2005-06 and 2011-12 Honduras Demographic and Health Survey Analysis of Vaccination Timeliness, Co-administration and Factors Associated with Vaccination Status

Draft Report of Findings

Kristin Bratton, Aaron Wallace (CDC)

Carolina Danovaro (PAHO)

JUNE 2014

Introduction

Although vaccines are one of the most cost-effective interventions for preventing morbidity and mortality worldwide, many children continue to lag behind in receiving timely and complete immunization. The region of the Americas has demonstrated a strong commitment to effective immunization programs: the region was the first to achieve the goal of polio elimination in 1991 and later, measles elimination in 2002 and rubella in 2009, and most South and Central American countries maintain high coverage rates for almost all scheduled vaccines.[1,2] The recommended immunization schedule of Honduras is as follows:

Vaccine	Recommended age of receipt
Bacille Calmette-Guerin (BCG), hepatitis B	birth
Pentavalent (Diphtheria, tetanus, pertussis (DTP), hepatitis B, *Haemophilus influenzae* type b)	2, 4, 6 months
Oral poliovirus vaccine (OPV)	2, 4, 6, 18 months
Rotavirus (Rota)	2, 4 months
Pnuemococcal conjugate vaccine (PCV)	2, 4, 6 months
Measles, mumps, rubella (MMR)	12 months

*Pentavalent is referred to as 'Penta' and Rotavirus referred to as 'Rota' hereafter.

The pneumococcal vaccine (PCV) and the rotavirus vaccine were introduced recently: PCV in April 2011 and rotavirus in 2009. In 2012, national coverage estimates in Honduras for BCG, the third dose of pentavalent vaccine, first dose of measles and the second dose of the rotavirus vaccine were 90%, 88%, 93%, and 87%, respectively.[3]

While many countries in the Americas have sufficiently high vaccination coverage rates, there is increasingly a focus on improving timeliness of vaccination. Timely adherence to vaccination schedules both minimizes the time individuals are unprotected against vaccine-preventable diseases, maximizes the effectiveness of vaccines, and for some vaccines may reduce the risk of febrile convulsions. Moreover, timeliness is particularly important for vaccines that have strict upper and lower age limits for administration, such as the rotavirus vaccine series.

We used data from the two most recent Demographic and Health Surveys (DHS) conducted in Honduras to describe and analyze timeliness of vaccination receipt, trends in co-administration of certain vaccines, and factors associated with timely vaccination.

Methods

The 2011-2012 DHS survey included immunization data on children up to five years of age at the time of the survey. Only children for which immunization cards could be produced (and dates of immunization could be

[1] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6202a3.htm

[2] http://www.cdc.gov/mmwr/preview/mmwrhtml/00032760.htm

[3] http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tscoveragebcg.html

ascertained) were included in our analysis. Out of the 10, 592 children on which data were collected, the number of children with health cards that were included in the analysis was 9,270 (87.5%). Analyses were performed taking into account the survey design of DHS.

The timeliness definitions were based on Honduras MOH and PAHO discussions (Table 1). In brief:

"On time" doses are doses administered during the recommended time period (blue column). For second or third doses of a series, the "on time" definition could include both an age range (e.g. 120-150 days of age for Penta 2) and an interval requirement (e.g. 28-58 days from the previous dose, for Penta 2 and 3). All "on time" doses are considered valid.

"Delayed" doses are doses administered after the recommended period (green columns). For second or third doses of a series, "delayed" could mean that a child received a dose at a later age than recommended (e.g. 151-365 days of age, for Penta2) or after a longer interval than recommended (e.g. >59 days after the previous dose, for Penta2). All delayed doses are considered valid.

"Late" doses are doses administered after the delayed period. Late doses can either be considered valid or invalid, depending upon the vaccine. However, these doses would not be counted when calculating routine immunization coverage in children <12 months of age and for MMR in children <24 months.

"Early" doses are doses administered before the recommended period. For second or third doses of a series, "early" could either mean that a child received a dose at an earlier age than recommended (e.g. <120 days of age, for Penta2) or with a shorter interval than recommended (e.g. <28 days after the previous dose, for Penta2). Early doses can either be considered valid or invalid, depending upon the vaccine.

Analyses were performed in SASv9.3 (all regression analyses and descriptive analyses) and R v.3.0.2 (survival analyses).

Table 1: Definitions of timeliness used for Honduras 2011-2012 DHS analysis

RED: invalid doses (early or late)

ORANGE: valid doses (early or late)

Vaccine	Recommended age	Dosis temprana-interval (EARLY)	Dosis temprana-age (EARLY)	Dosis oportuna (ON TIME)	Dosis tarde-age (DELAYED)	Dosis tarde-interval (DELAYED)	Dosis más tarde (LATE)
Penta1	2 months	--	<60 days of age **(invalid)**	60-90 days of age	91-364 days of age	--	>1 year of age (365 days)
Penta2	4 months	<28 days after previous dose **(invalid)**	<120 days of age	120-150 days of age and 28-58 days after previous dose	151-365 days of age	>59 days after previous dose	>1 year of age (365 days)
Penta3	6 months	<28 days after previous dose **(invalid)**	<180 days of age	180-210 days of age and 28-58 days after previous dose	211-365 days of age	>59 days after previous dose	>1 year of age (365 days)

Rota1	2 months	--	<60 days of age **(invalid)**	60-90 days of age	91-105 days of age	--	>105 days of age **(invalid)**
Rota2	4 months	<28 days after previous dose **(invalid)**	<120 days of age	120-150 days of age and 28-58 days after previous dose	151-240 days of age	>59 days after previous dose	>240 days of age **(invalid)**
MMR	12 months	--	< 365 days of age **(invalid)**	365-395 days of age	396-730 days of age	--	>2 days of age (730 days)

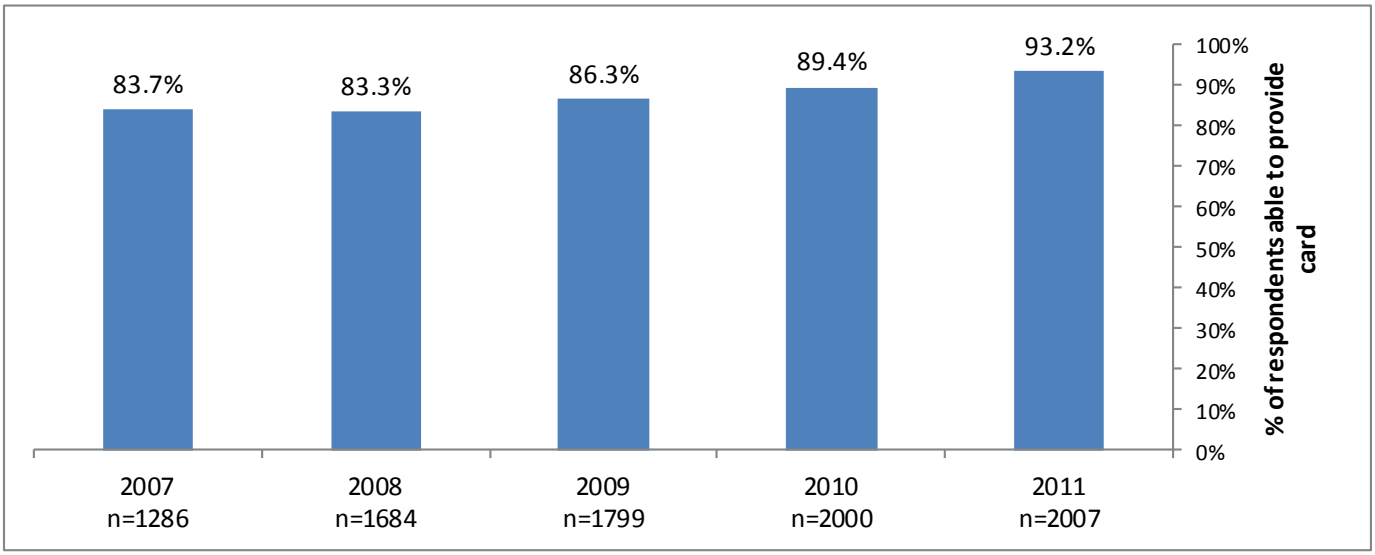
Both the 2011-12 DHS and the 2005-2006 DHS will be used to determine any associations between sociodemographic factors and timeliness of vaccination and to investigate whether predictors of timely vaccination may have changed over time.

