 - MAW Vaccines against Seasonal and Pandemic Influenza 2013 10 25 - 1 slide.pdf>*. 2013, Emory University.
2. *Key Facts about Influenza (Flu) & Flu Vaccine*. 2013 [cited 2013 25 December]; Available from: http://www.cdc.gov/flu/keyfacts.htm.
3. Brankston, G., et al., *Transmission of influenza A in human beings.* Lancet Infect Dis, 2007. **7**(4): p. 257-65.
4. Organization, W.H. *<GIP_InfluenzaVirusInfectionsHumans_Jul13.pdf>*. 2013.
5. Webster, R.G., *Influenza*, in *Brenner's Encyclopedia of Genetics (Second Edition)*, S. Maloy and K. Hughes, Editors. 2013, Academic Press: San Diego. p. 75-76.
6. *WHO Influenza Factsheet 211: Prevention and control of influenza pandemics and annual epidemics April 2009.* 2010 [cited 2014 14th April]; Available from: http://www.who.int/mediacentre/factsheets/fs211/en/.
7. Jain, S., et al., *Hospitalized Patients with 2009 H1N1 Influenza in the United States, April–June 2009.* New England Journal of Medicine, 2009. **361**(20): p. 1935-1944.
8. Ferguson, N.M., et al., *Strategies for containing an emerging influenza pandemic in Southeast Asia.* Nature, 2005. **437**(7056): p. 209-214.
9. Control, C.f.D. and Prevention, *Prevention and control of seasonal influenza with vaccines. Recommendations of the Advisory Committee on Immunization Practices--United States, 2013-2014.* MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports/Centers for Disease Control, 2013. **62**(RR-07): p. 1.
10. Izurieta, H.S., et al., *Influenza and the Rates of Hospitalization for Respiratory Disease among Infants and Young Children.* New England Journal of Medicine, 2000. **342**(4): p. 232-239.
11. Neuzil, K.M., et al., *The Effect of Influenza on Hospitalizations, Outpatient Visits, and Courses of Antibiotics in Children.* New England Journal of Medicine, 2000. **342**(4): p. 225-231.
12. Thompson, W.W., et al., *MOrtality associated with influenza and respiratory syncytial virus in the united states.* JAMA, 2003. **289**(2): p. 179-186.
13. Neuzil, K.M., C. Hohlbein, and Y. Zhu, *Illness among schoolchildren during influenza season: effect on school absenteeism, parental absenteeism from work, and secondary illness in families.* Archives of pediatrics & adolescent medicine, 2002. **156**(10): p. 986.
14. Riddiough, M.A., J.E. Sisk, and J.C. Bell, *Influenza vaccination: Cost-effectiveness and public policy.* JAMA, 1983. **249**(23): p. 3189-3195.
15. Schoenbaum, S.C., *Economic impact of influenza. The individual's perspective.* Am J Med, 1987. **82**(6a): p. 26-30.
16. Kilbourne, E.D., *Influenza Pandemics of the 20th Century* Emerging Infectious Diseases, January 2006 **12**(1).
17. Taubenberger, J. and D. Morens, *1918 Influenza: the Mother of All Pandemics* Emerging Infectious Diseases, January 2006. **12**(1).
18. Kilbourne, E.D., *Influenza pandemics: can we prepare for the unpredictable?* Viral Immunol, 2004. **17**(3): p. 350-7.
19. *Recommended composition of influenza virus vaccines for use in the 2014-2015 northern hemisphere influenza season*. 2014; Available from: http://www.who.int/influenza/vaccines/virus/recommendations/201402_recommendation.pdf?ua=1.
20. Centers for Disease Control and Prevention, *Prevention and Control of Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices (ACIP), 2010.* MMWR 2010. **59**.

21. Prevention, C.f.D.C.a., *Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices — United States, 2013–2014.* Morbidity and Mortality Weekly Report (MMWR), September 20, 2013. **62**(RR07): p. 1-43.
22. Anderson, R.M., *The concept of herd immunity and the design of community-based immunization programmes.* Vaccine, 1992. **10**(13): p. 928-935.
23. Plans-Rubió, P., *The vaccination coverage required to establish herd immunity against influenza viruses.* Preventive Medicine, 2012. **55**(1): p. 72-77.
24. Jefferson, T., et al., *Vaccines for preventing influenza in healthy children.* Cochrane Database Syst Rev, 2008. **2**(2).
25. Allison, M.A., et al., *Influenza vaccine effectiveness in healthy 6-to 21-month-old children during the 2003-2004 season.* The Journal of pediatrics, 2006. **149**(6): p. 755-762. e1.
26. Armstrong, P., et al., *Epidemiological study of severe febrile reactions in young children in Western Australia caused by a 2010 trivalent inactivated influenza vaccine.* BMJ open, 2011. **1**(1).
