

Supplemental material

Table S1: Socio-demographic characteristics of children aged 12-23 months, DLHS 1 – 3

Socio-demographic characteristics	<u>DLHS-1 (1998-99)</u>		<u>DLHS-2 (2002-04)</u>		<u>DLHS-3 (2007-08)</u>		<u>Combined DLHS surveys</u>		P-value**
	<i>N</i> *	Weighted percentage (95% CI)	<i>N</i>	Weighted percentage (95% CI)	<i>N</i>	Weighted percentage (95% CI)	<i>N</i>	Weighted percentage (95% CI)	
Mother's age at birth of eligible child	58,777		58,400		61,280		178,457		
≤ 18		8.7 (8.4 - 9.0)		17.4 (16.9 - 17.9)		6.6 (6.4 - 6.9)		10.0 (9.7 - 10.2)	<0.001
19-25		51.3 (50.8 - 51.9)		52.7 (52.1 - 53.4)		56.0 (55.5 - 56.4)		53.9 (53.6 - 54.2)	
26-35		35.6 (35.1 - 36.1)		27.1 (26.5 - 27.8)		33.9 (33.4 - 34.4)		32.5 (32.2 - 32.9)	
> 35		4.4 (4.2 - 4.6)		2.7 (2.6 - 2.9)		3.5 (3.4 - 3.7)		3.5 (34.4 - 36.5)	
Location	58,777		58,416		61,280		178,473		
Rural		79.7 (78.3 - 81.0)		72.3 (70.4 - 74.1)		72.2 (68.8 - 75.3)		74.1 (72.1 - 76.0)	<0.001
Urban		20.3 (19.0 - 21.7)		27.7 (25.9 - 29.6)		27.8 (24.7 - 31.2)		25.9 (24.0 - 27.9)	
Mother's education	56,584		54,998		61,280		172,862		
Illiterate (no schooling)		60.1 (59.4 - 60.7)		53.8 (52.8 - 54.8)		42.0 (41.1 - 42.8)		49.5 (48.9 - 50.1)	<0.001
Primary (1-5 years of schooling)		11.1 (10.8 - 11.5)		12.1 (11.7 - 12.6)		14.5 (14.2 - 14.9)		13.1 (12.9 - 13.3)	
Middle (6 - 8 years of schooling)		12.6 (12.2 - 13.0)		14.6 (14.1 - 15.1)		15.7 (15.4 - 16.0)		14.6 (14.4 - 14.8)	
High school and above (9 years & above)		16.2 (15.7 - 16.8)		19.5 (18.8 - 20.3)		27.9 (27.0 - 28.8)		22.8 (22.2 - 23.4)	
Type of dwelling	58,766		58,416		61,279		178,461		
Mud		42.5 (41.8 - 43.1)		36.9 (36.0 - 37.9)		37.6 (36.6 - 38.6)		38.7 (38.1 - 39.3)	<0.001
Semi-cemented		31.6 (31.1 - 32.2)		35.2 (34.5 - 35.9)		33.6 (33.0 - 34.0)		33.5 (33.1 - 33.9)	
Cemented		25.9 (25.3 - 26.6)		27.9 (27.0 - 28.9)		28.9 (27.7 - 30.1)		27.9 (27.1 - 28.6)	

Non-institutional						
		65.7 (65.1 - 66.4)	59.3 (58.4 - 60.2)	54.1 (53.2 - 55.1)	58.5 (57.8 - 59.1)	
Region	58,777		58,416	61,280	178,473	
North		28.5 (28.0 - 28.9)	26.0 (25.4 - 26.7)	31.0 (30.4 - 31.6)	29.0 (28.7 - 29.4)	
Central		7.7 (7.5 - 8.0)	8.2 (7.9 - 8.5)	10.3 (9.9 - 10.7)	9.1 (8.9 - 9.3)	
East		24.1 (23.6 - 24.5)	23.9 (23.2 - 24.7)	20.6 (20.0 - 21.2)	22.4 (22.0 - 22.7)	
North-East		4.0 (3.9 - 4.1)	3.1 (2.9 - 3.3)	10.1 (9.7 - 10.5)	6.7 (6.5 - 6.9)	<0.001
West		18.2 (17.8 - 18.6)	19.4 (18.7 - 20.1)	15.3 (14.8 - 15.8)	17.1 (16.8 - 17.5)	
South		17.6 (17.2 - 18.0)	19.4 (18.8 - 20.0)	12.8 (12.4 - 13.2)	15.7 (15.5 - 16.0)	

