

# BMJ Open Inequalities in complete childhood immunisation in Nepal: results from a population-based cross-sectional study

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## ABSTRACT

**Objective** To investigate the effect of different aspects of inequality on childhood immunisation rates in Nepal. The study hypothesised that social inequality factors (eg, gender of a child, age of mother, caste/ethnic affiliation, mother's socioeconomic status, place of residence and other structural barrier factors such as living in extreme poverty and distance to health facility) affect the likelihood of children being immunised.

**Design** Using gender of a child, age of mother, caste/ethnic affiliation, mother's socioeconomic status, place of residence and other structural barrier factors such as living in extreme poverty and distance to health facility as independent variables, we performed bivariate and multivariate logistic regression analyses.

**Setting** This study used data from the most recent nationally representative cross-sectional Nepal Demographic and Health Survey in 2016.

**Participants** The analysis reviewed data from 1025 children aged 12–23 months old.

**Outcome measures** The main outcome variable was childhood immunisation.

**Results** Only 79.2% of children were fully immunised. The complete vaccination rate of ethnic/caste subpopulations ranged from 66.4% to 85.2%. Similarly, multivariate analysis revealed that children from the previously untouchable caste (OR 0.58; CI 0.33 to 0.99) and the Terai caste (OR 0.54; CI 0.29 to 0.99) were less likely to be fully immunised than children from the high Hindu caste.

**Conclusion** Given Nepal's limited resources, we suggest that programmes that target the families of children who are least likely to be fully immunised, specifically those who are not only poor but also in financial crises and 'underprivileged' caste families, might be an effective strategy to improve Nepal's childhood immunisation rates.

## INTRODUCTION

Full immunisation coverage is one of the important agendas for sustainable development goal 3 (SDG 3). However, almost 20 million children under 5 are still not be fully immunised. This is a particular problem in low-income nations such as Nepal.<sup>1</sup> Full immunisation for young children is an instrumental variable for child health and well-being, which helps reduce infant and child morbidity and mortality rates as well as prevents the spread of infectious diseases.<sup>2,3</sup>

## Strengths and limitations of this study

- One of the strengths of the study is that it used a nationally representative sample incorporating all sections of socioeconomic, demographic and geographic characteristics, and therefore, the findings are robust and generalisable nationwide.
- Another strength of the study is that the results are useful to help inform national policies for childhood immunisation in Nepal.
- One limitation is the use of cross-sectional data and rely on the validity of the mother's answers to questions about vaccine utilisation since some mothers may have been unaware of different doses of vaccines that their children received.
- Another limitation is that the study excluded data on children who may have been vaccinated when they were over 23 months old.
- Next limitation could be communication issues between parents and healthcare service providers in the survey as well as personal and cultural barriers that affect the collection of the data.

Based on WHO protocols, children are considered to be fully immunised or have complete immunisation after receiving a dose of Bacillus Calmette-Guerin (BCG), three doses of diphtheria-tetanus-pertussis (DPT), three doses of oral polio and a dose of Measles, Mumps, and Rubella (MMR) vaccination to protect them from mumps, measles, rubella, polio and tetanus.<sup>4</sup> Due to international childhood immunisation efforts, infant and child mortality rates have fallen throughout the world including in sub-Saharan Africa and South Asia.<sup>5</sup> However, within targeted countries, including Nepal, immunisation rates and child mortality rates are unevenly distributed across subpopulations.<sup>3</sup> In this study, we sought to understand the specific challenges and the factors that impede or facilitate childhood immunisation in Nepal.