Results

Card retention rates

Among children included in the DHS, there is differential health card retention by year of birth: 93.2% of children born in 2011 were able to present health cards, compared to only 83.7% of children born in 2007 (**Figure 4**). Considerations may be given to have health workers encourage caregivers to keep and maintain health cards for children until 5 years of age. This allows more information to be collected through DHS surveys, further validating analyses similar to this one.

Figure 1: Health card retention by year of birth of child, Honduras 2007-2011*



**Notes: Estimates of coverage and timeliness from earlier years contain fewer children, as fewer children in these age groups had producible health cards from which vaccination information could be recorded. This is an important limitation of this analysis, and in general, a limitation of the use of the DHS survey for estimating immunization indicators.*

Average age of receipt of vaccination

Among children with vaccination cards, the average age at receipt of vaccination for all years assessed in the 2011-2012 DHS falls within the recommended age limits (**Table 2**).

Table 2: Average age, in days, at receipt of vaccination by year of birth among children with producible vaccination cards*, 2011-12 DHS

	On-time (recommended)	2007	2008	2009	2010	2011	p-value for trend
Penta1	60-90 days of age	72.6	72.9	71.2	67.9	64.3	0.02*
Penta2	120-150 days of age and 28-58 days after previous dose	144	144	141.8	137.7	134.5	0.01*
Penta3	180-210 days of age and 28-58 days after previous dose	221.7	221.3	214.8	206.9	200.4	0.01*
Rota1	>60 days of age			70.6	69.6	67.8	0.10
Rota2	120-150 days of age and 28-58 days after previous dose			139.5	138.4	134.3	0.20

Notes: '' indicates that the test for trend is significant. These numbers include only children with producible vaccination cards at the time of the survey.*

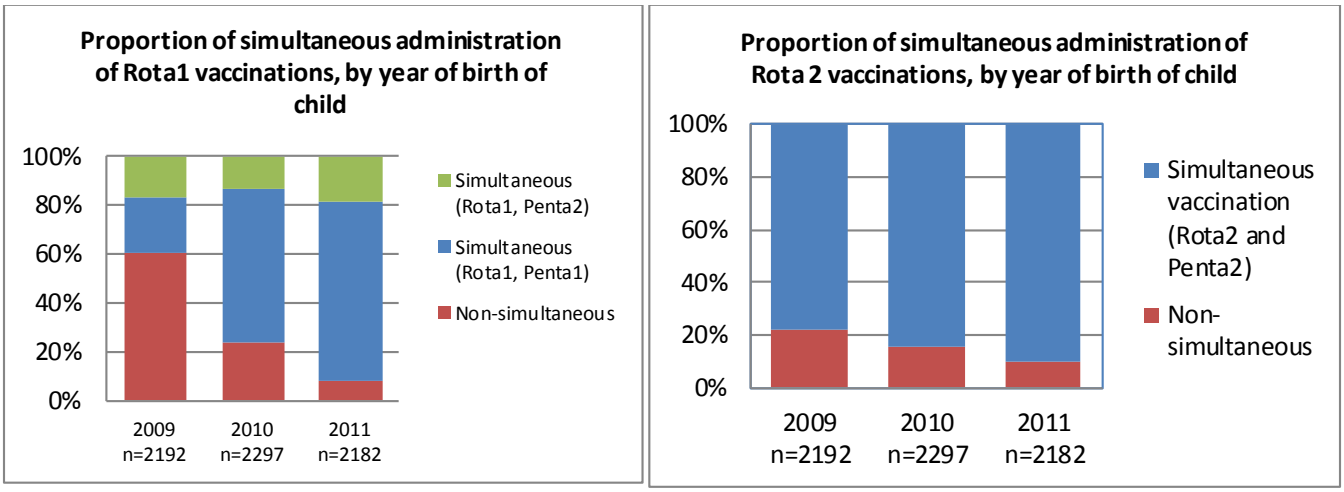
Programmatic Implications: Vaccinations are generally being received in a timely manner (within the recommended age range of administration). The immunization program should continue to ensure that doses are given on time.

Note that the analysis shown in table 2 includes only children with producible vaccination cards at the time of the survey; it is likely that children with vaccination cards are more likely to be vaccinated on time, as cards can remind caregivers when to return for vaccination. Consequently, these averages should not be interpreted as representative of national averages. Additionally, all children in the survey were included in these calculations, therefore it should be expected that children in later (younger) age groups are less likely to have received vaccines than those in earlier (older) age groups. Further, children in earlier (older) age groups have had more time to receive late vaccinations than children in earlier (younger) age groups, potentially leading to increases in averages among earlier cohorts.

Vaccine co-administration

In 2011, the Rota1 was co-administered with Penta1 in 73% of doses given (**Figure 2**). Approximately 19% of Rota1 doses are co-administered with Penta2 vaccine; 8% of Rota1 doses are given without either Penta1 or Penta2. In the same year, Rota2 was simultaneously administered with Penta2 in 90% of doses.

Figure 2: Simultaneous administration of Rotavirus vaccine with Pentavalent 1 and 2 vaccinations in Honduras, by year of birth, Honduras 2009-2011

