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# BMJ Open

## Determinants of Complete Childhood Immunization in Nepal

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**Title Page****Determinants of Complete Childhood Immunization in Nepal**

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## Determinants of Complete Childhood Immunization in Nepal

### Abstract

**Objective** Nepal is a developing country that is struggling to immunize all children fully. Poor immunization rates and the consequent spread of disease are not only national problems but have international implications. As a result, Nepal's immunization challenges have global implications. In the global south, low-income children and children from historically underprivileged families are less likely to be immunized than children from higher-income families. The purpose of the study was to explore associations between social determinants and complete childhood immunization in a low income country, such as Nepal.

**Design** A nationally representative cross-sectional study.

**Setting** Nepal

**Participants** Surviving 12-23 months old children (n=1025).

**Methods** We used the 2016 Nepal Demographic and Health Survey (NDHS), a nationally representative data set. In this study, we examine demographic, economic, and socio-cultural determinants of childhood immunization. We used data from the Child Recode File, and we only analyzed surviving 12-23 months old children (n=1025). A logistic regression analysis was employed to identify the factors that impede or facilitate the complete childhood immunization.

**Results** We found that only 79.2% of children were completely immunized. However, the complete vaccinate rates ranged from 66.4% to 85.2% among caste/ethnic groups, that indicates inequality in childhood immunization based on socially defined characteristics. Furthermore, factors that impede complete childhood immunizations were mother's lower level of education, a larger number of children, and distance to a health facility. Specifically, the result revealed that

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3 children from Terai Caste and Muslims were 42% less likely to get complete immunization than  
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5 children from High Hindu caste.  
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8 **Conclusion** Given Nepal's limited resources, we suggest that programs which target the families  
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10 of children who are least likely to be fully immunized, specifically those who are not only poor  
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12 but in financial crises and "underprivileged" caste families, might be an effective strategy to  
13  
14 improve Nepal's childhood immunization rates.  
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16

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18 **Keywords:** childhood complete immunization; inequalities; caste/ethnicity; Nepal  
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### 22 **Strength and limitations of the study**

- 24 ● This study is a representative population-based study, and findings can be generalized to  
25 all sections of the population.  
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- 28 ● Country-specific factors may impede or facilitate health equity and may contribute to a  
29 country's childhood immunization rates. In this study, we use Nepal as an example  
30 because of its unique and mosaic caste/ethnicity-based social stratification.  
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- 33 ● Although caste/ethnicity-based social exclusion has been legally abolished,  
34 caste/ethnicity-based sociocultural discrimination is still intact in the Nepalese society.  
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36 We examined whether a child's membership in an underprivileged caste/ethnic group  
37 affects the likelihood that the child will be fully immunized.  
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- 40 ● In Nepal, a child from a disadvantaged caste/ethnic group is less likely to be completely  
41 immunized than other children. This is an important finding as it relates to health equity  
42 in Nepal and may have implications regarding the need to understand social inequities in  
43 a country specific context before developing immunization programs.  
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- The single limitation of the study is the cross-sectional study design which hinders to make causal relationships among variables.

## Introduction

Nepal is a developing country that is struggling with its efforts to fully immunize children (e.g., a dose of BCG, three doses of DPTs, three doses of oral polios, and a dose of MMR). Slightly more than 20% of all children under 5 are not fully immunized which is consistent with 2018 WHO study results for developing nations.<sup>1</sup> It is well known that childhood immunization reduces infant and child morbidity and mortality rates and can reduce the spread of infectious diseases.<sup>2</sup>

The population of Nepal was estimated to be over 28 million by the end of 2017.<sup>3</sup> Nepal is one of the poorest countries in the world with a Human Development Index of 0.58 ranking 147<sup>th</sup> out of 187 countries with about 35.4% of people living in absolute poverty (on less than \$3.19 (US) per day).<sup>4</sup> In 2011, the average mortality rate in Nepal for children under five was 68 per 1,000, much higher for untouchable caste (Dalits), 90 per 1000.<sup>5</sup> Nepal's poverty as well as its socio-economic and geographical disparities create challenges to increasing its childhood immunization rates.<sup>5</sup>

Based on WHO protocols, children are considered to be fully immunized or have complete immunization after receiving a dose of Bacillus Calmette-Geurin (BCG), three doses of diphtheria-tetanus-pertussis (DPT), three doses of oral polio, and a dose of MMR vaccination to protect them from mumps, measles, rubella, polio, and tetanus.<sup>6</sup> Due to international childhood immunization efforts, infant and child mortality rates have fallen worldwide including those in sub-Saharan Africa and South Asian nations.<sup>7</sup> However, within targeted countries, including