Previous research has indicated that social exclusion affects access to healthcare, exacerbates health inequality and reduces healthcare service utilisation.<sup>2,3,6–10</sup> Previous research

on childhood immunisation coverage in South Asia has examined the effect of a child's gender, his/her family's level of wealth and education, regional inequalities, parental knowledge and attitudes about immunisation and issues related to mother's empowerment. In South Asia, numerous studies have demonstrated that individual factors (a child's gender), family factors (area of residence, household wealth and parental education), demographic factors (religion and caste affiliation) and societal factors (healthcare access and community literacy level) are associated with child immunisation rates.<sup>2 3 6-10</sup> The majority of immunisation studies in India has relied on surveys conducted by the National Family Health Survey between 1992/1993 and 2006 suggested that girls were less likely to be immunised than boys.<sup>11-13</sup> Studies also reported that children were more likely to be immunised if their parents had more knowledge about immunisation, their mothers had more education, they were raised in an urban setting, and their families had more money.<sup>14 15</sup>

In Nepal, the majority of research on immunisation has emphasised evaluating factors that affect access to healthcare as well as the quality of service delivery, including the vaccination rates.<sup>6</sup> Previous research in Nepal has found that poverty, geographic location (difficult terrain), being from a low caste or indigenous population, traditional cultural attitudes, being woman and low levels of maternal education all reduce the likelihood that a child will be immunised.<sup>2 6 7 10</sup> Previous research<sup>6</sup> found that children from indigenous and previously untouchable caste (eg, Dalits) were less likely to be immunised than high caste children. Terai caste and Muslim children were not included in the study analysis. Indeed, Terai caste and Terai Muslims are the most underprivileged and under representative communities in the Nepalese social structure.<sup>16 17</sup> In an attempt to build on this research and understand current challenges to immunisation in Nepal, this study not only explored demographic information and many of the factors considered above but also examined structural barrier factors that do not exist outside of Nepal. The aim of the study is to examine whether a child's gender, maternal age, caste/ethnic affiliation, mother's socioeconomic status, place of residence, extreme poverty and distance to health facilities affect the likelihood of a child being immunised in Nepal.

## METHODS

### Data

We used data from the 2016 Nepal Demographic Health Survey (NDHS), a nationally representative sample of Nepal. The data were collected by the Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys (MEASURE DHS) project.<sup>16</sup> The DHS project has collected the most comprehensive health data available in developing countries, including Nepal. The data are publicly available through the Ministry of Health and Population of Nepal, New Era Kathmandu and ICF International, USA. The survey is conducted every 5 years with support from the US Agency for International Development through its mission

in Nepal and was supported by the Ministry of Health and Population of Nepal. We used data from the Children's Data Section (ie, Child Recode File) of the 2016 NDHS. The data provide health information on every child who was born in the 5 years preceding the survey. The survey also provides information about children who received specific vaccine based on vaccination card and/or mother's report. We only analysed data for children from 12 to 23 months (n=1025). We selected this data because most children are completely immunised by the age of 24 months.<sup>18</sup>

### Dependent variable

As per the WHO recommendation, a child was considered to be fully immunised if s/he received a BCG vaccine at birth or soon after; three doses each of DPT and polio vaccine at 6, 10 and 14 weeks of age; and the measles vaccine at 9 months or soon thereafter.<sup>19</sup> We aggregated the values of a BCG vaccine, three DPT and polio vaccines and a dose of measles. A value of '1' was assigned for children who received all three vaccines and was considered to be fully immunised; children who were either unvaccinated or only partially vaccinated were grouped together and coded as '0'. Similarly, those children who received complete doses of DPT and polio vaccines were coded as 1 and those who were unvaccinated or only partially vaccinated for DPT and polio were coded as '0'. Those who received a measles vaccine were coded as 1 and all other values were coded as 0. In further analysis, we did not consider BGG vaccination because almost 98% children were BCG vaccinated.

### Independent variable coding

The individual level covariates included gender of the child, age of the mother, mother's educational attainment, family wealth index, mother's age and number of living children under the age of 5. These demographic, biological and socioeconomic characteristics were based on factors that had been previously shown to be associated with childhood immunisation.<sup>3 6 8 11 14 15 20</sup> We included Nepali-specific contextual factors such as caste/ethnic affiliation, ecological and regional location of residence (urban/rural and provinces). Other variables (eg, structural barrier factors for healthcare service utilisation) we considered were distance to a health facility and immediate financial situation (eg, money as a big problem to visit healthcare service and distance to healthcare facility).

