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Jose Fernando Echaiz Date

UNINTENDED PREGNANCY AND INADEQUATE
ROTAVIRUS IMMUNIZATION
IN PERUVIAN CHILDREN

BY

Jose Fernando Echaiz
Degree to be awarded: M.P.H.
Executive MPH

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Jose Fernando Echaiz
M.P.H., Emory University, 2016
M.D., Universidad Peruana Cayetano Heredia, 2004

Thesis Committee Chair: Vijaya Kancherla, PhD

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 of the degree of
Master of Public Health in the Executive MPH program
2016

Abstract

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Jose Fernando Echaiz

Introduction: Rotavirus is the most common cause of preventable severe diarrhea affecting children aged 5 years or less in the world, including Latin America. Unintended pregnancy is associated with adverse maternal and child outcomes, including inadequate immunizations.

Objective: To estimate the association between unintended pregnancy and inadequate rotavirus immunization in Peruvian children.

Methods: We conducted a secondary data analysis of Demographic and Health Survey (DHS) data from Peru, 2012. Multivariate logistic regression was conducted to determine the association of unintended pregnancy and inadequate rotavirus immunization. Unadjusted and adjusted odds ratios and their 95% confidence intervals are reported. Interaction between unintended pregnancy and other variables was assessed using Breslow-Day test.

Results: A total of 9,620 children were born in the preceding 5 years of the survey and, of them, 175 (1.74%) had died before the time of the survey. Among 9,445 alive children at the time of the survey, 51.1% were male. In total, 5,187 children (55.6%, 95% CI 54.1 – 57) had inadequate rotavirus vaccination. Unintended pregnancy was not associated with inadequate rotavirus vaccination on unadjusted analysis. There was a significant interaction between unintended pregnancy and maternal literacy status (p=0.006). Multivariate logistic regression showed that in illiterate women, children from unintended pregnancies had 2.3 times the odds of inadequate rotavirus vaccination compared to children from intended pregnancies. Also, inadequate polio (aOR 5.93, 95%CI 3.54 – 9.92), pneumococcal (aOR 6.28, 95%CI 5.02 – 7.86) and influenza (aOR 2.28, 95%CI 1.83 – 2.84) vaccinations, television in the household (aOR 1.35, 95%CI 1.09 – 1.67), and children whose mothers had only primary education (aOR 1.35, 95%CI 1.001 – 1.83) were independent predictors of inadequate rotavirus immunization. Breastfeeding education was associated with lower odds of inadequate rotavirus immunization (aOR 0.81 95%CI 0.67 – 0.99). There was no association between unintended pregnancy and rotavirus immunization in children of literate women.

Conclusions: Our findings indicate that literacy is an important factor that could mitigate the known adverse consequences of unintended pregnancy, particularly for child health outcomes. They also indicate that vaccination compliance may be highly interdependent when vaccinations are given in close proximity and that breastfeeding education has an impact on childhood rotavirus immunization.

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I dedicate this work to my home country Peru and all its people, especially my family.

I would like to thank Dr. Vijaya Kancherla and Dr. Magaly Blas for their support and for their dedication to maternal and child health. I am happy to have worked with professionals that are great at what they do.

I am forever grateful for my wife Theresa, who spent countless hours by my side watching me complete assignments over the last 3 years.

Finally, to my patients. They also motivate me to enrich my academic life and be a great doctor to them.

Table of Contents

I. Introduction

Infection with Rotavirus, an RNA virus, is the most common cause of severe diarrhea affecting children aged 5 years or less in the world.[1] This disease is a leading cause of death around the world, and in Latin America and the Caribbean alone it causes approximately 15,000 deaths, 75,000 hospitalizations, and 2 million clinic visits annually.[2] Rotavirus infection is preventable, and the World Health Organization (WHO) recommended the inclusion of rotavirus vaccine in the immunization schedule of Europe and the Americas in 2007, and expanded the recommendation to all infants aged <32 weeks worldwide in 2009.[3] Despite the improvements in morbidity and mortality seen after the introduction of the vaccine, Rotavirus remains an important cause of morbidity and mortality in children. Data from the WHO shows that by 2014, rotavirus vaccine had been introduced in 74 (38%) countries and that coverage with this vaccination was 19% globally, but the Americas had the highest coverage rate with 71%.[4] Non-immunization of children continues to be a public health problem worldwide, especially in developing countries. Many factors such as unemployment, birth order, low birth weight, poor prenatal care, have been found to be associated with incomplete basic immunization of a child, including unwanted pregnancy.[5] However, the exact nature of the association between unintended pregnancy and inadequate rotavirus immunization has been largely under researched, especially in low-income countries such as Peru. Pregnancy intention, specifically unwanted pregnancy is associated with a greater pregnancy risk and adverse child outcomes than those that are wanted.[6] The purpose of this research is to examine the association of self-reported pregnancy intention with inadequate rotavirus immunization, using nationally representative Demographic Health Survey data from the year 2012.

II. Background information and literature review

Global Epidemiology and burden of Rotavirus infection

Since its discovery in 1973, rotavirus has been the target of extensive research that confirmed rotavirus as the single most common cause of severe acute diarrhea leading to dehydration in young children worldwide.[7] Although the epidemiology of rotavirus infection varies by geographical location, globally rotavirus is responsible for approximately 111 million episodes of gastroenteritis requiring only home care, 25 million clinic visits, 2 million hospitalizations, and between 352,000 and 592,000 deaths per year in children <5 years of age.[8] There is no doubt that rotavirus has the attention of public health and global health experts around the world as it represents a major preventable cause of death in the pediatric population. It is estimated that 37% of the 578 000 diarrheal deaths in children under the age of 5 in 2013 were due to rotavirus, and that four countries (Democratic Republic of Congo, India, Nigeria and Pakistan) accounted for almost 50% of all rotavirus deaths in 2013.[1] In addition, more than 90% of rotavirus-related deaths occurred in countries eligible for Global Alliance for Vaccines and Immunization (GAVI) support. Rotavirus also results in a financial burden worldwide. Information derived from studies done in developed countries shows that for example in Canada, the estimated annual healthcare cost for rotavirus-related emergency department (ED) visits and added societal/parental costs ranges between $8.9 and $18.4 million; in Europe each year, Rotavirus incurred $0.54- $53.6 million in direct medical costs and $1.7-$22.4 million in indirect costs in 16 countries studied; and in the United States a study showed a pre-vaccine estimated annual national cost of $91 million and a post-vaccine estimated annual national cost of $31 million.[9-11] In developing countries the impact is more dramatic, and every year Rotavirus gastroenteritis results in 27 million hospital and outpatient visits and 527,000 deaths among children less than 5 years of age, with an estimated treatment cost of $325 million and total societal costs of $423 million.[12] Therefore, being a preventable disease of high financial burden, working towards its control through vaccination seems intuitively cost-effective. Rotavirus vaccine is readily available in many countries, however, several developing countries in Africa, Eastern Europe, the Middle East, and Asia where vaccination is not available continue to suffer from this disease. Although the available vaccines have been found to have lower efficacy (50%–64%) against severe Rotavirus gastroenteritis compared to developed countries, the effect on prevention of severe Rotavirus gastroenteritis are greater for developing countries than developed countries.[13]

Rotavirus in Latin America and Peru

The assessment of the burden of rotavirus disease in Latin American region has been tinkered by a lack of rotavirus diagnostic capacity and variable case definitions. Models used to assess the burden of rotavirus in Latin America have used prevalence data in children hospitalized due to diarrhea, data that come from studies in countries with similar per capita income or mortality. However, the most recent evidence from a surveillance network for hospitalizations due to diarrhea in Latin American and the Caribbean using standardized definitions and diagnostic assays by the Pan American Health Organization (PAHO) from 2005 to 2007 showed that the median percentage of positive stool specimens among 11 countries was 31.5% (range, 24%–47%) and that the mortality risk from Rotavirus in children under the age of 5 was 1 in 2874.[14] Unfortunately, this surveillance network did not include data from Peru.