## Childhood Complete Immunization in Nepal

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3 Nepal, immunization rates and child mortality rates are unevenly distributed across  
4  
5 subpopulations.<sup>8</sup> In this study, we sought to understand the specific challenges and the factors  
6  
7 that impede or facilitate childhood immunization in Nepal.  
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10 Previous research has indicated that social exclusion affects access to health care,  
11  
12 exacerbates health inequality, and reduces health care service utilization.<sup>2, 9, 10, 11, 12, 13, 14</sup>  
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14 Previous research on childhood immunization coverage in South Asia has examined the effect of  
15  
16 a child's gender, his/her family's level of wealth and education, regional inequalities, parental  
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18 knowledge and attitudes about immunization, and issues related to mother's empowerment. In  
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20 India, numerous studies have demonstrated that individual factors (a child's gender and birth  
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22 order), family factors (area of residence, household wealth, and parental education),  
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24 demographic factors (religion and caste affiliation), and societal factors (health care access and  
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26 community literacy level) are associated with child immunization rates.<sup>2, 12</sup> The majority of  
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28 immunization studies in India which relied on surveys conducted by the National Family Health  
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30 Survey (NFHS) between 1992/1993 and 2006 suggested that girls were less likely to be  
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32 immunized than boys.<sup>15, 16, 17</sup> These studies also reported that children were more likely to be  
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34 immunized if their parents had more knowledge about immunization, their mothers had more  
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36 education, they were raised in an urban setting, and their families had more money.<sup>18, 19</sup>  
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42 In Nepal, the majority of research on immunization has emphasized evaluating factors that  
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44 affect access to health care as well as the quality of service delivery, including the vaccination  
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46 rates.<sup>10</sup> Previous research in Nepal has found that poverty, geographic location (difficult  
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48 terrain), low caste or indigenous children, traditional cultural attitudes, being female, and low  
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50 levels of maternal education all reduce the likelihood that a child will be immunized.<sup>9, 10, 11, 14</sup>  
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52 Specifically, the study<sup>10</sup> revealed that children from indigenous and previously untouchable caste  
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3 (e.g., *Dalits*) were less likely to be immunized than High caste children; however, the status of  
4 complete immunization among Terai caste and Muslim children were not included in the study  
5 analysis. Indeed, Terai caste and Terai Muslims were the most underprivileged and underserved  
6 communities in the Nepalese social structure.<sup>5</sup> In addition, children are less likely to be fully  
7 immunized if they live far from a health facility.<sup>11</sup> In an attempt to build on this research and  
8 understand current challenges to immunization in Nepal, this study not only explored  
9 demographic information and many of the factors considered above but also examined  
10 geographic, socio-economic, and cultural context and considered social grouping that do not  
11 exist outside of Nepal.  
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### 26 **Nepal & South Asian Context**

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28 Nepal is a multi-lingual, multi-ethnic and multi-religious nation. It has three distinct  
29 geographic regions: the Mountain region, the Hill region, and the Terai region. The Mountain  
30 region includes areas with elevation of 3,000 meters above sea level to Mount Everest (elevation  
31 8,848 meters), the tallest Mountain in the world. The Hill region lies between elevations of 700  
32 and 3,000 meters above sea level, and the Terai region is relatively flat and borders of India.  
33 Different ethnic groups live in each of these geographic regions. For example, the Sherpa ethnic  
34 group lives in the Mountain region and the Tharus in the Terai region. In 2015, according to the  
35 Constitution of Nepal 2015, seven provinces were formed as Province 1, Province 2, Province 3,  
36 Province 4, Province 5, Province 6, and Province 7. The formation of the provinces was based on  
37 the language and caste/ethnic diversity although there is no majority caste/ethnic population in  
38 none of the provinces.  
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54 Notwithstanding, the abolishment of the caste system in 1990 in Nepal's Constitution, its  
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3 legacy is apparent and the caste/ethnic-based social structure and hierarchy is still intact. When  
4 we use the term “underprivileged or low caste,” we are talking about the way in which people in  
5 this caste are viewed in the sociocultural context of Nepal and not making a judgment about the  
6 caste ranking or the value of people from these castes. Caste/ethnic affiliation represents one’s  
7 place in the social hierarchy. There are 125 registered caste/ethnic groups in Nepal.<sup>3</sup> One’s caste  
8 is determined by birth. There are four major groupings of castes or *four vernas*: the *Brahmans*  
9 (priests, teachers, and scholars), the *Kshatriyas* (kings and warriors), the *Vaishyas* (traders and  
10 businesspeople, or indigenous people), and the Shudra (untouchables or occupational castes or  
11 *Dalits*).