All independent variables in the study were categorical variable, except the number of children under the age of 5. A boy was coded as '1' and a girl was coded as '2'. The NDHS provides mother age groups in 5-year interval (15-49). We recoded creating a mother's age group into four categories as 15-19, 20-29, 30-39 and 40-49.

There are 125 registered caste/ethnic groups in Nepal and one's caste/ethnicity is determined by birth. Within such heterogeneity of caste/ethnic groupings, the NDHS provides 11 different categories of caste/ethnicity affiliation, which we further grouped into four categories based on previous studies<sup>21</sup> as high Hindu caste, previously

untouchable caste (eg, Dalits), indigenous (Newars and Janajati) and other Terai caste (ie, Madeshi and Muslims). The NDHS provides mother's educational attainment as illiterate, primary school attainment, secondary school attainment and higher education attainment. We recoded again and coded as '0' for those mother who have never attended any schooling, '1' for primary education completion and '2' was coded for secondary and higher education attainment. The NDHS provides five categories of wealth index based on household's cumulative living standard and it was recoded as poorest, poor, middle, rich and richest.

Nepal has three distinct geographical regions (Mountain, Hill and Terai) and we coded geographical regions into three categories. The Mountain region includes areas with elevation of 3000 metres above sea level to Mount Everest (elevation 8848 m), the tallest Mountain in the world. The Hill region lies between elevations of 700 and 3000 m above sea level, and the Terai region is relatively flat and borders of India. Similarly, cities and towns were grouped into urban area that were coded as '1'; villages were grouped under the rural area that were coded as '2'.

In 2015, according to the Constitution of Nepal 2015, seven provinces were formed as province 1, province 2, province 3, province 4, province 5, province 6 and province 7. The formation of the provinces was based on the language and caste/ethnic diversity, although there is no majority caste/ethnic population in any of these provinces. These provinces were coded as categories variable: province 1, province 2, province 3, province 4, province 5, province 6 and province 7. We used province 3 as a 'reference category' because Kathmandu, the capital city of Nepal, is in province 3. We also included two factors that we predicted would be structural barriers to accessing vaccines; affordability (money was reported to be as big problem) and accessibility (distance to health facility). Those who responded that money was not a big problem were coded as '0' and those who responded that money was not a big problem were coded as '1'. Similarly, those who reported distance to healthcare facility was not a big problem were recoded as '0' and those who responded 'big problem' were coded as '1'.

### Data analyses

The statistical analyses were performed using the software SPSS for Windows (V.25). We first ran descriptive and bivariate statistical analyses. To identify factors that are significantly associated with complete childhood immunisation, we ran multivariate logistic regressions. Variables which were significant in our univariate analyses were included in the multivariate logistic regression analyses. To determine the statistical significance, we used a p value less than 0.05.

### Patient and public involvement statement

Patients and the public were not involved in the research.

### RESULTS

Overall, 79.2% of the children were fully immunised while 97.7% of children had received a BCG vaccination, 88.6% received full doses of polio vaccines, 87.4% received total doses of DPT vaccines and nearly 91% of the children had their measles vaccine (table 1).

Table 2 presents the descriptive characteristics of the sample and the bivariate association between independent and dependent variables. Fifty-six percent of the children were boys and 44% were girls. Almost 30% of the children were from high Hindu caste families, 16.4% were from the previously untouchable caste, 31.5% were from indigenous families and 22.3% were from the Terai caste or were Muslim. Nearly 30% of mothers never had any formal schooling. Results from bivariate analyses indicated that caste/ethnic affiliation, mother's education, wealth status, ecological region, provinces, number of children under 5, money to pay to get to a healthcare facility and distance to healthcare facilities were significantly associated with complete childhood immunisation. We also found that only 66.4% of Terai caste and Muslim children were fully immunised whereas 82.5% of high Hindu caste children were fully immunised. Similarly, 65.7% of children who live in province 2 were fully immunised, whereas almost 92% of children living in province 4 were fully immunised (table 2).