A recent meta-analysis found that the proportion of gastroenteritis cases due to rotavirus in Latin America and the Caribbean was 24.3% (95%CI 22.3–26.4) and the incidence of rotavirus gastroenteritis (RVGE) was 170 per 1000 children-years (95%CI 130–210), with an estimated annual mortality for 22 countries of 88.2 deaths per 100 000 children under 5 years (95%CI 79.3–97.1), an equivalent of 47,000 deaths).[15]

In 2004, the World Health Organization (WHO) estimated the mortality due to rotavirus in Peru to be 691 child deaths, with a mortality rate of 23 deaths per 100,000 children less than 5 years.[16] In Peru, one of earliest published studies revealed that in a longitudinal study from 1982 to 1984 in an underprivileged community in the capital, rotavirus was responsible for only 2.5% of cases of diarrhea in children aged less than 1 year.[17] A review of published and unpublished reports in the pre-vaccination era used to estimate the burden of disease in Peru found that rotavirus infection causes 384,000 cases of gastroenteritis, 64,000 clinic visits, 30,000 hospitalizations, and 1,600 deaths annually.[18] It concluded that by 5 years of age, more than 63% of Peruvian children will have suffered from RVGE, with 1 in 10 seeking care at a clinic, 1 in 20 hospitalized, and about 1 in 375 succumbing to the disease. Another study in a single hospital from Lima, the capital of Peru, from 2008 to 2009 revealed 33.3% hospitalized pediatric patients aged less than 5 years tested positive for rotavirus.[19] In the post-vaccination era, a prospective study in one district of the capital found a lower number of cases with 8.2% (26 of 316) in 2008, 4.1% (15 of 362) in 2009, and 2.4% (11 of 450) in 2010.[20] This study, although small and not representative, suggested a beneficial impact of the introduction of the rotavirus vaccine in the pediatric immunization schedule. A more recent study in a rural area of the country that used hospitalized patients determined that 35.9% tested positive for rotavirus using RNA gene amplification by PCR.

The financial burden of rotavirus infection in Latin America identified in a systematic review in 2011 showed that, in Peru, the inpatient cost was estimated at US$ 7.5 per case; yet another study estimated US$53.51 per inpatient day and US$12.03 for outpatient visits.[21] In this systematic review, however, Peru was notably inconspicuous due to the lack of research about both medical and non-medical economic burden of rotavirus compared to other countries in the region. However, prior to the introduction of the vaccine in the Peruvian schedule, a cost-effectiveness model estimated that a flexible rotavirus vaccine program could prevent 2227 deaths due to rotavirus disease, 2.5 million cases of rotavirus gastroenteritis, 1 million outpatient visits, and 116,000 inpatient admissions during 2009-2024.[22]

Rotavirus Vaccination in Peru

In 2008, the Minister of Health decided to include rotavirus, pneumococcal, and influenza vaccines in the country's recommended immunization program. Rotavirus and pneumococcal vaccine were introduced together in 2009. Rotavirus vaccination was to be given at ages 2 and 4 months. The vaccine coverage was 41% in 2009 and increased to 75% in 2010, putting Peru second only to Guatemala whereas other countries in the region considered high mortality under WHO (stratum D) had higher coverage rates: Bolivia (76%), Ecuador (97%) and Nicaragua (98%).[16,23] In 2009, Peru began reporting rotavirus diarrhea and bacterial pneumonia and meningitis. However, new studies on the coverage of rotavirus vaccine after 2010 are lacking. Recent data from a large cohort study in low birth weight infants showed that only 61.6% had received two doses by 9 months.[24]

Factors associated with incomplete or non-immunization for rotavirus in children

According to the WHO, immunization currently averts an estimated 2 to 3 million deaths every year yet an estimated 19.4 million infants worldwide are still missing out on basic vaccines. Timely Rotavirus immunization is important for vaccine efficacy and also for herd immunity. Several studies have addressed disparities in vaccination rates and have examined risk factors for incomplete rotavirus immunization. For example, a recent study in Europe found that after logistic regression maternal unemployment and high number of older siblings (3 or more) were associated with incomplete rotavirus immunization.[25] In the United States, use of the monovalent rotavirus vaccine resulted in significantly higher completion rates compared to the pentavalent vaccine (91.0% vs. 83.4%).[26] In Peru, low birth weight was associated with incomplete rotavirus immunization as well as late first dose.[24] In Brazil, incomplete vaccination in children less than 18 months of age (including incomplete rotavirus vaccination) was associated with prematurity (OR = 4.27), malnutrition (OR = 4.99), inadequate housing (OR = 2.88), and poor prenatal care (OR = 4.98).[27] Other risk factors found in a variety of populations are home delivery, lack of prenatal care, mother misperceptions on vaccine indications, no postnatal care, low maternal educational level, young maternal age, among others.[28,29] Finally, a study that included Peru and Guatemala showed that the introduction of the rotavirus vaccine had an effect on the compliance with the pentavalent vaccine,[30] suggesting that the compliance with vaccinations may be affected by other vaccinations given concomitantly or in close proximity.

The role of unintended pregnancy on childhood immunization

It is widely recognized that unintended pregnancy is associated with adverse outcomes in the mother and the child.[6] The impact of pregnancy intention on childhood preventative care has shown conflicting results. Early studies found that unwanted pregnancies had no independent effect on the likelihood of well-baby care[31] and a study using DHS data from 1995-1998 found variable associations in different countries, with intention significantly associated with basic vaccination in Egypt, Kenya, and Peru, but not in the Philippines or in Bolivia.[5] For example, in Kenya and Peru, children who were unwanted were 1.60 and 1.24 times less likely than wanted children to have received a full set of vaccinations. More recent research in Nepal revealed that unintended pregnancies were associated with higher risk of inadequate immunizations (OR = 1.18).[32] Another study in India found similar results (OR = 2.2).[33] In rural India, unwanted children were 1.38 (95 % CI: 1.01–1.87) times more likely than wanted babies to receive inadequate childhood vaccinations.[34]