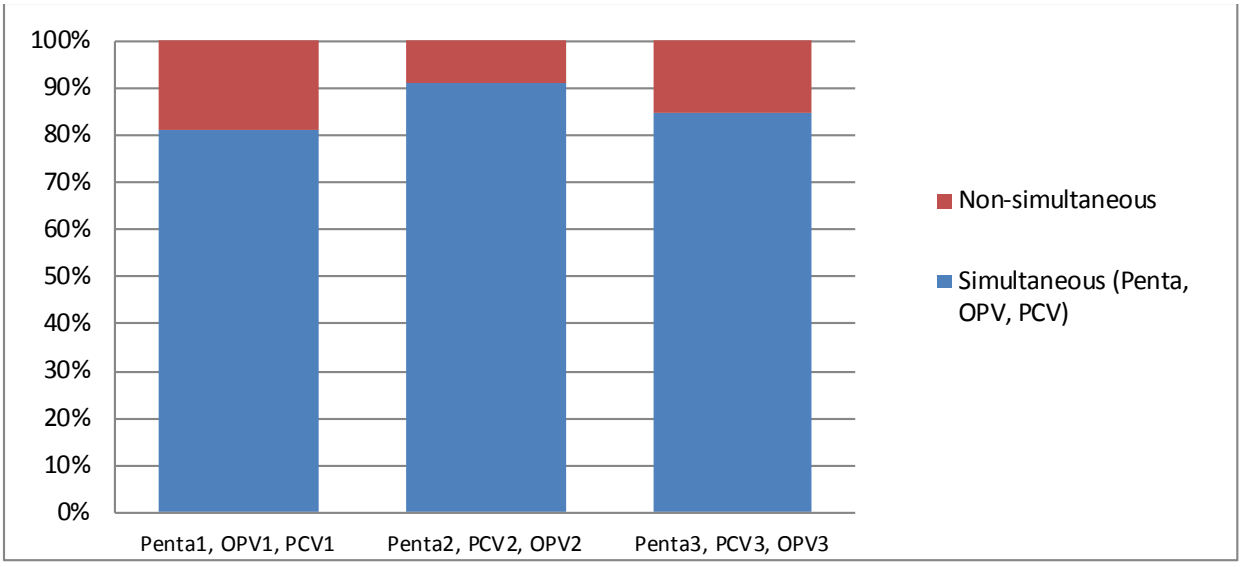


**Notes: Rotavirus vaccine was officially introduced in December 2009. Therefore, Figure 2 should not be considered an analysis of the trend of co-administered vaccine from 2009-2011, as only one complete cohort (born in 2010) has had the opportunity to receive rotavirus vaccine after this date.*

In 2011, rotavirus vaccine was administered alone in less than 10% of all doses. Co-administration of Rota1 with Penta1 and Rota2 with Penta2 is ideal, and efforts should focus on administering these vaccines at the same visit. To adhere to the age limits and interval requirements for administration of rotavirus vaccine, these visits should occur as close to 2 and 4 months of age as possible.

In 2011, PCV was consistently (in over 80% of doses) co-administered with the pentavalent and poliovirus vaccines (Figure 3). PCV should continue to be given simultaneously along with the 2, 4, and 6 month vaccines (Penta and OPV 1, 2, and 3, respectively).

Figure 3: Simultaneous administration of pneumococcal conjugate vaccine (PCV) with pentavalent and poliovirus vaccines (OPV and Penta 1,2, and 3) (n=2182), 2011



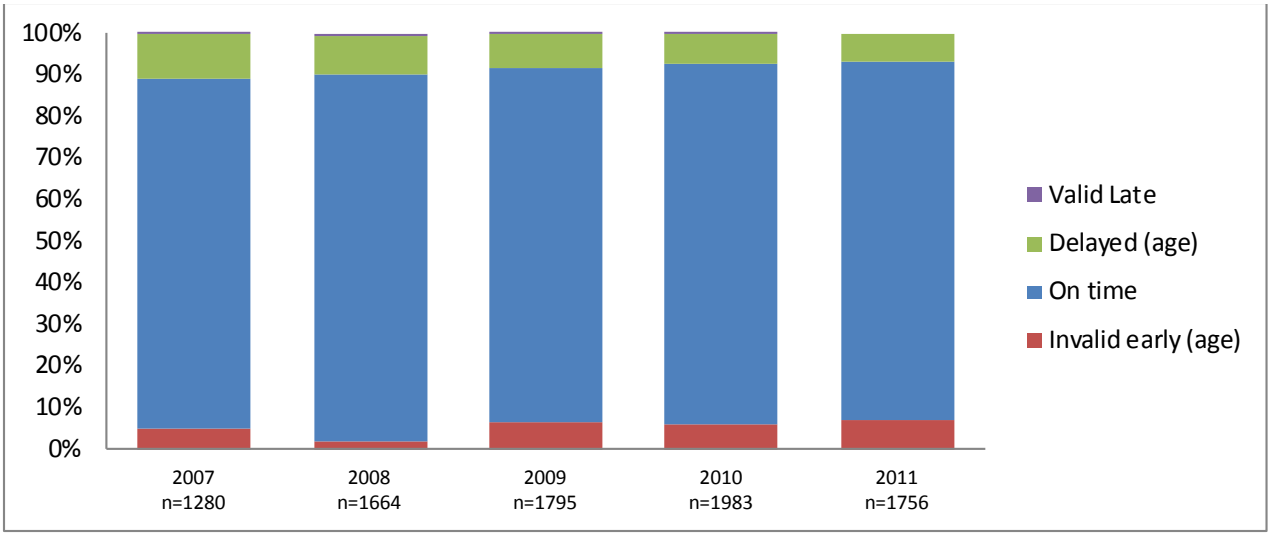
Vaccination Timeliness

In 2011, 86% of Penta1 doses were given on time (between 60 and 90 days of age), with 7% of doses given before 60 days of age (**Figures 5A-5C**). 86% of Penta2 and Penta3 doses are delayed, either based on age of the child or the interval between doses. Very few doses are being given late.

Overall, Pentavalent vaccine doses are being given either on time or with very little delay; there are very few late doses given. While doses should ideally be given at the correct ages and in appropriate intervals, almost all doses given are valid. Focus should center on continuing to minimize invalid late or early doses and ensuring that children are on time for not only the first dose, but the following two doses of Pentavalent as well.

All children in the survey were included in these graphs, therefore it should be expected that children in later (younger) age groups are less likely to have received vaccines than those in earlier (older) age groups. Further, children in earlier (older) age groups have had more time to receive late vaccinations than children in earlier (younger) age groups.

Figure 5A: Penta1 doses by timeliness category, by year of birth, Honduras 2007-2011*



**Notes: Section of the graph bars are arranged from earlier doses (bottom) to later doses (top). Although there were a large proportion of delayed Penta2 and Penta3 doses administered, this reflects the rigidity of the timeliness definitions used: untimely early doses were not taken into account when determining timeliness of later doses. Therefore, a late Penta1 dose would almost certainly make Pent a2 and 3 doses 'late', even if they were administered according to the recommended intervals between doses.*

Figure 5B: Penta2 doses by timeliness category, by year of birth, Honduras 2007-2011*