Results from the multivariate analysis showed that children from the previously untouchable caste (OR 0.58; CI 0.33 to 0.99) and the Terai caste (OR 0.54; CI 0.29 to 0.99) were less likely to be fully immunised than children from the high Hindu caste. Similarly, children from the Terai caste were less likely to have had polio and DPT vaccine than children from high Hindu castes. Children living in Hill region were more likely to be fully immunised and more likely to get complete doses of polio vaccines and DPT vaccines than children living in Mountain region. Although statistical significance was weaker, more abundant wealth status was correlated with a child's likelihood of being vaccinated, such as a total dose of polio, a measles vaccine and overall full immunisation. Similarly, children from mothers reporting immediate financial problems (eg, money is a big problem) were less likely to be fully immunised, including a complete dose of DPT and measles, than their counterpart (see table 3).

### DISCUSSION

Article 20 of the United Nations Convention on the Rights of the Child (UNCRC) declares that no child should be left behind or deprived of his or her rights to access healthcare, including the right to be fully immunised.<sup>22</sup> In

**Table 1** Childhood immunisation by the vaccine type

Vaccination	A BCG vaccine	Three polio vaccines	Three DPT vaccine	A measles vaccine	Complete immunisation
% vaccinated	97.7	88.6	87.4	91.1	79.2
Gender of the child					
Male	98.2	88.4	86.5	91.1	78.1
Female	96.9	88.8	88.6	91.4	80.6
Age of the mother					
15–19	98.3	89.3	86.0	94.2	80.2
20–29	97.9	88.6	87.5	90.4	79.0
30–39	96.5	88.3	87.7	93.6	80.1
40–49	95.2	85.7	90.5	81.0	71.4
Caste/ethnic affiliation					
High Hindu caste	99.7	91.1	92.5	96.1	85.2
Previously untouchables	97.0	88.1	87.5	88.6	74.9
Indigenous	97.5	90.4	89.8	95.0	84.8
Terai caste, Muslims	95.6	83.0	77.3	81.2	66.4
Mother's education					
None	96.7	84.4	83.8	84.1	70.8
Primary	97.1	89.4	87.0	91.3	77.3
Secondary and higher	98.4	90.7	89.7	95.3	84.9
Wealth status					
Poorest	98.0	85.8	88.2	92.5	77.6
Poor	97.0	88.7	87.8	91.3	80.0
Middle	97.8	86.5	83.4	86.5	74.0
Richer	98.6	93.3	89.0	94.7	84.6
Richest	96.3	89.9	89.9	90.8	81.7
Ecological region					
Mountain	98.9	80.5	85.1	94.3	72.4
Hill	98.8	92.5	93.2	96.0	86.5
Terai	96.5	86.4	82.9	86.6	74.2
Place of residence					
Urban	97.8	89.1	87.0	91.1	79.3
Rural	97.5	88.0	88.0	91.2	79.0
Provinces					
Province 1	97.2	85.1	85.8	96.5	79.4
Province 2	96.0	82.5	77.8	80.8	65.7
Province 3	98.1	92.5	92.5	95.3	86.0
Province 4	100	96.7	94.3	97.6	91.9
Province 5	98.3	96.1	90.4	87.0	79.7
Province 6	97.9	86.1	84.7	94.4	77.1
Province 7	97.0	89.6	91.8	94.0	83.6
Money needed to visit a healthcare facility					
Not a big problem	98.6	91.1	93.5	96.2	86.8
Big problem	97.0	86.9	83.3	87.8	74.0
Distance to health facility					
Not a big problem	98.2	92.0	91.3	94.9	84.6
Big problem	97.3	86.5	95.1	86.0	75.9

BCG, Bacillus Calmette–Guerin; DPT, diphtheria-tetanus-pertussis.