III. Manuscript Chapter

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Introduction

Infection with Rotavirus, an RNA virus, is the most common cause of severe diarrhea affecting children aged 5 years or less in the world.[1] The most recent evidence from a surveillance network for hospitalizations due to diarrhea in Latin American and the Caribbean using standardized definitions and diagnostic assays by the Pan American Health Organization (PAHO) from 2005 to 2007 showed that the median percentage of positive stool specimens among 11 countries was 31.5% (range, 24%–47%) and that the mortality risk from rotavirus in children under the age of 5 was 1 in 2874.[14] Unfortunately, this surveillance network did not include data from Peru. In 2004, the World Health Organization (WHO) estimated the mortality due to rotavirus in Peru to be 691 child deaths, with a mortality rate of 23 deaths per 100,000 children less than 5 years.[16] In 2008, the Ministry of Health decided to include rotavirus, pneumococcal, and influenza vaccines in the country's immunization program. Rotavirus and pneumococcal vaccine were introduced together in 2009. Rotavirus vaccination was to be given at ages 2 and 4 months. The vaccine coverage was 41% in 2009 and increased to 75% in 2010, putting Peru second only to Guatemala whereas other countries in the region, considered high mortality under WHO (stratum D), had higher coverage rates: Bolivia (76%), Ecuador (97%) and Nicaragua (98%).[16,23] Timely rotavirus immunization is important for vaccine efficacy and also for herd immunity. In Peru, low birth weight was associated with low rotavirus immunization compliance as well as late first dose.[24] Incomplete vaccinations in children less than 18 months of age (including incomplete rotavirus vaccination) have been found to be associated with prematurity (OR = 4.27), malnutrition (OR = 4.99), inadequate housing (OR = 2.88), and poor prenatal care (OR = 4.98).[27] Other risk factors found in a variety of populations are home delivery, lack of prenatal care, mother misperceptions on vaccine indications, no postnatal care, low maternal educational level, young maternal age.[28,29] Inadequate immunization of children continues to be a public health problem worldwide, especially in developing countries. Many factors such as unemployment, birth order, low birth weight, and poor prenatal care, were found to be associated with incomplete basic immunization of a child, including unwanted pregnancy.[5] However, the exact nature of the association between unintended pregnancy and inadequate rotavirus immunization has been largely under researched, especially in low-income countries such as Peru. The purpose of this research is to examine the association of self-reported pregnancy intention with inadequate rotavirus immunization, using nationally representative Demographic Health Survey data from the year 2012.

Methods

We analyzed data from the 2012 DHS from Peru to estimate the association between unintended pregnancy and inadequate rotavirus immunization.

Study Setting, Population and Sample

We performed a secondary analysis of data from DHS conducted in the Peru between the months of March and December of 2012. The DHS is a nationally representative sample survey designed to collect information on health behaviors and practices, reproductive preferences, domestic violence, HIV knowledge, family planning, fertility, and maternal and child health. The DHS program was established by the United States Agency for International Development (USAID) in 1984. Peru has been a part of this program since 1986. Details of this survey are published and they are available through the DHS portal.[35]

The Peru DHS 2012 is a complex survey that uses stratification and sample weights. The core questionnaire Phase 6 was used in Peru for the year 2012. Subjects were selected in strata based on provincial location and clusters of households were carefully chosen. The 2012 sample comprised 28,376 households, with 24,552 women between 15 and 49 years of age. A total of 27,488 households were interviewed and, of the total amount of eligible women, 23,888 (97.3%) interviews were completed.

The individual women questionnaire is composed of many sections to assess birth history, pregnancy, postnatal care, and breastfeeding a well as immunization and health, among others. The birth history data obtains information about the children born in the preceding 59 months of the time of the interview. For each child born in the last 5 years (alive at the time of the interview), data is collected on prenatal control (only applicable to the very last child), pregnancy intention, immunizations, postnatal control (only applicable to the very last child), and anthropometric data. Each child is analyzed as a separate case. For multiple births (i.e., twins) only the first born is included. There are two main sampling weights in DHS surveys: household weights and individual weights. There were 50 strata for this survey design. Since information about prenatal care and postnatal care was restricted to the very last child alive at the time of the survey, these factors were excluded from the analysis.

Outcome and exposure variables

The outcome of our study was inadequate rotavirus immunization, defined as a child older than 4 months of age at the time of the interview who had not received the recommended two doses of rotavirus vaccine; or a child 4 months or younger who had not received the first dose of the vaccine. The primary exposure of interest was unintended pregnancy. A woman was considered to have had an unintended pregnancy, if she reported that at the time of her pregnancy with one of the children born in the last 5 years preceding the survey (and alive at the time of the survey), she either wanted to postpone it (mistimed) or did not want to become pregnant with more children at all (unwanted).

Co-variables

We also examined co-variables related to other immunizations. Inadequate polio immunization was defined as lack of the recommended first dose of polio vaccine in a child younger than 4 months of age;

or lack of the first or second doses in a child between 4 and 6 months of age; or lack of any of the three doses of the polio vaccine in a child 6 months or older. Inadequate BCG immunization was defined as a child older than 1 month of age at the time of the interview that had not received the recommended BCG vaccine. The inadequate measles immunization variable refers to a child older than 12 months of age at the time of the interview had not received the recommended first dose of measles vaccine or measles, mumps, rubella (MMR) vaccine. Inadequate influenza immunization was defined as a child older than 6 months of age at the time of the interview that did not receive the recommended two doses of influenza vaccine. Finally, inadequate pneumococcal immunization was defined as a child less than 4 months of age at the time of the interview that did not receive the recommended first dose of pneumococcal vaccine; a child between 4 and 12 months of age at the time of the interview did not receive the recommended first dose or second dose of pneumococcal vaccine; or a child older than 12 months at the time of the interview did not receive either the recommended first, second or third doses of pneumococcal vaccine.

Other vaccines including pentavalent, viral hepatitis B, diphtheria/pertussis/tetanus and Haemophilus were not considered for analysis because children might have received either pentavalent doses or individual component doses depending on availability, therefore determination of the timely completion vaccination was not possible.

Birth weight was categorized using standard World Health Organization (WHO) classification. Very low birth weight was defined as less than 1500 g, low birth weight as less than 2500 g, normal birth weight between 2500 and 4000 g, and high birth weight as more than 4000 g. The duration of breastfeeding, when applicable, was classified as: child was never breastfed, child was breastfed up to 6 months of age or beyond. The time when antenatal care was initiated, when applicable, was divided in three categories whether the prenatal care was started during the first, second or third trimester. The place of birth of a child was classified as follows: MINSA (Peru’s subsidized healthcare under the Ministry of Health) if a child was born in any facility under the administration of that system; EsSalud (Social Security) when a child was born in any EsSalud facility; Private is the child was born in a private hospital or private office; home if the child was born at the mother's house; and other if a child was born at a local government facility (non-hospital), non-governmental organization, church or non-health-system venue, midwife's home, Air Force facility or any other not listed above. This same classification was used for the location where the child had their first 2-month postnatal check. As for the provider who provided the postnatal care, we identified 3 categories: Doctors, Midwives or Nurses, and Other Healthcare workers.

The wealth index is a DHS measure calculated using data on a household's ownership of selected assets; materials used for housing construction; and types of water access and sanitation facilities. This separates all interviewed households into five wealth quintiles and categorized as poorest, poor, middle, rich and richest. A woman was categorized as illiterate is she was unable to read. No data on ability to write was collected.