27. Control, C.f.D. and Prevention, *Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP)--United States, 2012-13 influenza season.* MMWR. Morbidity and mortality weekly report, 2012. **61**(32): p. 613.
28. Freeman, D. and A. Barno, *Deaths from Asian influenza associated with pregnancy.* Obstetrical & Gynecological Survey, 1960. **15**(2): p. 212-213.
29. MARTIN, C.M., et al., *Asian influenza A in Boston, 1957-1958: II. Severe staphylococcal pneumonia complicating influenza.* Archives of Internal Medicine, 1959. **103**(4): p. 532.
30. Jamieson, D.J., et al., *H1N1 2009 influenza virus infection during pregnancy in the USA.* The Lancet, 2009. **374**(9688): p. 451-458.
31. Goodnight, W.H. and D.E. Soper, *Pneumonia in pregnancy.* Critical care medicine, 2005. **33**(10): p. S390-S397.
32. Jamieson, D., R. Theiler, and S. Rasmussen, *Emerging infections and pregnancy.* Emerg Infect Dis, 2006. **12**: p. 1638 - 1643.
33. Kort, B.A., R.C. Cefalo, and V.V. Baker, *Fatal influenza A pneumonia in pregnancy.* American journal of perinatology, 1986. **3**(03): p. 179-182.
34. Baker, D.A., *Viral diseases in pregnancy.* Clinical Obstetrics and Gynecology, 1990. **33**(2): p. 217.
35. Jamieson, D., et al., *H1N1 2009 influenza virus infection during pregnancy in the USA.* Lancet, 2009. **374**: p. 451 - 458.
36. Creanga, A., et al., *Severity of 2009 pandemic influenza A (H1N1) virus infection in pregnant women.* Obstet Gynecol, 2010. **115**: p. 717 - 726.
37. Siston, A., et al., *Pandemic 2009 influenza A(H1N1) virus illness among pregnant women in the United States.* JAMA, 2010. **303**: p. 1517 - 1525.
38. Neuzil, K.M., et al., *Impact of influenza on acute cardiopulmonary hospitalizations in pregnant women.* American journal of epidemiology, 1998. **148**(11): p. 1094-1102.
39. Schanzer, D., J. Langley, and T. Tam, *Influenza-attributed hospitalization rates among pregnant women in Canada 1994-2000.* J Obstet Gynaecol Can, 2007. **29**: p. 622 - 629.
40. Reuman, P.D., et al., *Maternal-infant transfer of influenza-specific immunity in the mouse.* J Immunol, 1983. **130**(2): p. 932-6.
41. Mbawuike, I.N., et al., *Vaccination with inactivated influenza A virus during pregnancy protects neonatal mice against lethal challenge by influenza A viruses representing three subtypes.* Journal of virology, 1990. **64**(3): p. 1370-1374.
42. Munoz, F.M. and J.A. Englund, *Vaccines in pregnancy.* Infectious disease clinics of North America, 2001. **15**(1): p. 253-271.

43. Groothuis, J.R., et al., *Immunization of high-risk infants younger than 18 months of age with split-product influenza vaccine.* Pediatrics, 1991. **87**(6): p. 823-828.
44. Munoz, F.M. and J.A. Englund, *A step ahead: infant protection through maternal immunization.* Pediatric Clinics of North America, 2000. **47**(2): p. 449-463.
45. Sumaya, C.V. and R.S. Gibbs, *Immunization of pregnant women with influenza A/New Jersey/76 virus vaccine: reactogenicity and immunogenicity in mother and infant.* Journal of Infectious Diseases, 1979. **140**(2): p. 141-146.
46. Bridges, C.B., et al., *Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP).* MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports/Centers for Disease Control, 2003. **52**(RR-8): p. 1-34; quiz CE1-4.
47. Kohler, P.F. and R.S. Farr, *Elevation of cord over maternal IgG immunoglobulin: evidence for an active placental IgG transport.* 1966.
48. Hobbs, J.R. and J.A. Davis, *Serum gamma-G-globulin levels and gestational age in premature babies.* Lancet, 1967. **1**(7493): p. 757-9.
49. Sweet, C., K.J. Jakeman, and H. Smith, *Role of milk-derived IgG in passive maternal protection of neonatal ferrets against influenza.* J Gen Virol, 1987. **68 (Pt 10)**: p. 2681-6.
50. Zaman, K., et al., *Effectiveness of maternal influenza immunization in mothers and infants.* New England Journal of Medicine, 2008. **359**(15): p. 1555-1564.
51. Benowitz, I., et al., *Influenza Vaccine Given to Pregnant Women Reduces Hospitalization Due to Influenza in Their Infants.* Clinical Infectious Diseases, 2010. **51**(12): p. 1355-1361.