**Table 2** Descriptive characteristics of the sample and bivariate association between independent variables and complete childhood immunisation (N=1025)

Variables	All population		Three polio vaccines		Three DPT vaccines		A measles vaccine		Completely immunised	
	N	(%)	Yes (N)	%	Yes (N)	%	Yes (N)	%	Yes (N)	%
Gender of the child										
Male	570	55.6	504	88.4	493	86.5	519	91.1	145	78.1
Female	455	44.4	404	88.8	403	88.6	415	91.4	366	80.6
Age of the mother										
25–19	121	11.8	108	89.3	104	86.0	114	94.2	97	80.2
20–29	712	69.5	631	88.6	623	87.5	643	90.4	562	79.0
30–39	171	16.7	151	88.3	150	87.7	160	93.6	137	80.1
40–49	21	2.0	18	85.7	19	90.5	17	81.0	15	71.4
Caste/ethnic affiliation			**		****		****		****	
High Hindu caste	305	29.8	278	91.1	282	92.5	293	96.1	260	82.5
Previously untouchables	168	16.4	148	88.1	147	87.5	148	88.6	125	74.9
Indigenous	232	31.5	292	90.4	290	89.8	307	95.0	274	84.8
Terai caste, Muslims	299	22.3	190	83.0	177	77.3	186	81.2	152	66.4
Mother's education			**		**		****		****	
None	302	29.5	255	84.4	253	83.9	253	84.1	213	70.8
Primary education	207	20.2	185	89.4	180	87.0	189	91.3	160	77.3
Secondary and higher	516	50.3	468	90.7	463	89.7	492	95.3	438	84.9
Wealth status					**		*		*	
Poorest	254	24.8	218	85.8	224	88.2	235	92.5	197	77.6
Poor	230	22.4	204	88.7	202	87.8	210	91.3	184	80.0
Middle	223	21.8	193	86.5	186	83.4	193	86.5	165	74.0
Richer	209	20.4	195	93.3	186	89.0	197	94.7	176	84.6
Richest	109	10.6	98	89.9	98	89.9	99	90.8	89	81.7
Ecological region			****		****		****		****	
Mountain	87	8.5	70	80.5	74	85.1	82	94.3	63	72.4
Hill	429	41.9	398	92.8	400	93.2	412	96.0	371	86.5
Terai	509	49.7	440	86.4	422	82.9	440	86.6	377	74.2
Place of residence										
Urban	585	57.1	521	89.1	509	87.0	533	91.1	464	79.3
Rural	440	42.9	387	88.0	387	88.0	401	91.3	347	79.0
Provinces			***		****		****		****	

Continued

Table 2 Continued

Variables	All population		Three polio vaccines		Three DPT vaccines		A measles vaccine		Completely immunised	
	N	(%)	Yes (N)	%	Yes (N)	%	Yes (N)	%	Yes (N)	%
Province 1	141	13.8	120	85.1	121	85.8	136	96.5	112	79.4
Province 2	198	19.3	163	82.3	154	77.8	160	80.8	130	65.7
Province 3	107	10.4	99	92.5	99	92.5	102	95.3	92	86.0
Province 4	123	12.0	119	96.7	116	94.3	120	97.6	113	91.9
Province 5	178	17.4	163	91.6	161	90.4	154	87.0	141	79.7
Province 6	144	14.0	124	86.1	122	84.7	136	94.4	111	77.1
Province 7	134	13.1	120	89.6	123	91.8	126	94.0	112	83.6
Number of children under 5 (M; SD)	1.61; 0.902		2.12; 1.38		2.10; 1.38***		2.09; 1.38****		2.05; 1.36****	
Money needed to visit			**		****		****		****	
Not a big problem	416	40.6	379	91.1	389	93.5	400	96.2	361	86.8
Big problem	609	59.4	529	98.9	507	83.3	534	87.8	450	74.0
Distance to health facility			**		***		***		****	
Not a big problem	389	38.0	358	92.0	355	91.3	369	94.9	329	84.6
Big problem	636	62.0	550	86.5	541	85.1	565	89.0	482	75.9

\*p ≤ 0.10. \*\*p ≤ 0.05. \*\*\*p ≤ 0.01. \*\*\*\*p ≤ 0.001.  
DPT, diphtheria-tetanus-pertussis; N, number.