Statistical analysis

We performed all analyses using sampling weights and adjusted for clustering and stratification relevant to DHS sampling. We calculated frequencies and their corresponding weighted percentages or means and standard deviations as appropriate, and their 95% confidence intervals using Wilson's method for proportions. Bivariate analysis was done to compare rotavirus immunization among categories of pregnancy intention (unintended or intended) using Rao-Scott chi-square test. Unadjusted odds ratios and 95% confidence intervals (CI) were estimated to investigate the association between unintended pregnancy and inadequate rotavirus immunization among children. Multivariate logistic regression was conducted to identify the association between unintended pregnancy and inadequate rotavirus immunization controlling for maternal education, breastfeeding education, child insurance under Peru's subsidized comprehensive healthcare, inclusion of rotavirus in the immunization schedule, other inadequate immunizations and presence of television in the household. Adjusted and adjusted odds ratios (aOR) and their 95% confidence intervals are reported. Interaction between unintended pregnancy and area of residence (urban vs. rural), maternal education, age, marital status and literacy status was done using Breslow-Day test at the 0.05 significance level. Confounding was defined as a meaningful change (using a threshold of 10%) in the odds ratio for unintended pregnancy upon removal of the potential confounder. Multicollinearity of variables was checked using condition indexes and variance decomposition proportions. Data analysis was done using complex survey procedures in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Ethics

The DHS Program distributes unrestricted survey data files for legitimate academic research. This study was approved by the Emory University Institutional Board Review.

Results

A total of 23,888 women between the ages of 15 and 49 years were interviewed in the 2012 DHS for Peru. They gave birth to 47,261 children, of which 44,590 (94.9%) were alive at the time of the survey. A total of 9,620 children were born in the preceding 5 years of the survey and, of them, 175 (1.74%) had died before the time of the survey. Of 9,445 children alive at the time of the survey, 51.1% were male.

Among the 9,620 pregnancies in the preceding 5 years of the survey, 4,224 (43.91%, 95% CI 42.76 – 45.07) were wanted at the time the woman became pregnant; but a striking 56.09% of women had unintended pregnancies, with 2981 women (30.99%, 95% CI 29.94 – 32.06) reporting a mistimed pregnancy and 2415 (25.1%, 95% CI 24.05 – 26.19) reporting it as unwanted. Unintended pregnancy was more common in women aged 15 to 24 years old, with 63.6% of them reporting unintended pregnancies, compared to 49.5% in the 25 – 34 group and 53% in those 35 years or older. Also, unintended pregnancy was more common among those with high school education (71.1%).

A total of 5,187 children (54.92%, 95% CI 53.78 – 56.05) born in the last 5 years preceding the survey had inadequate rotavirus vaccination. In our unadjusted analysis, having received any vaccination as part of an immunization campaign in the preceding two years was associated with increased odds of inadequate rotavirus vaccination (OR: 1.55; 95%CI 1.38 – 1.75). Similarly, inadequate rotavirus immunization was associated with inadequate polio vaccination (OR: 6.61; 95%CI 5.3 – 8.24), BCG (OR: 2.16; 95%CI 1.73 – 2.7), measles (OR: 1.66; 95%CI 1.32 – 2.07), influenza (OR: 3.78; 95%CI 3.29 – 4.35), and pneumococcal (OR: 19.44; 95%CI 16.62 – 22.73) immunizations. In addition, compared to children born to women aged 25 – 34, those born to older women had higher odds of inadequate rotavirus vaccination (OR: 1.23; 95%CI 1.08 – 1.41) whereas children of younger women had less odds of inadequate vaccination (OR: 0.81; 95%CI 0.71 – 0.92). Children born at home had 41% higher odds of not receiving adequate rotavirus immunization compared to those born in the Ministry of Health network ($p < 0.0001$) and third-born children had 23% higher odds of inadequate rotavirus immunization compared to firstborn ones ($p = 0.005$). On the other hand, children registration in Peru's national registry of identification (RENIEC), child or maternal insurance under Peru's subsidized comprehensive health insurance (Seguro Integral de Salud, SIS), children whose mothers received breastfeeding education, and children vaccinated in 2009 or after (the year rotavirus vaccine was introduced in the national schedule) had lower odds of inadequate rotavirus vaccination as seen in Table 1.

The only statistically significant interaction was between unintended pregnancy and literacy ($p = 0.006$). The results of the multivariate analysis, addressing this interaction, are shown in Table 2. Incomplete polio, pneumococcal and influenza vaccinations remained strong independent predictors of incomplete rotavirus immunization. Insurance under SIS remained a strong protective factor for rotavirus vaccination. Children from households with televisions had 35% higher odds of incomplete immunization compare to households without televisions. Children born to women that received breastfeeding education had lower odds of incomplete vaccination (OR: 0.81; 95%CI 0.67 – 0.99) and children that did not complete the measles vaccine had also lower odds of incomplete rotavirus vaccination (OR: 0.45; 95%CI 0.32 – 0.62). Finally, children whose mothers had only primary education had 35% higher odds of incomplete rotavirus vaccination compared to children of mothers with higher education.

Table 3 shows the effect of unintended pregnancy on rotavirus immunization by literacy level (illiterate vs. not illiterate) adjusting for other covariates. In illiterate women, adjusting for other covariates, children from unintended pregnancies had 2.3 times the odds of incomplete rotavirus vaccination compared to children from intended pregnancies. There was no association between unintended pregnancy and rotavirus immunization in children of literate women.

Discussion

Our study addressed two important public health problems in the developing world: rotavirus infection and unintended pregnancies. Although in Peru much attention has been given to the prevention of rotavirus infection through immunization, and rotavirus immunization coverage improved in the last decade, many children remain non-immunized and little attention has been placed on determinants of inadequate or non-immunization against rotavirus, including the role of unintended pregnancy. Identification of these factors is important in a time when vaccination rates have stagnated, in order to identify vulnerable groups and enhance immunization programs. This is the first study examining the association of unintended pregnancy and inadequate rotavirus immunization in Peru, using nationally representative data and while looking at other factors.

We found that more than fifty percent of the children of women in the 2012 DHS for Peru had inadequate rotavirus immunization. Although this figure appears to be inconsistent with the increasing rotavirus immunization overage rates in Peru since 2009, the immunization coverage is defined by Peru's Ministry of Health as the total amount of children 12 months or less that received rotavirus immunization, regardless of the timing of vaccination. Our definition takes into account compliance with the immunization schedule. Timing of vaccination has important implications for vaccine immunogenicity and efficacy, and for prevention of poor outcomes. A study from Nepal demonstrated a significant delay in receipt of infant vaccines using prospective cohort data despite traditional coverage metrics being high.[36] Adequacy of immunization, timing and compliance may need to be incorporated by Peru's immunization program in addition to the classic metrics, in order to better evaluate the impact of such program in a time when coverage rates have stagnated.