52. Mak, D.B., et al., *Pandemic (H1N1) 2009 influenza vaccination coverage in Western Australia.* Med J Aust, 2010. **193**(7): p. 401-4.
53. Bone, A., et al., *Population and risk group uptake of H1N1 influenza vaccine in mainland France 2009–2010: results of a national vaccination campaign.* Vaccine, 2010. **28**(51): p. 8157-8161.
54. Mereckiene, J., et al., *Influenza A (H1N1) pdm09 vaccination policies and coverage in Europe.* 2012.
55. Ozer, A., et al., *Status of pandemic influenza vaccination and factors affecting it in pregnant women in Kahramanmaras, an eastern Mediterranean city of Turkey.* PLoS One, 2010. **5**(12): p. e14177.
56. Sammon, C.J., et al., *Pandemic influenza vaccination during pregnancy: An investigation of vaccine uptake during the 2009/10 pandemic vaccination campaign in Great Britain.* Human vaccines & immunotherapeutics, 2013. **9**(4): p. 917-923.
57. Wiley, K.E., et al., *Uptake of influenza vaccine by pregnant women: a cross-sectional survey.* Med J Aust, 2013. **198**(7): p. 373-5.
58. Fabry, P., A. Gagneur, and J.-C. Pasquier, *Determinants of A (H1N1) vaccination: cross-sectional study in a population of pregnant women in Quebec.* Vaccine, 2011. **29**(9): p. 1824-1829.
59. Yuet Sheung Yuen, C., et al., *Prevalence and predictors of maternal seasonal influenza vaccination in Hong Kong.* Vaccine, 2013. **31**(45): p. 5281-5288.
60. Control, C.f.D. and Prevention, *Influenza vaccination coverage among pregnant women-United States, 2012-13 influenza season.* MMWR. Morbidity and mortality weekly report, 2013. **62**(38): p. 787.
61. Fiore, A.E., et al., *Prevention and control of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2008.* MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports/Centers for Disease Control, 2008. **57**(RR-7): p. 1-60.
62. Ahluwalia, I.B., et al., *Seasonal influenza vaccine coverage among pregnant women: pregnancy risk assessment monitoring system.* Journal of women's health, 2011. **20**(5): p. 649-651.

63. Nguyen, T., et al., *Acceptance of a pandemic influenza vaccine: a systematic review of surveys of the general public.* Infection and Drug Resistance, 2011. **4**: p. 197.
64. Janz, N.K. and M.H. Becker, *The Health Belief Model: A Decade Later.* Health Education & Behavior, 1984. **11**(1): p. 1-47.
65. Hilyard, K.M., et al., *Determinants of Parental Acceptance of the H1N1 Vaccine.* Health Educ Behav, 2013.
66. Control, C.f.D. and Prevention, *Influenza vaccination coverage among pregnant women-29 States and New York City, 2009-10 season.* MMWR. Morbidity and mortality weekly report, 2012. **61**(7): p. 113.
67. Yeager, D.P., E.C. Toy, and B. Baker III, *Influenza vaccination in pregnancy.* American journal of perinatology, 1999. **16**(06): p. 283-286.
68. Silverman, N.S. and A. Greif, *Influenza vaccination during pregnancy. Patients' and physicians' attitudes.* The Journal of reproductive medicine, 2001. **46**(11): p. 989-994.
69. Beel, E.R., et al., *Knowledge and attitudes of postpartum women toward immunization during pregnancy and the peripartum period.* Hum Vaccin Immunother, 2013. **9**(9): p. 1926-31.
70. Silverman, N. and A. Greif, *Influenza vaccination during pregnancy. Patients' and physicians' attitudes.* J Reprod Med, 2001. **46**: p. 989 - 994.
71. Marsh, H.A., et al., *Message Framing Strategies to Increase Influenza Immunization Uptake Among Pregnant African American Women.* Matern Child Health J, 2013.
72. Wray, R.J., et al., *How can you improve vaccination rates among older African Americans?* J Fam Pract, 2007. **56**(11): p. 925-9.
73. Wray, R.J., et al., *Influenza vaccination concerns among older blacks: a randomized controlled trial.* Am J Prev Med, 2009. **36**(5): p. 429-434.e6.
74. Freimuth, V.S., et al., *Trust During the Early Stages of the 2009 H1N1 Pandemic.* Journal of Health Communication, 2013: p. 1-19.
75. Ortiz, J.R., J.A. Englund, and K.M. Neuzil, *Influenza vaccine for pregnant women in resource-constrained countries: A review of the evidence to inform policy decisions.* Vaccine, 2011. **29**(27): p. 4439-4452.
76. Black, R.E., S.S. Morris, and J. Bryce, *Where and why are 10 million children dying every year?* Lancet, 2003. **361**(9376): p. 2226-34.