*N' represents unweighted sample size

** P-value from the Chi-squared test for differences in proportions by DLHS survey

Table S2: Results of the multivariate regression modeling for partially vaccinated children, DLHS1-3

Covariates	Weighted Proportion (95% CI)*			Adjusted Prevalence Odds Ratio (95% CI)**	
	Almost all (6-7 doses)	Some (3-5 doses)	Very few (1-2 doses)	Very few vs. Almost all vaccines	Some vs. Almost all vaccines
Survey period					
1998 - 1999	48.8 (47.9 - 49.8)	32.8 (31.7 - 33.9)	18.4 (17.5 - 19.2)		Ref
2002 - 2004	47.0 (45.3 - 48.8)	35.6 (34.4 - 36.7)	17.4 (16.1 - 18.8)	1.18 (1.06 - 1.30)	1.23 (1.14 - 1.33)
2007 - 2008	52.8 (51.9 - 53.8)	35.8 (34.9 - 36.7)	11.4 (10.9 - 11.8)	0.69 (0.64 - 0.74)	1.14 (1.05 - 1.24)
Location					
Rural	56.9 (55.8 - 58.0)	31.6 (30.7 - 32.6)	11.5 (10.6 - 12.3)		Ref
Urban	48.6 (47.8 - 49.2)	36.0 (35.4 - 36.5)	15.4 (14.9 - 16.0)	1.02 (0.92 - 1.13)	0.99 (0.93 - 1.06)
Religion					
Hindu	50.9 (49.9 - 51.9)	34.8 (34.2 - 35.4)	14.3 (13.6 - 14.9)		Ref

Muslim	46.2 (44.8 - 47.5)	36.2 (35.3 - 37.2)	17.6 (16.4 - 18.8)	1.39 (1.25 - 1.55)	1.19 (1.17 - 1.28)
Christian	49.1 (46.2 - 52.0)	37.7 (35.4 - 39.9)	13.2 (11.1 - 15.2)	1.29 (0.98 - 1.68)	1.21 (1.04 - 1.39)
Other***	60.3 (57.4 - 63.2)	31.0 (28.4 - 33.5)	8.7 (7.0 - 10.4)	0.67 (0.53 - 0.85)	0.79 (0.70 - 0.89)
Social class					
General class	53.9 (52.9 - 55.0)	33.2 (32.2 - 34.1)	12.9 (12.1 - 13.7)		Ref
Scheduled caste	49.6 (48.0 - 51.2)	35.6 (34.3 - 3.0)	14.8 (13.8 - 15.7)	1.11 (0.99 - 1.24)	1.04 (0.95 - 1.14)
Scheduled tribe	46.8 (45.1 - 48.5)	38.2 (36.9 - 39.5)	15.0 (13.7 - 16.2)	1.14 (0.98 - 1.32)	1.03 (0.93 - 1.14)
Other backward classes	49.7 (48.6 - 50.8)	34.8 (34.0 - 35.7)	15.5 (14.8 - 16.2)	1.22 (1.11 - 1.34)	1.05 (0.96 - 1.14)
Mother's age at birth of eligible child					
≤ 18	48.1 (46.2 - 50.0)	36.1 (34.3 - 38.0)	15.8 (14.6 - 17.0)	1.17 (1.05 - 1.30)	1.08 (0.98 - 1.18)
19-25	51.8 (50.7 - 52.8)	34.9 (34.2 - 35.6)	13.3 (12.6 - 14.0)		Ref
26-35	49.7 (48.6 - 50.7)	34.4 (33.5 - 35.4)	15.9 (15.1 - 16.7)	1.00 (0.94 - 1.07)	0.92 (0.87 - 0.97)
> 35	42.5 (39.8 - 45.2)	39.1 (36.6 - 41.5)	18.4 (16.8 - 20.0)	1.01 (0.87 - 1.19)	1.03 (0.90 - 1.18)
Mother's education					
High school and above (9 years & above)	66.6 (65.3 - 67.8)	26.6 (25.5 - 27.8)	6.8 (6.1 - 7.5)		Ref
Middle (6 - 8 years of schooling)	56.6 (55.0 - 58.2)	33.0 (31.7 - 34.4)	10.4 (9.5 - 11.3)	1.01 (0.87 - 1.19)	1.25 (1.13 - 1.39)
Primary (1 - 5 years of schooling)	52.8 (51.0 - 54.5)	34.5 (33.2 - 35.8)	12.7 (11.6 - 13.8)	1.00 (0.94 - 1.07)	1.30 (1.16 - 1.46)
No schooling	43.8 (42.9 - 44.6)	37.9 (37.3 - 38.6)	18.3 (17.6 - 19.0)	1.17 (1.05 - 1.30)	1.53 (1.38 - 1.69)
Number of antenatal care visits					
≥ 7	63.9 (61.5 - 66.3)	28.0 (26.2 - 29.9)	8.1 (6.6 - 9.5)		Ref