Our findings suggest that mother's ability to read in Peru may play an important role on post-pregnancy outcomes such as childhood immunization. Some studies have examined the association between literacy status and unintended pregnancy in low-income countries and have reported conflicting results. Metwally et al. (2015) found that low-level education and illiteracy of the wife was associated with unintended pregnancy in Egyptian couples.[37] Another study conducted in Nepal found that illiterate women experienced more unintended pregnancies but multivariate analysis failed to show an association,[38] and, among Ethiopian women, literacy status was not associated with unintended pregnancies.[39] However, the association between literacy and child outcomes appears to be more consistent. In Ethiopia, data from two studies demonstrated that compared to illiterate women, literate women were up to three times more likely to fully vaccinate their children.[40] In India, complete vaccination was more likely if the mother was literate.[41] In Swaziland, literate women were 1.8 times more likely to utilize immunization services for their children.[42] In Pakistan, low literacy and education of the head of the household and the spouse was associated with low vaccination coverage.[43] Finally, an unpublished study from Peru found that in 1984, 80.24% and 67.85% of children of mothers with secondary or higher education respectively were immunized compared to 32.75% and 23.72% of children of mothers with primary or no education respectively.[44] In our study, compared to children from women with higher education, the children of women with primary education were significantly more likely to have inadequate rotavirus vaccination. The same was not found for children of women with no education at all, but the small proportion of women with no education may have biased the results. The role of literacy in less-developed countries is independently recognized in the pathway from schooling through health literacy and to child care outcomes in reproductive health.[45] Thus, literate women that suffer unintended pregnancies may protect their pregnancies and their child's health better than illiterate women, and therefore, improving literacy skills of Peruvian women might help improve vaccination rates. After all, developing countries health status indicators (life expectancy and infant-maternal survival rates, for example) are known to improve as the population's literacy level increases.[46]

Only one study has examined the association between unintended pregnancy and childhood immunization in Peru. Data from 1996 showed that unwanted pregnancies were associated with increased likelihood that a child had not received full vaccination by age 12 months.[5] In that study, however, Marston et al. found no such association with mistimed pregnancies and did not report results on unintended pregnancies (mistimed and unwanted). Also, the outcome was a full set of vaccinations as opposed to individual immunizations. The aforementioned study was made before the implementation of the rotavirus vaccine, so the compliance for this vaccine has not been well studied until now. However, based on that study and the results of this study, it is likely that, in Peru, the negative effect of unintended pregnancy on childhood immunization may continue to be a problem.

Other secondary findings of this study deserve attention. We found also that breastfeeding education was associated with less odds of incomplete rotavirus immunization. The benefits of breastfeeding on child health have been well established.[47] However, maternal breastfeeding education may play a role as an important modifier of behavior that could result in better breastfeeding practices, increase compliance with post-natal care and, therefore, compliance with recommended vaccinations. For example, the effect of breastfeeding education based on the health belief model resulted in significantly better scores in terms of self-efficacy, knowledge, and attitude in a study done in primiparous women.[48] In our study, conversely, there was no difference in rotavirus immunization based on duration of breastfeeding, therefore the education program probably works through other pathways of behavioral science when it comes to compliance with immunizations.

One notable result of this study is the significant association of inadequate rotavirus immunization with other inadequate immunizations such as polio, influenza and pneumococcal vaccines. These vaccines are scheduled in close proximity and the compliance with one may have an impact on others. For example, in Australia, the introduction of rotavirus vaccination improved the timing of diphtheria-tetanus-pertussis vaccination.[49,50] In addition, Schweitzer et al. found similar findings in two countries in Latin America, one of them being Peru, where the introduction of the rotavirus vaccine improved the coverage and timing of other similarly scheduled vaccinations.[30] Since vaccination against measles does not happen until the child is between 12 and 15 months, a positive relationship may not be seen. Our data showed that inadequate measles vaccination was actually associated with lower odds of inadequate rotavirus immunization.

The protective effect of both child's insurance under SIS and vaccination on or after 2009 is not unexpected. The availability of the vaccine in large scale after its introduction in the national immunization schedule as well as the large proportion of children under SIS, the comprehensive healthcare insurance of Peru, may explain these results. On the other hand, one interesting finding is the association of the presence of a television (TV) in the household and increased odds of incomplete immunization, especially when neither watching TV, listening to the radio nor reading the newspaper by women were associated with rotavirus immunization. It is possible that the media had an effect on women's partners' or other family members' perception of vaccination and resulted in low children immunization against rotavirus, especially due to the heavily publicized criticism from anti-vaccine groups in the recent years. Another interesting finding was that birth weight was not associated with rotavirus immunization in this study of survey data, but a previous cohort study in Peru found that vaccination of very-low-birth-weight infants is significantly delayed, especially in those with a birth-weight of less than 1000 g.[24]

Our study had some limitations. First, the DHS collects vaccination information from 2 sources: directly from the child's vaccination card (either date recorded or vaccine marked on the card) and vaccination reported by the mother. Although the frequency of the source varied by vaccination and rotavirus immunization frequency by self-report was less than 0.2%, other vaccinations had higher frequencies of self-report and this might have introduced recall bias. However, previous studies in low income settings have found that maternal recall has a high sensitivity when it comes to identifying vaccinated children aged 12-23 months, similar to information taken from vaccination cards.[51] Also, we did not include ante-natal care or post-natal care data in the analysis as this data was only available for the very last alive child. However, we conducted a similar analysis for the last born child only and results were similar (data not shown).

Our study has many advantages as well. The use of DHS data with high response rates, national coverage, superior interviewer training, and standardized data collection procedures provides an excellent source of data. We conducted an assessment of several other determinants of inadequate rotavirus immunization and an assessment of vaccination adequacy and compliance rather than vaccination coverage rates.

Conclusion

Unintended pregnancy was associated with inadequate rotavirus immunization in children of illiterate women. Literacy status modified the effect of unintended pregnancy on immunization against rotavirus with no association seen between unintended pregnancy and inadequate rotavirus vaccination in children of literate women. This indicates that literacy is an important factor that could mitigate the known adverse consequences of unintended pregnancy, particularly for child health outcomes. Our results also indicate that vaccination compliance may be highly interdependent when vaccinations are given in close proximity and that breastfeeding education has an impact on childhood rotavirus immunization. This is the first study that has investigated the relationship between pregnancy intendedness and adequacy of rotavirus immunization in Peru and it is of great value for policy and program development.