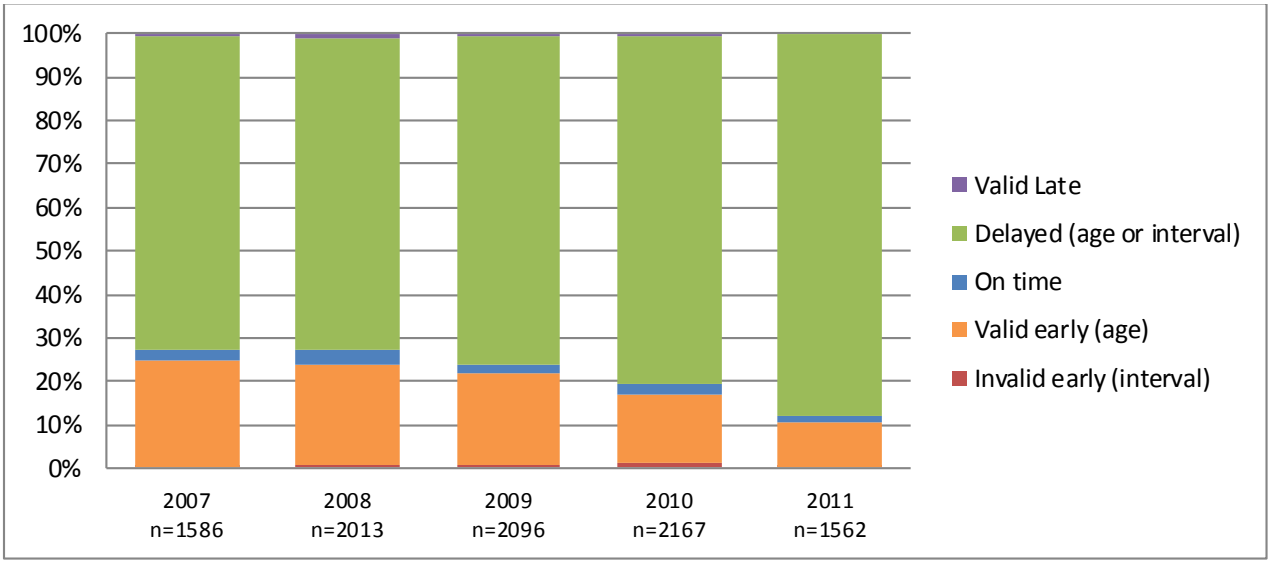
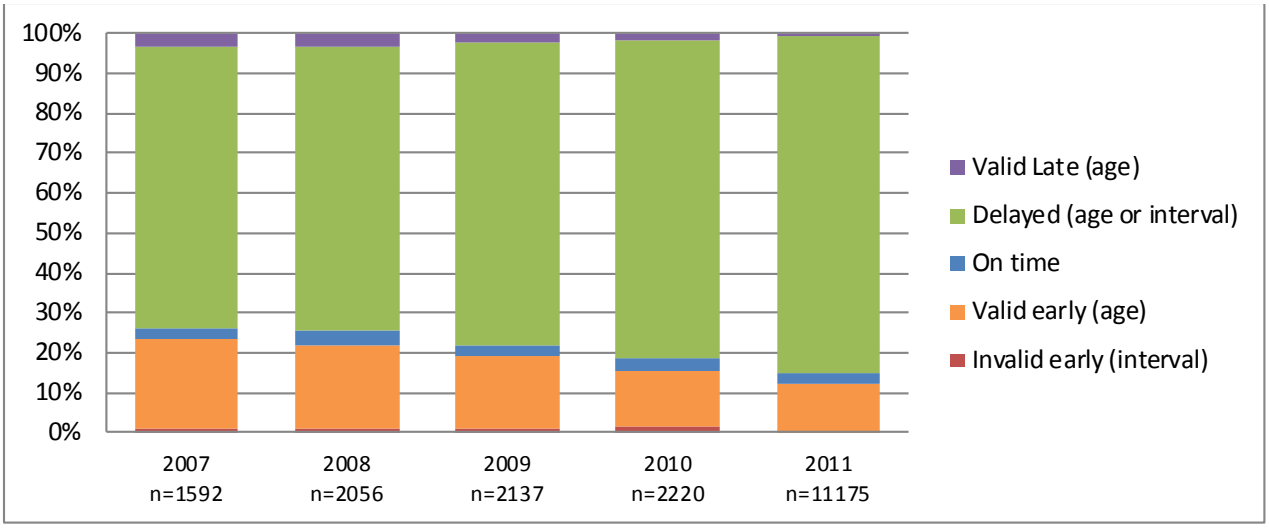


Figure 5C: Penta3 doses by timeliness category, by year of birth, Honduras 2007-2011*



In 2011, 87% of Rota1 doses are given on time, but 6.5% were given too early and 3.1% were given too late. Most Rota2 doses are delayed (92%), but almost all doses given (>99%) are valid (**Figures 6A-6B**).

Figure 6A: Timeliness of Rota1 doses by category, by year of birth, Honduras 2009-2011*

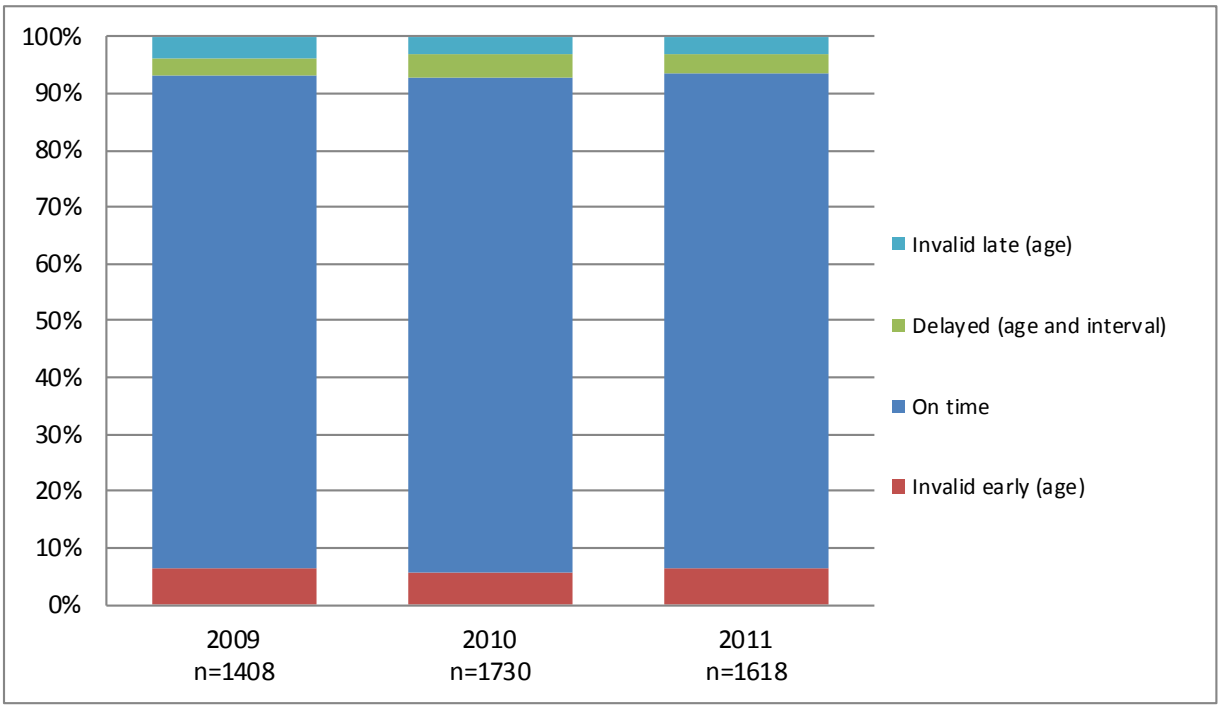
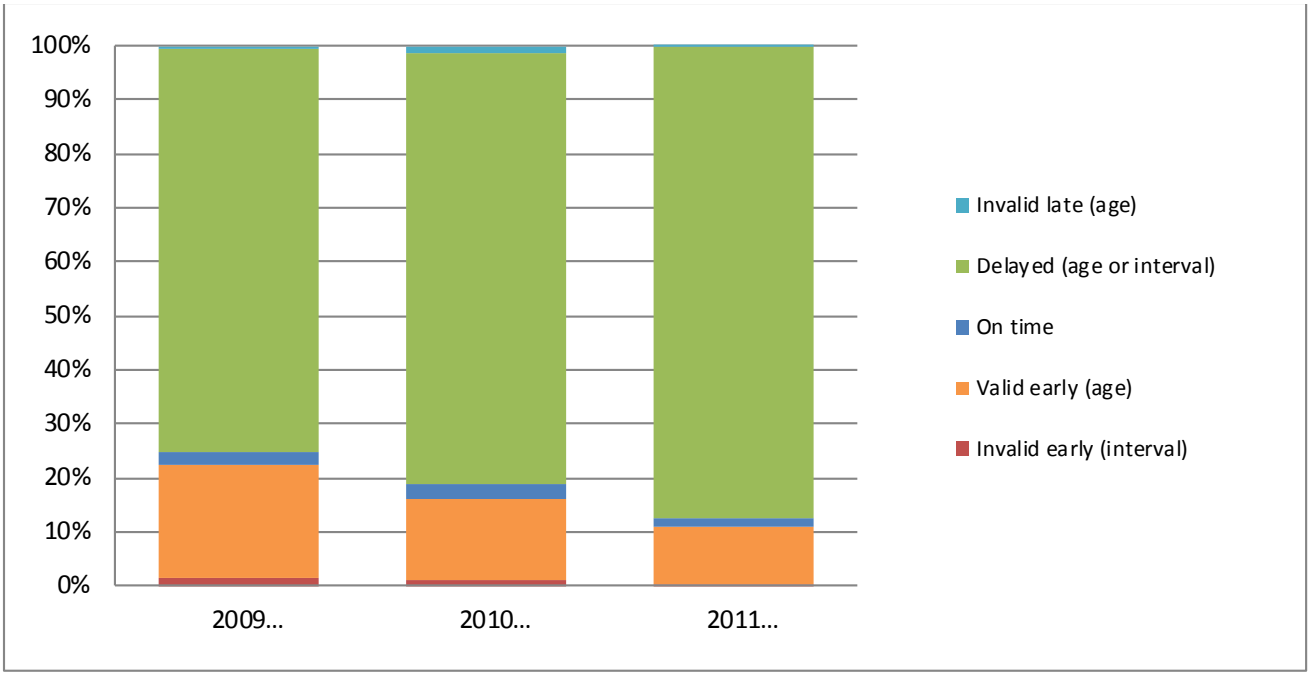