**Table 3** Logistic regression analysis for complete immunisation in Nepal

Variables	Three polio vaccines			Three DPT vaccines			A measles vaccine			Complete immunisation		
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<b>Caste/ethnic affiliation</b>												
High Hindu caste (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Untouchables	0.61	0.30 to 1.24	0.57	0.28 to 1.17	0.54	0.22 to 1.30	0.58**	0.22 to 1.30	0.58**	0.22 to 1.30	0.58**	0.33 to 0.99
Indigenous	0.79	0.42 to 1.48	0.72	0.38 to 1.39	0.96	0.40 to 2.34	0.96	0.40 to 2.34	0.96	0.40 to 2.34	0.96	0.58 to 1.59
Terai caste, Muslims	0.48*	0.22 to 1.05	0.36**	0.16 to 0.79	0.56	0.22 to 1.44	0.54**	0.22 to 1.44	0.54**	0.22 to 1.44	0.54**	0.29 to 0.99
<b>Mother's education</b>												
None (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Primary	1.24	0.70 to 2.19	0.95	0.55 to 1.62	1.77*	0.96 to 3.28	1.13	0.96 to 3.28	1.13	0.96 to 3.28	1.13	0.73 to 1.75
Secondary and higher	1.07	0.64 to 1.81	0.78	0.47 to 1.30	1.95**	1.04 to 3.63	1.23	1.04 to 3.63	1.23	1.04 to 3.63	1.23	0.81 to 1.86
<b>Wealth status</b>												
Poorest (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Poor	1.56	0.84 to 2.90	1.14	0.60 to 2.16	1.45	0.65 to 3.21	1.32	0.65 to 3.21	1.32	0.65 to 3.21	1.32	0.80 to 2.18
Middle	1.54	0.78 to 3.05	1.06	0.53 to 2.08	1.12	0.49 to 2.54	1.16	0.49 to 2.54	1.16	0.49 to 2.54	1.16	0.67 to 2.00
Richer	2.70*	1.20 to 6.09	1.25	0.59 to 2.62	2.44*	0.93 to 6.39	1.71*	0.93 to 6.39	1.71*	0.93 to 6.39	1.71*	0.93 to 3.15
Richest	1.44	0.57 to 3.58	1.19	0.48 to 2.99	1.03	0.36 to 2.94	1.19	0.36 to 2.94	1.19	0.36 to 2.94	1.19	0.57 to 2.45
<b>Ecological region</b>												
Mountain (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Hill	2.51**	1.23 to 5.09	2.72**	1.24 to 5.99	1.25	0.41 to 3.76	2.14**	0.41 to 3.76	2.14**	0.41 to 3.76	2.14**	1.17 to 3.90
Terai	1.32	0.56 to 3.07	0.76	0.31 to 1.88	0.58	0.16 to 2.10	1.27	0.16 to 2.10	1.27	0.16 to 2.10	1.27	0.62 to 2.60
<b>Provinces</b>												
Province 3 (ref.)	1.00		1.00		1.00		1.00		1.00		1.00	
Province 1	0.57	0.22 to 1.43	0.99	0.38 to 2.59	2.04	0.51 to 8.15	0.83	0.51 to 8.15	0.83	0.51 to 8.15	0.83	0.39 to 1.73
Province 2	0.67	0.23 to 1.94	1.31	0.45 to 3.74	0.72	0.20 to 2.64	0.75	0.20 to 2.64	0.75	0.20 to 2.64	0.75	0.32 to 1.72
Province 4	1.95	0.55 to 6.90	1.15	0.38 to 3.43	1.66	0.37 to 7.49	1.62	0.37 to 7.49	1.62	0.37 to 7.49	1.62	0.67 to 3.89
Province 5	1.10	0.39 to 3.05	2.02	0.71 to 5.78	0.54	0.16 to 1.84	0.91	0.16 to 1.84	0.91	0.16 to 1.84	0.91	0.42 to 1.98
Province 6	0.55	0.21 to 1.40	0.39*	0.15 to 1.09	1.02	0.29 to 3.56	0.65	0.29 to 3.56	0.65	0.29 to 3.56	0.65	0.31 to 1.36
Province 7	0.94	0.34 to 2.54	1.67	0.59 to 4.74	1.28	0.36 to 4.55	1.26	0.36 to 4.55	1.26	0.36 to 4.55	1.26	0.57 to 2.77
Number of children under 5	1.15	0.92 to 1.43	0.98	0.80 to 1.19	0.97	0.78 to 1.21	0.96	0.78 to 1.21	0.96	0.78 to 1.21	0.96	0.81 to 1.44