Tables

Table 1. Childhood, Maternal, and Other Characteristics associated with inadequate rotavirus vaccination, Demographic Health Survey, Year 2012, Peru (N=9445)

Variables	Inadequate rotavirus vaccination (n= 5187) N (weighted %)	Adequate Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR	95% C.I.	*p* value*
CHILD CHARACTERISTICS					
Child’s gender					
Male	2634 (55)	2154 (45)	1.02	0.92 - 1.13	0.85
Female	2553 (54.8)	2104 (45.2)	1	Ref	
Child's place of birth					
Home	994 (62.2)	566 (37.8)	**1.41**	**1.22 - 1.64**	**<0.0001**
Other†	99 (62)	61 (38)	1.4	0.9 - 2.18	0.14
Private	323 (56.2)	250 (43.8)	1.1	0.86 - 1.4	0.44
EsSalud	632 (55.4)	515 (44.6)	1.07	0.89 - 1.28	0.5
MINSA	3139 (53.8)	2866 (46.2)	1	ref	N/A
Child's Birth weight					

Variables	Inadequate rotavirus vaccination (n= 5187) N (weighted %)	Adequate Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR	95% C.I.	*p* value*
VLBW	21 (64.3)	18 (35.7)	1.51	0.61 - 3.74	0.37
LBW	342 (57.1)	267 (42.9)	1.12	0.88 - 1.42	0.35
HBW	277 (57.6)	179 (42.4)	1.14	0.86 - 1.52	0.37
NBW	4052 (54.4)	3568 (45.6)	1	ref	N/A
Birth order					
1st	1624 (52.9)	1459 (47.1)	1	ref	N/A
2nd	1374 (55.8)	1114 (44.2)	1.12	0.97 - 1.3	0.126
3rd or higher	2189 (58)	1685 (42)	**1.23**	**1.06 - 1.42**	**0.005**
Registered in RENIEC					
Yes	4763 (54.6)	4077 (45.4)	**0.46**	**0.36 - 0.6**	**<0.0001**
No	422 (72.3)	180 (27.7)	1	ref	N/A
Child never breastfed					
Yes	36 (67.8)	18 (32.2)	1.69	0.83 - 3.43	0.14
No	5150 (55.5)	4239 (45.5)	1	ref	N/A
Child SIS status					
Yes	2193 (50.9)	2220 (49.1)	**0.72**	**0.64 - 0.8**	**<0.0001**
No	2971 (59.1)	2031 (40.9)	1	ref	N/A
Any vaccine at immunization campaign					
Yes	1506 (62.8)	973 (37.2)	**1.55**	**1.38 - 1.75**	**<0.0001**
No	3524 (52.2)	3282 (47.8)	1	ref	N/A
Other immunizations					
Polio inadequate	1563 (85.8)	223 (14.2)	**6.61**	**5.3 - 8.24**	**<0.0001**
Polio adequate	3483 (47.8)	4035 (52.2)	1	ref	N/A
BCG inadequate	503 (71.5)	199 (28.5)	**2.16**	**1.73 - 2.7**	**<0.0001**
BCG adequate	4514 (53.8)	4052 (46.2)	1	ref	N/A
Measles inadequate	592 (70.2)	231 (29.8)	**1.66**	**1.32 - 2.07**	**<0.0001**
Measles adequate	3728 (58.7)	2816 (41.3)	1	ref	N/A
Influenza inadequate	3708 (66.5)	1908 (33.5)	**3.78**	**3.29 - 4.35**	**<0.0001**
Influenza adequate	880 (34.5)	1848 (65.5)	1	ref	N/A
Pneumococc. inadequate	4450 (82.9)	960 (17.1)	**19.44**	**16.62 -**	**<0.0001**
Pneumococc. adequate	737 (20)	3298 (80)	1	ref	N/A
MATERNAL FACTORS					
Pregnancy intention					
Unintended pregnancy	2905 (55.1)	2396 (44.9)	**0.98**	**0.93 - 1.04**	**0.53**

Variables	Inadequate rotavirus vaccination (n= 5187) N (weighted %)	Adequate Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR	95% C.I.	*p* value*
Intended pregnancy	2282 (56.1)	1862 (43.9)	1	ref	
Mother's age (years)					
15 - 24	1399 (51)	1345 (49)	**0.81**	**0.71 - 0.92**	**0.002**
25 - 34	2352 (55)	1923 (55)	1	ref	N/A
35 and older	1436 (59.2)	990 (40.8)	**1.23**	**1.08 - 1.41**	**0.02**
Mother's education					
None	200 (58.6)	147 (41.4)	1.21	0.9 - 1.62	0.21
Primary	1704 (57.7)	1310 (42.3)	1.16	0.98 - 1.37	0.08
Secondary	2241 (54.9)	1881 (45.1)	1.03	0.89 - 1.20	0.67
Higher	1042 (54)	920 (46)	1	ref	N/A
Marital status					
Formerly/Never married	692 (56.8)	578 (43.2)	1.06	0.91 - 1.24	0.47
Married	4495 (55.4)	3680 (44.6)	1	ref	N/A
Partner's education					
None	70 (59)	53 (41)	1.192	0.73 - 1.95	0.48
Primary	1279 (57.2)	982 (42.8)	1.107	0.88 - 1.39	0.38
Secondary	3105 (55.6)	2550 (44.4)	1.037	0.84 - 1.27	0.73
Higher	471 (54.7)	393 (45.3)	1	ref	N/A
Language spoken					
Native‡	660 (54.9)	559 (45.1)	0.97	0.82 - 1.15	0.73
Spanish or foreign	4527 (55.6)	3699 (44.4)	1	ref	N/A
Radio in home					
Yes	3828 (54.5)	3293 (37.5)	0.9	0.78 - 1.05	0.17
No	1130 (57)	885 (43)	1	ref	N/A
TV in home					
Yes	3765 (54.9)	3229 (45.1)	0.97	0.85 - 1.11	0.68
No	1194 (55.6)	949 (44.4)	1	ref	N/A
Literacy					
Illiterate	451 (58.7)	342 (41.3)	1.15	0.95 - 1.39	0.14
Not illiterate	4716 (52.9)	3910 (44.7)	1	ref	N/A
Reads news					
No	3868 (55)	3241 (45)	0.93	0.81 - 1.06	0.27

Variables	Inadequate rotavirus vaccination (n= 5187) N (weighted %)	Adequate Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR	95% C.I.	*p* value*
Yes	1319 (56.9)	1017 (43.1)	1	ref	N/A
Watches TV					
No	2025 (55.9)	1555 (44.1)	1.02	0.91 - 1.14	0.71
Yes	3162 (55.4)	2703 (44.6)	1	ref	N/A
Listens to radio					
No	2359 (55.3)	1884 (44.7)	0.98	0.87 - 1.11	0.77
Yes	2828 (55.8	2374 (44.2)	1	ref	N/A
Mother works					
Yes	2998 (56.6)	2344 (44.3)	1.09	0.98 - 1.22	0.11
No	2189 (54.4)	1914 (45.6)	1	ref	N/A
Works in agriculture					
Yes	1302 (54.8)	1080 (45.2)	0.96	0.85 - 1.09	0.56
No	3885 (55.8)	3178 (44.2)	1	ref	N/A
SIS during pregnancy					
Yes	2738 (50.4)	2831 (49.6)	**0.79**	**069 - 0.91**	**0.001**
No	1294 (56.2)	1028 (43.8)	1	ref	N/A
Breastfeeding education					
Yes	2766 (52.8)	2549 (47.2)	**0.79**	**0.7 - 0.88**	**<0.0001**
No	2421 (58.8)	1709 (41.2)	1	ref	N/A
Mother smokes					
Yes	126 (61.3)	63 (38.7)	1.27	0.8 - 2.03	0.31
No	5061 (55.4)	4195 (44.6)	1	ref	N/A
Distance is a problemɫ					
Yes	2590 (55.6)	2070 (44.4)	1	0.89 - 1.12	0.97
No	2597 (55.5)	2188 (44.5)	1	ref	N/A
Mother in EsSalud					
Yes	906 (56.5)	701 (43.5)	1.05	0.91 - 1.22	0.51
No	4281 (55.3)	3557 (44.7)	1	ref	N/A
OTHER					
Wealth index					