3 - 6	60.8 (59.8 - 61.8)	30.7 (29.8 - 31.6)	8.5 (7.9 - 9.1)	0.73 (0.59 - 0.90)	0.89 (0.78 - 1.00)
1 - 2	49.1 (47.9 - 50.4)	36.6 (35.5 - 37.6)	14.3 (13.4 - 15.2)	1.03 (0.81 - 1.32)	1.07 (0.96 - 1.21)
None	40.1 (39.2 - 41.0)	38.9 (38.0 - 39.8)	21.0 (20.2 - 21.8)	1.03 (0.81 - 1.32)	1.06 (0.93 - 1.20)
Maternal tetanus vaccination					
Yes	54.8 (53.9 - 55.7)	33.3 (32.7 - 34.0)	11.9 (11.3 - 12.4)		Ref
No	38.4 (37.4 - 39.3)	39.9 (38.9 - 40.8)	21.7 (20.7 - 22.8)	1.74 (1.58 - 1.92)	1.29 (1.20 - 1.38)
Gender of eligible child					
Male	50.9 (50.1 - 51.8)	34.9 (34.3 - 35.5)	14.1 (13.4 - 14.8)		Ref
Female	49.7 (48.6 - 50.7)	35.2 (34.4 - 36.0)	15.1 (14.4 - 15.9)	1.09 (1.02 - 1.19)	1.03 (0.98 - 1.07)
Place of delivery					
Institutional government	59.0 (57.6 - 60.4)	31.4 (30.3 - 32.6)	9.6 (8.7 - 10.4)		Ref
Institutional private	60.9 (59.5 - 62.3)	29.4 (28.3 - 30.6)	9.7 (8.6 - 10.7)	1.09 (0.93 - 1.29)	0.99 (0.91 - 1.09)
Non-institutional	45.7 (44.9 - 46.4)	37.3 (36.8 - 37.9)	17.0 (16.4 - 17.6)	1.08 (0.96 - 1.22)	1.07 (1.00 - 1.13)
Vaccination card					
Yes (seen)	63.7 (62.6 - 64.8)	29.2 (28.3 - 30.2)	7.1 (6.4 - 7.7)		Ref
Yes (not seen)	53.9 (52.9 - 54.8)	35.9 (35.3 - 36.6)	10.2 (9.5 - 10.9)	1.60 (1.43 - 1.80)	1.40 (1.33 - 1.48)
No	34.1 (33.2 - 35.0)	39.5 (38.5 - 40.5)	26.3 (25.6 - 27.1)	5.40 (4.86 - 6.00)	2.19 (2.05 - 2.35)