Continued



Table 3 Continued

Variables	Three polio vaccines		Three DPT vaccines		A measles vaccine		Complete immunisation	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Money needed to visit	1.00		1.00		1.00		1.00	
Not a big problem	1.14	0.69 to 1.88	0.47***	0.28 to 0.81	0.55*	0.28 to 1.09	0.66**	0.44 to 1.00
Distance to health facility								
Not a big problem	1.00		1.00		1.00		1.00	
Big problem	0.65	0.39 to 1.09	0.81	0.49 to 1.32	0.63	0.34 to 1.18	0.81	0.54 to 1.22
Overall model $\chi^2$	48.856		71.466		85.663		80.948	
Cox and Snell R <sup>2</sup>	0.047		0.067		0.080		0.076	

\*\*p≤0.10. \*\*\*p≤0.05. \*\*\*\*p≤0.01. \*\*\*\*\*p≤0.001.  
DPT, diphtheria-tetanus-pertussis.

line with the UNCRH, Nepal began offering free vaccines to vaccinate its children fully. Despite the progress on immunisation of 1-year-old children, complete childhood immunisation has still remained a challenge in Nepal.<sup>23</sup>

The government of Nepal has committed to achieve UN SDG 3 and sought to increase the childhood vaccination rates through its National Immunisation Programme by providing childhood immunisation to all sections of the population. In order to ensure that Nepal can successfully implement programmes designed to increase childhood vaccination rates, it is essential to understand who is and who is not being vaccinated. We highlight some of the key findings of this study.

The findings of this analysis are consistent with previous research and indicate that family financial problems (acute poverty; for example, the money to visit health facility) as well as being a member of a low or underprivileged caste all affect the likelihood that a child will or will not be immunised. The fact is that Nepal is one of the lowest income countries in the world with a Human Development Index of 0.58 ranking 147th out of 187 countries with about 35.4% of people living in absolute poverty (on less than US\$3.19 per day).<sup>24</sup> In 2011, the average mortality rate in Nepal for children under 5 was 68 per 1000, much higher for previously untouchable caste (Dalits), 90 per 1000.<sup>16</sup> The finding of the study further supports the Nepal's socioeconomic and geographical disparities create challenges to increasing its childhood immunisation rates. Despite access to free vaccines throughout the country, intersection of acute poverty and belonging to socially excluded caste/ethnic groups still makes it less likely to be fully vaccinated by age 2.