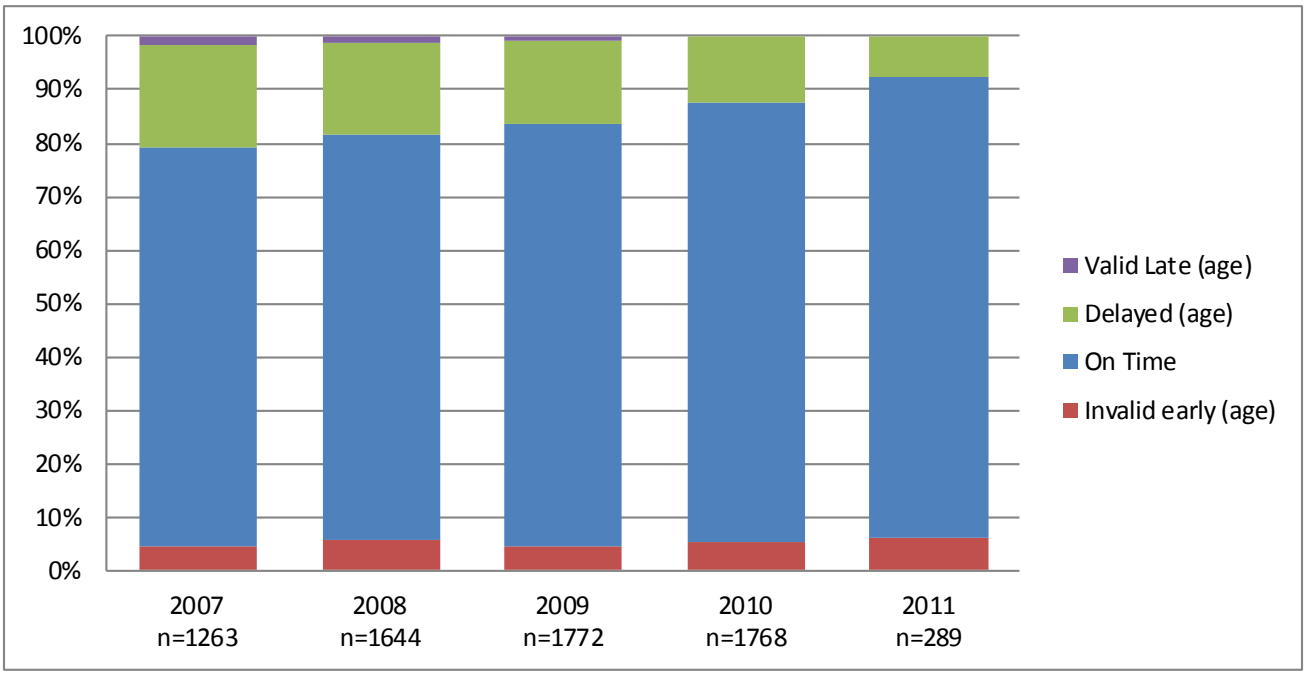
Figure 6B: Timeliness of Rota2 doses by category, by year of birth, Honduras 2009-2011*



**Notes: All children in the survey were included in these graphs, therefore it should be expected that children in later (you nger) age groups are less likely to have received vaccines than those in earlier (older) age groups. Further, children in earlier (older) age groups have had more time to receive late vaccinations than children in earlier (younger) age groups.*

In 2011, 86% of MMR doses were given on time. 8% of doses were delayed (**Figure 7**). On the whole, measles vaccine is being administered in a timely manner. Programs should continue to ensure that the measles vaccine is administered even if the child is late for the vaccine (>395 days, or >13 months, of age).