Variables	Inadequate rotavirus vaccination (n= 5187) N (weighted %)	Adequate Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR	95% C.I.	*p* value*
Poorest	1413 (55.3)	1422 (45.7)	1.07	0.91 - 1.24	0.43
Poor	1279 (54.4)	1137 (45.6)	1.03	0.89 - 1.19	0.72
Middle	941 (55.1)	859 (44.9)	1	ref	N/A
Rich	756 (58.5)	517 (41.5)	1.16	0.95 - 1.4	0.14
Richest	409 (52.9)	339 (47.1)	0.98	0.78 - 1.23	0.85
Rotavirus included in immunization schedule					
Yes (2009 and after)	2824 (42.4)	3916 (57.6)	**0.09**	**0.08 - 0.1**	**<0.0001**
No (before 2009)	2363 (89.3)	342 (10.7)	1	ref	N/A
Area of residence					
Rural	2027 (53.8)	1781 (46.2)	0.93	0.83 - 1.04	0.22
Urban	2932 (55.6)	2397 (44.4)	1		N/A

* Rao-Scott chi square

† NGO, local, local air force facility, or other

‡ Quechua or Aymara languages

ɫ If distance to get healthcare was considered a problem

SIS: Subsidized comprehensive healthcare insurance; EsSalud: Peru's Social Security; MINSA: Ministry of Health; RENIEC: Peru's national registry of identification; TV: television; VLBW: very low birth weight; LBW: low birth weight; NBW: normal birth wright; HBW: high birth weight.

Table 2. Multivariable Analysis examining the Association between Pregnancy Intention on Rotavirus Vaccination, stratified by maternal literacy; Demographic Health Survey, Peru, 2012† (n=9445)

Stratum	Incomplete rotavirus vaccination (n= 5187) N (weighted %)	Completed Rotavirus vaccination (n= 4258) N (weighted %)	Crude OR (95%CI)	aOR	95% C.I.
Illiterate					
Unintended	306 (58.8)	246 (41.2)	1.01 (0.19-1.48)	**2.55**	**1.2 – 4.4**
Intended	145 (58.5)	96 (41.5)	1	1	ref
Not illiterate					
Unintended	2588 (54.7)	2146 (45.3)	0.95 (0.83-1.09)	0.89	0.7 – 1.1
Intended	2128 (56)	1764 (44)	1	1	ref

† Adjusted for maternal education, SIS insurance, breastfeeding education, time rotavirus available on schedule, presence of television in the household, and pneumococcal, influenza, measles and polio vaccinations.

aOR: adjusted odds ratio; CI: confidence interval

Table 3. Multivariable Logistic Regression Analysis examining the association between Unintended Pregnancy and Inadequate Rotavirus Vaccination, Demographic Health Survey, Peru, 2012*

Variables	Adjusted OR	95% C.I.	*p* value
Illiterate			
Unintended pregnancy	**2.55**	**1.2 – 4.4**	**0.011**
Intended pregnancy	1	ref	
Not illiterate			
Unintended pregnancy	0.89	0.7 – 1.1	0.297
Intended pregnancy	1	ref	
Mother received breastfeeding education			
Yes	**0.81**	**0.67 – 0.99**	**0.036**
No	1	ref	N/A
Rotavirus included in immunization schedule			
Yes (2009 and after)	**0.21**	**0.16 – 0.26**	**<0.0001**
No (before 2009)	1	ref	N/A
Polio incomplete	**5.93**	**3.54 – 9.92**	**<0.0001**
Polio complete	1	ref	N/A
Measles incomplete	**0.45**	**0.32 – 0.62**	**<0.0001**
Measles complete	1	ref	N/A
Influenza incomplete	**2.28**	**1.83 – 2.84**	**<0.0001**
Influenza complete	1	ref	N/A
Pneumococcal incomplete	**6.28**	**5.02 – 7.86**	**<0.0001**
Pneumococcal complete	1	ref	N/A
Child SIS status			
Yes	**0.79**	**0.64 – 0.97**	**0.023**
No	1	ref	N/A
Mother's education			
None	1.78	0.93 – 3.41	0.08
Primary	**1.35**	**1.001 – 1.83**	**0.049**

Variables	Adjusted OR	95% C.I.	*p* value
Secondary	1.19	0.94 – 1.50	0.15
Higher	1	Ref	N/A
TV in home			
Yes	**1.35**	**1.09 – 1.67**	**0.007**
No	1	ref	

*Each variable is adjusted for all other variables in the model.

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IV. Summary, Public Health Implications, Possible Future Directions

With the use of nationally representative data from DHS, we studied the determinants of incomplete rotavirus immunization, focusing on pregnancy intention. We found a high frequency of inadequate rotavirus immunization and many determinants that could be targeted by public health programs. Cohort studies to evaluate determinants of inadequate or delayed immunization, including the role of unintended pregnancy must be conducted to corroborate these results. However, until then, the use of survey data provides valuable information for adjustments in public health policy. Rotavirus non-immunization in children has serious implications in the developing world. Although efforts are underway to improve infectious-diarrhea-related mortality in Peru and the inclusion of the rotavirus vaccine in the national schedule is one of them, ongoing education as well as family planning and improvements in literacy skills of Peruvian women might help improve vaccination rates and compliance.

The introduction of educational programs about unintended pregnancy and its impact on health outcomes in schools, universities or through local government agencies will be important in creating awareness and perhaps modifying behavior with the final goal of reducing the high rates of unintended pregnancy that have scourged Peru for decades. In addition, large media campaigns and advertising as well as the use of television and/or social media can be considered as a behavioral strategy to target both problems: unintended pregnancy and childhood immunization. Education of women and/or couples about child care and childhood immunizations before and after pregnancy must be a key component of family planning in Peru.

We cannot emphasize enough the significance of literacy in a country such as Peru. An improvement has been observed in Peru's literacy level for the last ten years but rural areas continue to have high rates of illiteracy. Efforts should continue across the country, but especially in rural areas and the Andean region where illiteracy remains a problem. By educating the population and decreasing illiteracy we can empower women and couples to offset some of the negative effects of unintended pregnancies and improve both maternal and child health in Peru.

In addition, as rotavirus immunization coverage rates in Peru have stagnated since 2011 and the role of immunization compliance is important for immunogenicity and outcomes, the information provided in this study will serve as base for future enhancements in the immunization program and perhaps allow for the incorporation of timeliness and compliance metrics for the continuous assessment of the success of such programs.

Finally, future women's demographic and health surveys conducted in Peru should consider not only received vs. did not receive vaccination status in their children, but take into account the age of the child and the immunization schedule in order to better assess immunization compliance through this important survey.