Notwithstanding, the abolishment of the caste system in 1990 in Nepal's Constitution, its legacy is apparent and the caste/ethnic-based social structure and hierarchy is still intact. Previous studies have documented that the caste/ethnicity-based social exclusion is deeply rooted in Nepalese social structure, specifically people belonging to the untouchable caste as well as belonging to Terai caste (including Madeshi and Muslims) face broad-based discrimination and are socially excluded from the power structures in society.<sup>17</sup> As consequences of such social exclusion, they are more likely to experience other forms of disadvantages such as living in poverty and exposure of domestic violence.<sup>25</sup> Consistent with this social context, children belonging to previously untouchable and Terai caste are less likely to be fully immunised than other children.

Mothers with at least a secondary education were more likely to vaccinate their children.<sup>26</sup> This finding is consistent in the case of measles vaccination in Nepal. However, that was not true for other vaccines. The measles vaccine has to be completed between 9 and 12 months, whereas other vaccines are usually done earlier. Likewise, household wealth status itself was not a strong statistically significant predictor for childhood immunisation. However, acute poverty (eg, families which lack the money needed to visit a healthcare facility) is a significant barrier for complete immunisation. This is likely because the government has provided free vaccines in Nepal since the inception of the Expanded Programme on



Immunisation in 1979.<sup>27</sup> This suggests that though in many places in Nepal vaccines are readily available in healthcare centres, acute poverty affects some women's ability to access to these healthcare centres. Mothers who reported 'money as a big problem' to visit healthcare facilities were less likely to fully immunise their children. Nepal currently provides some financial incentives to mothers who give birth in hospitals or health centres. We recommend that this programme be expanded to offer financial incentives to mothers who immunise their children in an effort to further reduce financial barriers to immunisation.

We found that there are no gender differences between children who were fully immunised in Nepal. This finding is inconsistent with the previous studies that were conducted in South Asian context, especially India<sup>11–13</sup> However, there is a sex ratio imbalance in the overall population; 44% of children were girls and 56% were boys. This indicates the male preference in Nepalese societies and the possibility of sex-selective abortion.<sup>28</sup> Interestingly, this sex preference does not seem to have influenced childhood immunisation rates in Nepal. Further inquiry is needed to understand why.

We found that children living in the Hill region were more likely to be fully vaccinated than other subpopulations. The people in the Hill region belong to the top and the bottom of the caste system and they brought the tradition of caste-based social structure. Such tradition of social groupings included the Brahmins (priests, teachers and scholars), the Kshatriyas (kings and warriors), the Vaishyas (traders and business-people or indigenous people) and the Shudra (untouchables or occupational castes or Dalits). The majority of people who live in the Hill region is from high Hindu caste backgrounds, and this population has a more significant influence on linguistic, sociopolitical and cultural aspects in Nepal.<sup>29</sup>

### Recommendations

The study explored social inequalities in Nepal, such as belonging to the underprivileged caste/ethnic group, living in acute poverty and geographical disparities predicted to impede or facilitate childhood immunisation for Nepalese children. Based on the study findings, we recommend that it is essential to reduce deep-rooted social inequalities in order to effectively deliver essential social and health services, including childhood immunisation. One way to do this is to improve social inclusion and to provide welfare programmes, particularly for socially underprivileged caste/ethnic populations. We also recommend providing financial incentives to families that immunise their children. Such practices would support UN SDG 3, Article 20 of the UNCRH and Rights to Healthcare which is also mandated by Article 35 of the 2015 Nepalese Constitution.

### CONCLUSION

Each country has their own issues that limit access to health and welfare services. In Nepal, we found that children belonging to the underprivileged caste/ethnic groups and those whose mothers reported being in a

financial crisis situation (eg, money is a big problem to visit healthcare facility) were the least likely to be fully immunised. We recommend working to reduce deep seated social inequalities in Nepal that are correlated with children being less likely to be vaccinated. Nepal not only needs to do more than legislate to end the caste system (which has been done) but also needs to enforce such legislation. Another way to improve access to childhood vaccines would be to increase educational opportunities for girls. Finally, and perhaps the most easily accomplished, more systematic vaccination programmes such as community-based education and financial incentives to vaccinate children could be designed to specifically target socially excluded children.

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