* Coverage proportions presented for combined DLHS surveys and are calculated using the total weighted sample of children in each covariate category as the denominator

** Adjusted for type of dwelling, age of child in months and geographical region

*** Other religions include Sikh, Buddhism, Jainism, Judaism and Atheism

Table S3: Comparative categorization of reported reasons for non-vaccination using standard operational categories (supply/demand), “5As Taxonomy for Determinants of Vaccine Uptake” and “Classification of Factors Affecting Receipt of Vaccines” [31].

Reasons for non-vaccination (DLHS category)	Standard operational category	5As Taxonomy for Determinants of Vaccine Uptake (Thomson A, et al., 2016)	Classification of Factors Affecting Receipt of Vaccines (Hadler S et al., 2008)
Place of immunization too far	Supply-side	Access	Immunization systems
Time of immunization inconvenient	Supply-side	Affordabililty	Immunization systems
Mother too busy	Demand-side	Affordability	Family characteristics
Financial problem	Demand-side	Affordabililty	Immunization systems
Family problem/mother ill	Demand-side	Affordability	Family characteristics
Unaware of need for immunization	Demand-side	Awareness	Parental attitudes and knowledge
Place of immunization unknown	Demand-side	Awareness	Parental attitudes and knowledge
Time of immunization unknown	Demand-side	Awareness	Parental attitudes and knowledge
Child too young for immunization	Demand-side	Acceptance	Parental attitudes and knowledge
Fear of side effects	Demand-side	Acceptance	Parental attitudes and knowledge
No faith in immunization	Demand-side	Acceptance	Parental attitudes and knowledge

Child ill so not taken	Demand-side	Acceptance	Parental attitudes and knowledge
Child is girl/Customary	Demand-side	Acceptance	Parental attitudes and knowledge
ANM absent	Supply-side	Not categorized	Immunization systems
Vaccine not available	Supply-side	Not categorized	Immunization systems
Child ill, taken but not given	Supply-side	Not categorized	Immunization systems
Long waiting time	Supply-side	Not categorized	Immunization systems

Table S4: Vaccination proportions for Indian children aged 12-23 months by vaccination card status, DLHS 1-3

Category	Weighted percentages (95% CI)				Relative change (%)*	P-value**
	DLHS-1 (1998-99)	DLHS-2 (2002-04)	DLHS-3 (2007-08)	Combined surveys (DLHS 1 - 3)		
<i>Vaccination card status</i>						
No	35.1 (34.5 - 35.6)	39.6 (38.9 - 40.5)	25.1 (24.6 - 25.7)	31.5 (31.1 - 31.9)	-28.4	
Yes, not seen	30.8 (30.3 - 31.3)	29.0 (28.4 - 29.5)	31.0 (30.6 - 31.4)	30.4 (30.1 - 30.7)	0.6	<0.001
Yes, seen	34.1 (33.6 - 34.7)	31.4 (30.7 - 32.1)	43.9 (43.3 - 44.4)	38.1 (31.1 - 31.9)	28.7	
<i>No Vaccination card</i>						
BCG	38.5 (37.6 - 39.4)	47.1 (46.0 - 48.1)	58.0 (57.0 - 58.9)	48.8 (48.3 - 49.4)	50.6	<0.001
DPT3	30.5 (29.7 - 31.3)	29.7 (28.8 - 30.7)	26.4 (25.5 - 27.3)	28.7 (28.1 - 29.2)	-5.9	<0.001