VI. Appendices

Appendix 1: DHS data release and authorization letter

May 24, 2016

Fernando Echaiz
Emory

Dear Fernando:

You are authorized to use all available Peru Demographic and Health Survey (DHS) datasets, for your research project titled: "Unintended pregnancy and Rotavirus non-immunization in Peruvian children".

To download the DHS datasets, please login to your user account at:

http://www.dhsprogram.com/data/dataset_admin/login_main.cfm

- The user name is your registered email address: jechaiz@emory.edu
- The password is the one you selected during the registration process.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS datasets must not be passed on to other researchers without the written consent of DHS. You are requested to submit an electronic or hard copy of any reports/publications resulting from using the DHS data files to our office.

Sincerely,

Bridgette Wellington

Data Archivist
The Demographic and Health Surveys (DHS) Program

530 Gaither Road, Suite 500 • Rockville, MD 20850 US • +1.301.407.6500 • +1.301.407.6501 fax • icfi.com

Appendix 2. Emory IRB approval letter

EMORY UNIVERSITY

Institutional Review Board

TO: Jose Echaiz Arroyo
Principal Investigator
Unassigned Department

DATE: July 13th, 2016

RE: **Expedited Approval**
IRB00088863
Unintended pregnancy and Rotavirus non-immunization in Peruvian children, an analysis of the demographic and health survey 2012

Thank you for submitting a new application for this protocol. This research is eligible for expedited review under 45 CFR.46.110 and/or 21 CFR 56.110 because it poses minimal risk and fits the regulatory category F5 as set forth in the Federal Register. The Emory IRB reviewed it by expedited process on **July 13th, 2016** and granted approval effective from **July 13th, 2016** through **July 12th, 2017**. Thereafter, continuation of human subjects research activities requires the submission of a renewal application, which must be reviewed and approved by the IRB prior to the expiration date noted above. Please note carefully the following items with respect to this approval:

- CFR 46.110 and 46.404
- Subpart D: assent and parent permission waiver
  - 88863 Subpart D Worksheet.doc
- Study protocol.docx *(Date Uploaded: July 8th, 2016)*
- 88863 Waiver_Consent_Elements_of_Consent worksheet.doc
- 88863 HIPAA_Alteration worksheet.doc

A complete waiver of HIPAA authorization and informed consent has been granted by the IRB. Protected Health Information of which use or access has been determined to be necessary by the IRB: identifying codes will be obtained.

Any reportable events (e.g., unanticipated problems involving risk to subjects or others, noncompliance, breaches of confidentiality, HIPAA violations, protocol deviations) must be reported to the IRB according to our Policies & Procedures at www.irb.emory.edu, immediately, promptly, or periodically. Be sure to check the reporting guidance and contact us if you have questions. Terms and conditions of sponsors, if any, also apply to reporting.

Before implementing any change to this protocol (including but not limited to sample size, informed consent, study design, you must submit an amendment request and secure IRB approval.

In future correspondence about this matter, please refer to the IRB file ID, name of the Principal Investigator, and study title. Thank you

Parul Reddy
Analyst Assistant
This letter has been digitally signed

Appendix 3. Immunization data collection tool in Spanish, DHS Peru 2012.

SECCIÓN 4B. INMUNIZACIÓN Y SALUD

CUESTIONARIO ADICIONAL

451	ANOTE EL NÚMERO Y CONDICIÓN DE SOBREVIVENCIA DE CADA NACIDO VIVO DESDE ENERO DEL 2007 HAGA LAS PREGUNTAS PARA CADA UNO DE ESTOS NACIMIENTOS, EMPEZANDO CON EL ÚLTIMO. (SI HAY MÁS DE TRES NACIDOS VIVOS UTILICE LA SEGUNDA COLUMNA DEL FORMULARIO ADICIONAL).			
452	VERIFIQUE NÚMERO DE ORDEN EN 212	ÚLTIMO NACIDO VIVO NÚMERO DE ORDEN	PENÚLTIMO NACIDO VIVO NÚMERO DE ORDEN	ANTEPENÚLTIMO NACIDO VIVO NÚMERO DE ORDEN
453	DE 212, ANOTE EL NOMBRE DE 216, SI ESTA VIVO O MUERTO	NOMBRE ____ VIVO / MUERTO (PASE A 453 EN PRÓXIMA COLUMNA; O, SI NO HAY MÁS NACIMIENTOS PASE A 456)	NOMBRE ____ VIVO / MUERTO (PASE A 453 EN PRÓXIMA COLUMNA; O, SI NO HAY MÁS NACIMIENTOS PASE A 456)	NOMBRE ____ VIVO / MUERTO (PASE A 453 EN PRÓXIMA COLUMNA; O, SI NO HAY MÁS NACIMIENTOS PASE A 456)
454	¿Tiene usted la tarjeta de vacunación de (NOMBRE)? ¿Me permite verla por favor?	SÍ, VISTA ... 1 (PASE A 456) SÍ, NO VISTA ... 2 (PASE A 456) SIN TARJETA ... 3	SÍ, VISTA ... 1 (PASE A 456) SÍ, NO VISTA ... 2 (PASE A 456) SIN TARJETA ... 3	SÍ, VISTA ... 1 (PASE A 456) SÍ, NO VISTA ... 2 (PASE A 456) SIN TARJETA ... 3
455	¿Tuvo usted alguna vez la tarjeta de vacunación de (NOMBRE)?	SI ... 1 NO ... 2 (PASE A 456)	SI ... 1 NO ... 2 (PASE A 456)	SI ... 1 NO ... 2 (PASE A 456)

456 **ENTREVISTADORA**
1 AL FINAL DE LA ENTREVISTA COPIE DEL CARNÉ LAS FECHAS DE VACUNACIÓN PARA CADA VACUNA.
2 ANOTE "44" EN LA COLUMNA "DÍA" SI LA TARJETA MUESTRA QUE SE DIÓ UNA VACUNA, PERO NO SE ANOTÓ LA FECHA.

ÚLTIMO NACIDO VIVO

NÚMERO DE ORDEN   NOMBRE ____

		DÍA / MES / AÑO		DÍA / MES / AÑO		DÍA / MES / AÑO
BCG (Recién nacido)	BCG		ANTIHEPATITIS B HvB (Recién nacido)		HVB 0	
POLIO	P 1		P 2		P 3	
PENTAVALENTE (DPT + HVB + HIB)	Pe 1		Pe 2		Pe 3	
DPT	DPT 1		DPT 2		DPT 3	
ANTIHEPATITIS B - HVB	HvB 1		HvB 2		HvB 3	
ANTIHAEMOPHILUS - HIB	Hib 1		Hib 2		Hib 3	
TETRAVALENTE	T					
HEXAVALENTE	He 1		He 2		He 3	
ROTAVIRUS	Rot 1		Rot 2			
NEUMOCOCO	Neu 1		Neu 2		Neu 3	
INFLUENZA	Inf 1		Inf 2			
ANTISARAMPIONOSA / SPR	SPR		ANTIAMARILICA - AMA		AMA	

REFUERZOS Y VITAMINA " A "

DPT	1ero		2do			
SPR	1ero					
VITAMINA "A"	VA 1		VA 2		VA 3	
	VA 4		VA 5		VA 6	

27