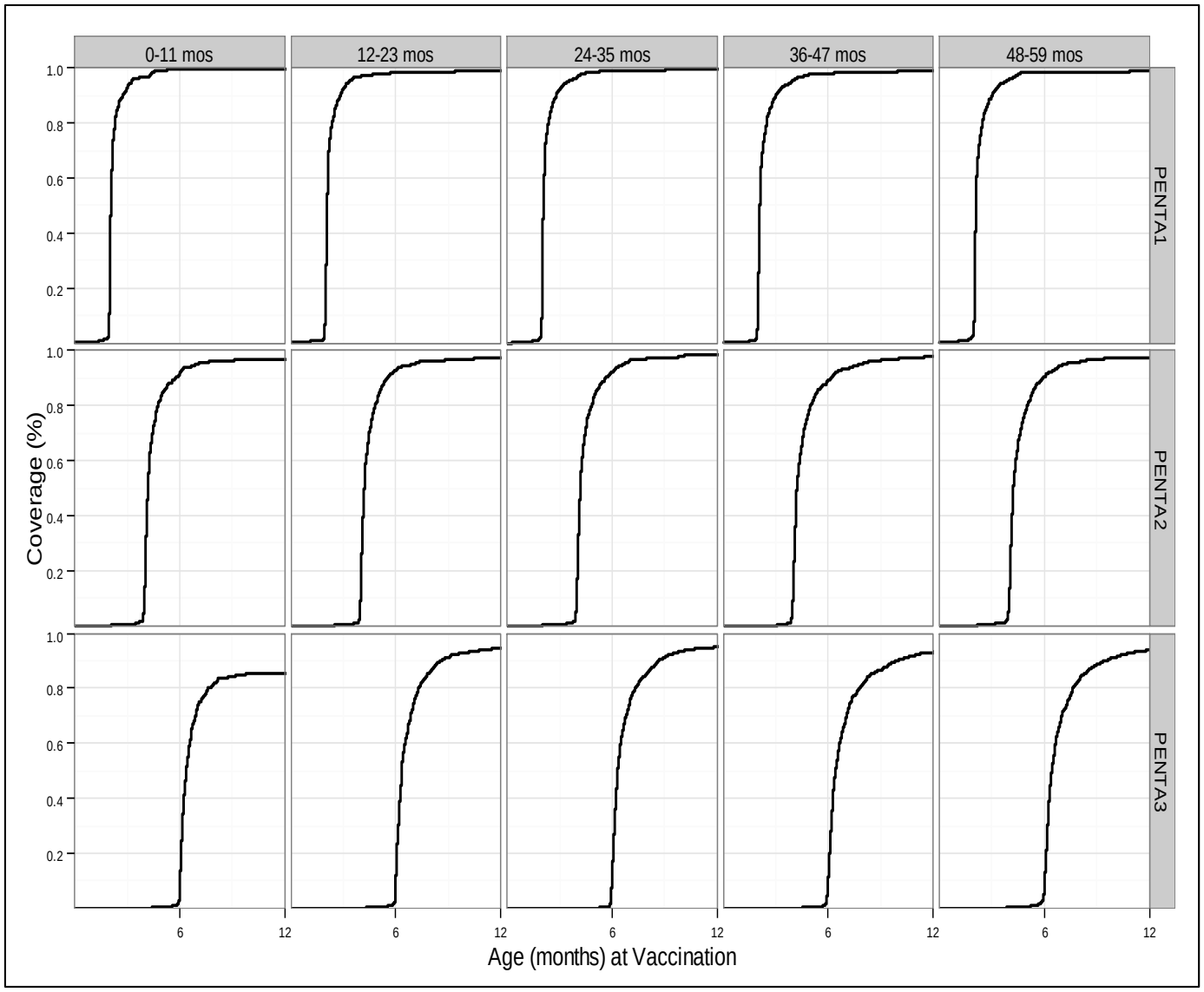
Figure 7: Timeliness of Measles vaccination by category, by year of birth, Honduras 2007-2011*



**Notes: All children in the survey were included in these graphs, therefore it should be expected that children in later (yo unger) age groups are less likely to have received vaccines than those in earlier (older) age groups. Further, children in earlier (older) age groups have had more time to receive late vaccinations than children in earlier (younger) age groups.*

Figure 8 illustrates the Penta1-3 vaccination curves shown by age cohort, with % of cohort vaccinated on the y axis (**Figure 8**). These curves depict the 'rate' of vaccination in each cohort, with steeper curves indicating that the cohort was vaccinated more quickly. Overall, most children in each cohort are being vaccinated during or close to the recommended month (see x axis), with little variation across the age cohorts included in the 2011-12 DHS. Most Pentavalent vaccinations were administered during or close to the recommended age. The program should continue to focus on administering all three doses of pentavalent vaccine on time.

Figure 8: Timeliness of Penta1-3 doses illustrated using vaccination curves, by age at time of survey, Honduras 2011

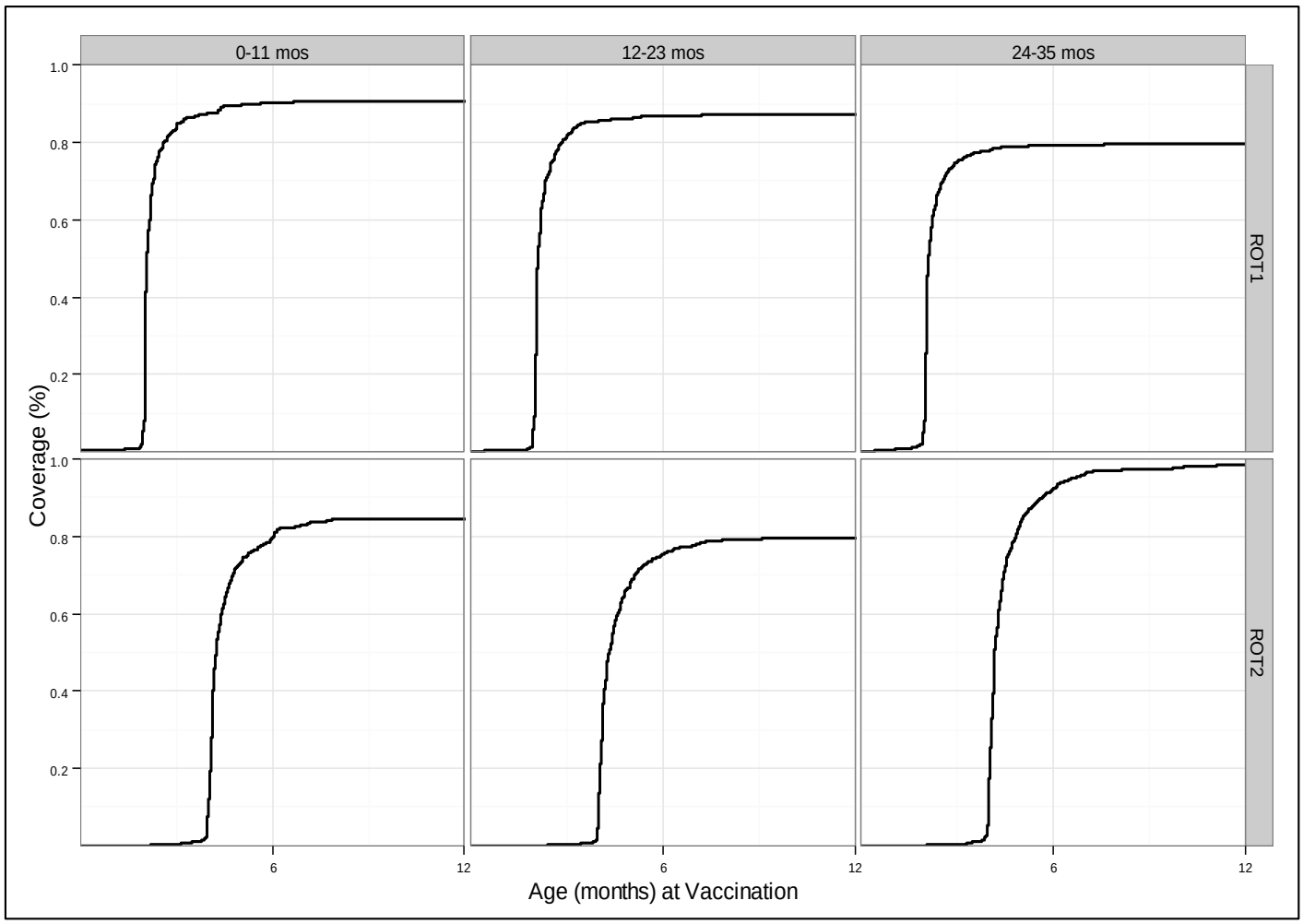


Notes: The y-value of the curve at the right-hand side of each plot corresponds to the % of children vaccinated at 12 months of age in each cohort. As expected, the curve is higher for Penta 1 (a higher percentage of children have received Penta1 at 12 months) than for Penta2, and Penta3 is lowest.