OPV3	34.5 (33.7 - 35.4)	31.2 (30.2 - 32.2)	32.9 (31.9 - 33.8)	32.8 (32.3 - 33.4)	-4.6	<0.001
Measles	26.1 (25.3 - 27.0)	29.8 (28.9 - 30.7)	37.8 (36.9 - 38.8)	31.9 (31.3 - 32.4)	44.8	<0.001
Fully vaccinated	21.9 (21.2 - 22.7)	22.5 (21.6 - 23.4)	22.7 (21.8 - 23.5)	22.4 (21.9 - 22.9)	3.7	
Partially vaccinated	23.7 (23.0 - 24.5)	29.9 (29.1 - 30.7)	40.0 (39.0 - 40.9)	32.0 (31.5 - 32.5)	68.8	<0.001
Unvaccinated	54.3 (53.4 - 55.2)	47.7 (46.6 - 48.7)	37.4 (36.4 - 38.3)	45.6 (45.1 - 46.2)	-31.1	
<u>Vaccination card, not seen</u>						
BCG	89.2 (88.6 - 89.7)	91.2 (90.5 - 91.8)	93.5 (93.1 - 93.9)	91.8 (91.5 - 92.1)	4.8	<0.001
DPT3	80.7 (80.0 - 81.4)	71.7 (70.6 - 72.8)	56.4 (55.5 - 57.2)	66.5 (66.0 - 67.0)	-30.1	<0.001
OPV3	82.3 (81.5 - 83.3)	71.2 (70.1 - 72.3)	60.0 (59.0 - 60.7)	68.5 (67.9 - 69.0)	-27.1	<0.001
Measles	72.8 (72.0 - 73.7)	70.2 (69.0 - 71.3)	75.3 (74.6 - 75.9)	73.4 (72.9 - 73.9)	3.4	<0.001
Fully vaccinated	66.8 (65.8 - 67.7)	60.6 (59.4 - 61.8)	51.0 (50.2 - 51.9)	57.5 (56.9 - 58.1)	-23.7	
Partially vaccinated	28.0 (27.1 - 28.9)	34.1 (33.0 - 35.3)	44.7 (43.9 - 45.4)	37.7 (37.2 - 38.3)	59.6	<0.001
Unvaccinated	5.2 (4.8 - 5.7)	5.3 (4.8 - 5.8)	4.3 (4.0 - 4.6)	4.8 (4.6 - 5.0)	-17.3	
<u>Vaccination card, seen</u>						
BCG	96.6 (96.2 - 96.9)	97.0 (96.5 - 97.4)	98.9 (98.7 - 99.1)	98.0 (97.8 - 98.2)	2.3	<0.001
DPT3	88.7 (88.2 - 89.4)	83.1 (82.1 - 84.0)	83.7 (83.2 - 84.1)	84.7 (84.4 - 85.1)	-5.6	<0.001

OPV3	88.7 (88.1 - 89.3)	81.4 (80.5 - 82.4)	92.0 (91.6 - 92.4)	89.0 (88.6 - 89.3)	3.7	<0.001
Measles	81.7 (81.0 - 82.4)	78.7 (77.7 - 79.7)	90.6 (90.1 - 91.0)	86.0 (85.6 - 86.4)	10.9	<0.001
Fully vaccinated	77.8 (77.0 - 78.6)	71.7 (70.5 - 72.8)	76.4 (76.0 - 77.0)	75.7 (75.3 - 76.1)	-2.7	
Partially vaccinated	21.5 (20.8 - 22.3)	27.6 (26.5 - 28.8)	22.6 (22.0 - 23.1)	23.4 (23.0 - 23.8)	8.8	<0.001
Unvaccinated	0.6 (0.5 - 0.7)	0.7 (0.5 - 1.0)	1.0 (0.8 - 1.2)	0.8 (0.7 - 0.9)	33.3	

N = 58 777, 58 416 & 61 279 for DLHS-1, DLHS-2 & DLHS-3 respectively

BCG: Bacillus Calmette - Guerin, DPT: Diphtheria-Pertussis-Tetanus, OPV: Oral Polio Vaccine

*Relative change calculated as ((DLHS1%/DLHS3%)-1)

**P-value of trend from Chi-square using Rao-Scott design adjustment