77. *Immunization in Pakistan*. 2010, Pakistan Institute of Legislative Development and Transparency.
78. Badar, N., et al., *Influenza Virus Surveillance in Pakistan during 2008-2011.* PLoS ONE, 2013. **8**(11): p. e79959.
79. Ali, S.A., et al., *Pandemic influenza A (H1N1) pdm09: An unrecognized cause of mortality in children in Pakistan.* Scandinavian journal of infectious diseases, 2013. **45**(10): p. 791-795.
80. *Fluarix - Inactivated split influenza vaccine*. 2011 24th November 2011 [cited 2014 14th April]; Available from: http://www.pakreviews.com/health-beauty/update/fluarix-inactivated-split-influenza-vaccine.
81. *Expanded Programme on Immunization*. Pakistan 2014 [cited 2014 14th April]; Available from: http://www.emro.who.int/pak/programmes/expanded-programme-on-immunization.html.
82. National Institute of population Studies Islamabad, P., *Pakistan Demographic and Health Survey 2006-07*. 2008: Macro International.
83. UNICEF., *State of the World's Children: Celebrating 20 Years of the Convention on the Rights of the Child*. 2009: Unicef.
84. Usman, H.R., et al., *Redesigned immunization card and center-based education to reduce childhood immunization dropouts in urban Pakistan: a randomized controlled trial.* Vaccine, 2009. **27**(3): p. 467-472.

85. Babalola, S. and U. Lawan, *Factors predicting BCG immunization status in northern Nigeria: a behavioral-ecological perspective.* Journal of Child Health Care, 2009. **13**(1): p. 46-62.
86. Owino, L., et al., *Factors influencing immunisation coverage in Mathare Valley, Nairobi.* East African medical journal, 2009. **86**(7).
87. Tadesse, H., A. Deribew, and M. Woldie, *Predictors of defaulting from completion of child immunization in south Ethiopia, May 2008–A case control study.* BMC Public Health, 2009. **9**(1): p. 150.
88. Joseph, A., et al., *Improving immunization coverage.* World Health Forum, 1988. **9**(3): p. 336-40.
89. Freeman, P., J. Thomason, and G. Bukenya, *Factors affecting the use of immunization among urban settlement dwellers in Papua New Guinea.* Papua and New Guinea medical journal, 1992. **35**(3): p. 179-185.
90. Chhabra, P., et al., *Immunization in urbanized villages of Delhi.* The Indian Journal of Pediatrics, 2007. **74**(2): p. 131-134.
91. Maekawa, M., et al., *Factors affecting routine immunization coverage among children aged 12-59 months in Lao PDR after regional polio eradication in western Pacific region.* Bioscience trends, 2007. **1**(1): p. 43.
92. Phukan, R.K., M.P. Barman, and J. Mahanta, *Factors associated with immunization coverage of children in Assam, India: over the first year of life.* Journal of tropical pediatrics, 2009. **55**(4): p. 249-252.
93. *Background Paper on Influenza Vaccines and Immunization SAGE Working Group*. 2012.
94. Wong, V., D. Fong, and M. Tarrant, *Brief education to increase uptake of influenza vaccine among pregnant women: a study protocol for a randomized controlled trial.* BMC Pregnancy and Childbirth, 2014. **14**(1): p. 19.
95. Rudan, I., et al., *Epidemiology and etiology of childhood pneumonia.* Bulletin of the World Health Organization, 2008. **86**(5): p. 408-416B.
96. *Pakistan Demographic and Healthy Survey*. 2013, National Institute of Population Studies .
97. Siddiqui, N.T., et al., *Ethnic Disparities in Routine Immunization Coverage A Reason for Persistent Poliovirus Circulation in Karachi, Pakistan?* Asia-Pacific Journal of Public Health, 2014. **26**(1): p. 67-76.
98. Khowaja, A.R., et al., *Parental perceptions surrounding polio and self-reported non-participation in polio supplementary immunization activities in Karachi, Pakistan: a mixed methods study.* Bulletin of the World Health Organization, 2012. **90**(11): p. 822-830.
99. Varan, A.K., et al., *Intention to accept< i> Bordetella pertussis</i> booster vaccine during pregnancy in Mexico City*. Vaccine, 2014.
100. *Influenza vaccination coverage among pregnant women --- United States, 2010-11 influenza season.* (1545-861X (Electronic)).
101. Ding, H., et al., *Influenza vaccination coverage among pregnant women–National 2009 H1N1 Flu Survey (NHFS).* American journal of obstetrics and gynecology, 2011. **204**(6): p. S96-S106.
102. Ahluwalia, I.B., et al., *Correlates of seasonal influenza vaccine coverage among pregnant women in Georgia and Rhode Island.* Obstetrics & Gynecology, 2010. **116**(4): p. 949-955.