Figure 9 illustrates the Rota1-2 vaccination curves by age cohort, with % of cohort vaccinated on the y axis (Figure 9). These curves depict the 'rate' of vaccination in each cohort, with steeper curves indicating that the cohort was vaccinated more quickly. Overall, most children in each cohort are being vaccinated during or close to the recommended month (see x axis).

In 2010, most rotavirus vaccinations were administered during or close to the recommended age. Focus should continue on administering rotavirus vaccine on time and simultaneously with other vaccinations given at 2 and 4 months of age.

Figure 9: Timeliness of Rota1-2 doses, by age at time of survey, Honduras 2011



**Notes: Rotavirus vaccine was officially introduced in December 2009. Figure 9 should not be considered an analysis of the trend of timeliness of rotavirus vaccine from 2009-2011, as children 0-11 months of age (born in 2010) are the first complete cohort to have the opportunity to receive rotavirus vaccine after this date.*

Factors associated with timely vaccination

Socio-demographic and cultural characteristics were compared to vaccination status to determine whether a significant association existed (**Appendix 1 – Table 2**). Characteristics highlighted in red have significant odds ratios lower than 1 (or, in other words, are characteristics that indicate someone is less likely to be vaccinated on time) and those highlighted in green have significant odds ratios higher than 1 (are characteristics that indicate someone is more likely to be vaccinated on time).

There are few demographic characteristics that emerge consistently as predictors of timely immunization. Firstborn children were found to have a higher likelihood of timely vaccination for several vaccines in the 2011-2012 and 2005-06 survey, and children of persons who identified as Misquito were less likely to be vaccinated on time (variable available in the 2011-12 survey only). However, none of these relationships were significant for every vaccine that was assessed and there were no clear trends across the two surveys. There is no clear pattern of demographic groups that are consistently more or less timely in receiving

Summary

This analysis demonstrates that, in general, vaccinations are given in a timely manner in Honduras. Most doses of vaccines that can and that should be co-administered are co-administered. Very few invalid doses of any vaccine are administered. Further, there is a high level of equity among vaccinated children, as few demographic groups emerged as chronically late for vaccination.

Several recommendations may be made based on this report.

- While the proportion of vaccinations recommended at 2, 4, and 6 months given simultaneously is high, the program should focus on consistent co-administration of Rota1 with Penta1 (rather than Rota1 alone or together with Penta2) and Rota2 with Penta2, while adhering to the recommended ages and intervals of administration of Rota1 and Rota2. PCV should continue to be co-administered with 2, 4, and 6 month vaccines as frequently as possible. Health workers must be encouraged to administer vaccinations simultaneously, when appropriate.
- Although most doses of rotavirus vaccine are valid, close to 10% of doses administered are invalid (either given to children age <2 months or before the 28-days interval required between dose 1 and dose 2). Administration of invalid doses of Rotavirus vaccine should be minimized. Rotavirus vaccine administration generally is recommended to occur in a specific window in order to be both immunogenically effective and safe. Continued efforts should be made to adhere to the upper and lower age limits for rotavirus vaccination by encouraging timely vaccination. Honduras' new immunization registry should help systematically monitor vaccination timeliness. Health workers must receive proper training in recognizing when a dose is invalid and in encouraging caregivers to attend the health center at a time when the maximum number of valid doses can be administered to the child.
- Efforts should be made to reduce any inequity with respect to vaccination timeliness that may exist because of membership to a specific religious or cultural group. Vaccination should be equally accessible to all groups and every person should be encouraged to seek health services.

Appendix: Factors compared to vaccination status

Characteristics highlighted in red have significant odds ratios lower than 1 (or, in other words, are characteristics that indicate someone is less likely to be vaccinated on time) and those highlighted in green have significant odds ratios higher than 1 (are characteristics that indicate someone is more likely to be vaccinated on time).

Predictors of timeliness of vaccination with Rota1 **(11-12 survey)**

Characteristics	**OR**	**95%CI**	
Female	0.915	0.754	1.111
Firstborn child (vs. any other order child)	1.147	0.911	1.444
Religion			
No religion	0.908	0.659	1.253
Evangelical/Protestant	0.918	0.745	1.131
Catholic	ref		
Race/ethnicity			
Misquito	0.376	0.253	0.561
Lenca	1.441	0.964	2.154
Other	0.905	0.6	1.365
None	ref		
Residence in urban area	0.972	0.762	1.24
Wealth quintile			
1st wealth quintile	0.821	0.604	1.116
2nd wealth quintile	0.901	0.661	1.227
3rd wealth quintile			
4th wealth quintile	1.086	0.775	1.521
5th wealth quintile	1.099	0.736	1.64
Maternal age			
Age 15-19	ref		
Age 20-24	0.982	0.753	1.28
Age 25-29	0.903	0.686	1.19
Age 30-34	0.736	0.545	0.993
Maternal education (some)	1.778	0.625	5.061
Maternal literacy	1.344	0.513	3.521
Maternal occupation			
Professional, technical, management	ref		
Not working	1.515	0.97	2.367
Clerical, sales, services, skilled manual	1.378	0.871	2.182
Agriculture, household/domestic, unskilled manual	1.049	0.647	1.701
Mother married	1.455	1.142	1.853
Maternal TT Receipt	0.993	0.797	1.236

Predictors of timeliness of vaccination with Penta1 **(11-12 survey)**

Characteristics	OR	95%CI	
Female	0.907	0.772	1.065
Firstborn child	1.398	1.149	1.7
Religion			
No religion	0.903	0.688	1.186
Evangelical/Protestant	0.863	0.727	1.025
Catholic	ref		
Race/ethnicity			
Misquito	0.398	0.282	0.563
Lenca	1.63	1.156	2.299
Other	0.884	0.621	1.259
None	ref		
Residence in urban area	0.987	0.802	1.213
Wealth quintile			
1st wealth quintile	0.946	0.737	1.215
2nd wealth quintile	1.084	0.843	1.393
3rd wealth quintile	ref		
4th wealth quintile	1.324	1.003	1.747
5th wealth quintile	1.37	0.981	1.913
Maternal age			
Age 15-19	ref		
Age 20-24	1.113	0.893	1.387
Age 25-29	1.142	0.915	1.426
Age 30-34	0.922	0.728	1.168
Maternal education (some)	1.128	0.395	3.22
Maternal literacy	2.053	1.041	4.052
Maternal occupation			
Professional, technical, management	ref		
Not working	1.291	0.873	1.909
Clerical, sales, services, skilled manual	1.25	0.836	1.87
Agriculture, household/domestic, unskilled manual	1.022	0.675	1.549
Mother married	1.585	1.297	1.939
Maternal TT Receipt	0.993	0.829	1.189

Predictors of timeliness of vaccination with Penta3 **(11-12 survey)**

Characteristics	OR	95%CI	
Female	1.031	0.707	1.503
Firstborn child	0.863	0.556	1.341
Religion			
No religion	0.774	0.389	1.538
Evangelical/Protestant	0.917	0.613	1.37
Catholic	ref		
Race/ethnicity			
Misquito	1.803	0.748	4.346
Lenca	1.27	0.698	2.308
Other	0.444	0.139	1.411
None	ref		
Residence in urban area	1.567	0.909	2.704
Wealth quintile			
1st wealth quintile	1.48	0.768	2.854
2nd wealth quintile	1.48	0.756	2.896
3rd wealth quintile	ref		
4th wealth quintile	2.076	1.027	4.197
5th wealth quintile	1.912	0.853	4.287
Maternal age			
Age 15-19	ref		
Age 20-24	0.687	0.411	1.149
Age 25-29	0.885	0.534	1.466
Age 30-34	0.932	0.525	1.653
Maternal education (some)			
Maternal literacy	0.309	0.09	1.066
Maternal occupation			
Professional, technical, management	ref		
Not working	1.14	0.483	2.69
Clerical, sales, services, skilled manual	0.957	0.383	2.393
Agriculture, household/domestic, unskilled manual	0.864	0.323	2.314
Mother married	1.076	0.716	1.617
Maternal TT Receipt	1.666	1.04	2.669
Timely receipt of Penta1	1.385	0.492	3.902
Timely receipt of Penta2	0.692	0.208	2.297
Timely receipt of Rota1	1.172	0.456	3.011

Predictors of timeliness of vaccination with MMR **(11-12 survey)**

Characteristics	OR	95%CI	
Female	1.219	0.971	1.531
Firstborn child	1.586	1.218	2.064
Religion			
No religion	1.019	0.694	1.497
Evangelical/Protestant	0.891	0.699	1.137
Catholic	ref		
Race/ethnicity			
Misquito	0.36	0.209	0.618
Lenca	1.621	1.001	2.624
Other	0.811	0.518	1.269
None	ref		
Residence in urban area	1.164	0.864	1.569
Wealth quintile			
1st wealth quintile	0.811	0.56	1.173
2nd wealth quintile	1.222	0.832	1.794
3rd wealth quintile	ref		
4th wealth quintile	0.815	0.562	1.183
5th wealth quintile	0.757	0.492	1.165
Maternal age			
Age 15-19	ref		
Age 20-24	0.691	0.506	0.944
Age 25-29	0.931	0.678	1.277
Age 30-34	1.065	0.75	1.512
Maternal education (some)	0.395	0.037	4.27
Maternal literacy	0.675	0.154	2.948
Maternal occupation			
Professional, technical, management	ref		
Not working	1.312	0.794	2.165
Clerical, sales, services, skilled manual	1.264	0.755	2.118
Agriculture, household/domestic, unskilled manual	1.296	0.735	2.285
Mother married	1.034	0.799	1.337
Maternal TT Receipt	0.919	0.709	1.192
Timely receipt of Penta1	0.907	0.514	1.602
Timely receipt of Penta2	0.561	0.325	0.968
Timely receipt of Penta3	0.777	0.45	1.343
Timely receipt of Rota1	1.882	1.108	3.195

Predictors of timeliness of vaccination with Penta1 **(05-06 survey)**

Characteristics	OR	95%CI	
Female	1.047	0.901	1.216
Firstborn child	1.558	1.281	1.896
Religion			
No religion			
Evangelical/Protestant			
Catholic			
Race/ethnicity			
Misquito			
Lenca			
Other			
None			
Residence in urban area	0.959	0.773	1.19
Wealth quintile			
1st wealth quintile	0.769	0.603	0.979
2nd wealth quintile	0.92	0.723	1.172
3rd wealth quintile	ref		
4th wealth quintile	1.053	0.809	1.371
5th wealth quintile	1.169	0.852	1.604
Maternal age			
Age 15-19	ref		
Age 20-24	1.125	0.917	1.38
Age 25-29	1.269	1.032	1.561
Age 30-34	1.247	0.993	1.566
Maternal education (some)	1.094	0.455	2.635
Maternal literacy	0.933	0.577	1.51
Maternal occupation			
Professional, technical, management	ref		
Not working	0.987	0.645	1.511
Clerical, sales, services, skilled manual	0.894	0.574	1.391
Agriculture, household/domestic, unskilled manual	0.79	0.504	1.238
Mother married	1.127	0.957	1.327
Maternal TT Receipt	0.916	0.782	1.073

Predictors of timeliness of vaccination with Penta3 **(05-06 survey)**

Characteristics	OR	95%CI	
Female	1.182	0.884	1.582
Firstborn child	0.992	0.69	1.428
Religion			
No religion			
Evangelical/Protestant			
Catholic			
Race/ethnicity			
Misquito			
Lenca			

Other			
None			
Residence in urban area	1.396	0.877	2.221
Wealth quintile			
1st wealth quintile	0.881	0.551	1.408
2nd wealth quintile	0.774	0.486	1.23
3rd wealth quintile	ref		
4th wealth quintile	0.759	0.456	1.263
5th wealth quintile	1.1	0.612	1.977
Maternal age			
Age 15-19	ref		
Age 20-24	0.984	0.651	1.487
Age 25-29	0.894	0.591	1.351
Age 30-34	1.179	0.769	1.806
Maternal education (some)			
Maternal literacy	0.889	0.348	2.272
Maternal occupation			
Professional, technical, management	ref		
Not working	0.768	0.377	1.565
Clerical, sales, services, skilled manual	0.643	0.302	1.372
Agriculture, household/domestic, unskilled manual	0.743	0.343	1.611
Mother married	1.003	0.732	1.374
Maternal TT Receipt	1.195	0.87	1.641
Timely receipt of Penta1	1.588	1.031	2.445
Timely receipt of Penta2	1.683	0.972	2.913

Predictors of timeliness of vaccination with MMR **(05-06 survey)**

Characteristics	**OR**	**95%CI**	
Female	1.127	0.963	1.32
Firstborn child	1.874	1.521	2.309
Religion			
No religion			
Evangelical/Protestant			
Catholic			
Race/ethnicity			
Misquito			
Lenca			
Other			
None			
Residence in urban area	1.031	0.823	1.292
Wealth quintile			
1st wealth quintile	0.851	0.659	1.1
2nd wealth quintile	1.068	0.829	1.374
3rd wealth quintile	ref		

4th wealth quintile	1	0.765	1.308
5th wealth quintile	0.849	0.623	1.158
Maternal age			
Age 15-19	ref		
Age 20-24	1.026	0.815	1.292
Age 25-29	1.216	0.98	1.511
Age 30-34	1.146	0.909	1.445
Maternal education (some)	1.684	0.67	4.231
Maternal literacy	1.215	0.709	2.081
Maternal occupation			
Professional, technical, management	ref		
Not working	0.824	0.534	1.271
Clerical, sales, services, skilled manual	0.73	0.466	1.143
Agriculture, household/domestic, unskilled manual	0.722	0.456	1.143
Mother married	1.163	0.981	1.379
Maternal TT Receipt	0.906	0.763	1.075
Timely receipt of Penta1	1.807	1.494	2.185
Timely receipt of Penta2	0.888	0.618	1.276
Timely receipt of Penta3	1.126	0.789	1.606