## 22 **Methods**

### 23 ***Data***

24 We used data from the 2016 Nepal Demographic Health Survey (the 2016 NDHS), a  
25 nationally representative sample of Nepal. The data was collected by the MEASURE  
26 Demographic and Health Survey (DHS) project.<sup>5</sup> The DHS project has collected the most  
27 comprehensive health data available in developing countries, including Nepal. The data is  
28 publicly available through the Ministry of Health and Population of Nepal, New Era Kathmandu,  
29 and ICF International USA. The survey is conducted every five years with support from the US  
30 Agency for International Development (USAID) through its mission in Nepal and was supported  
31 by the Ministry of Health and Population of Nepal. We used data from the Child Recode File and  
32 we only analyzed surviving 12-23 months old children (n=1025). We selected this data because  
33 most children are completely immunized by the age of 24 months.<sup>20</sup>

### 34 ***Dependent Variable coding***

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3 As per the WHO recommendation, a child was considered to be fully immunized if s/he  
4 received a BCG vaccine at birth or soon after; three doses each of DPT and polio vaccine at 6,  
5 10, and 14 weeks of age; and the measles vaccine at 9 months or soon thereafter.<sup>21</sup> We  
6 aggregated the values of a BCG vaccine, three DPT and polio vaccines, and a dose of measles.  
7 A value of “1” was assigned for children who received all three vaccines and was considered to  
8 be fully immunized; children who were either unvaccinated or only partially vaccinated were  
9 grouped together and coded as “0”.

### 19 ***Independent variable coding***

21 The individual level covariates included: gender, mother’s educational attainment, family  
22 wealth index, size of the household, mother’s age, birth order rank of a child, and mother’s age at  
23 first birth. These demographic, biological, and socioeconomic characteristics were based on  
24 factors that had been previously shown to be associated with childhood immunization.<sup>9, 10, 22</sup> We  
25 included Nepali specific contextual factors, such as caste/ethnic affiliation, ecological and  
26 regional location of residence (urban/rural and provinces). We also included the variables in the  
27 analysis such as distance to a health facility and immediate financial situation (e.g. money as a  
28 big problem to visit health care service).

### 39 ***Data Analyses***

41 The statistical analyses were performed using the software SPSS for Windows (version  
42 25). We first ran descriptive and bivariate statistical analyses. To identify factors that are  
43 significantly associated with complete childhood immunization, we ran multivariate logistic  
44 regressions. To determine the statistical significance, we used a p-value less than 0.05.

### 51 ***Patient and Public Involvement statement***

53 Patients and the public were not involved in the research.

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## Results

Overall, 72.9% of the children were fully immunized while 98% 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. Childhood Immunization by the Vaccine Type**

Percentage vaccinated					
	A BCG vaccine	Three Polio vaccines	Three DPT vaccine	A Measles vaccine	Complete Immunization
<i>Total</i>	<i>97.7</i>	<i>88.6</i>	<i>87.4</i>	<i>91.2</i>	<i>79.2</i>
Gender					
Male	98.2	88.4	86.5	91.1	78.1
Female	96.9	88.8	88.6	91.4	80.6
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 education	97.1	89.4	87.0	91.3	77.3
Secondary Education	98.4	89.4	88.3	94.7	82.4
Higher Education	98.6	94.3	93.6	97.1	91.4
Wealth Status					
Poor	97.5	87.2	88.0	91.9	78.7
Middle	97.8	86.5	83.4	86.5	74.0
Rich	97.8	92.1	89.3	93.4	83.6
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 health care 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

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% girls. Almost 30% of the children were from high caste Hindus, 16.4 % from the previously untouchable caste, 31.5 % from indigenous community, and 22.3 % were from the Terai caste and Muslims. Nearly 30% of mothers never had any formal schooling. Results from bivariate analyses showed that variables such as caste/ethnic affiliation, mother's education, wealth status, ecological region, provinces, number of living children, money to pay to get to a health care facility and distance to health care facilities were significantly associated with complete childhood immunization. We also found that only 66% of Terai Caste and Muslim children were fully immunized whereas 82.5% of high caste Hindu children were fully immunized. Similarly, 71% of children whose mothers were illiterate were fully immunized whereas 91.4% of children whose mothers had some college or higher level of education were fully immunized.

**Table 2.** Descriptive Characteristics of the Sample and Bivariate Association between Independent Variables and Complete Childhood Immunization (N=1025)

	All Population		Completely Immunized	
	Number	(%)	yes (n)	%
Gender of a child				
Male	570	55.6	145	78.1
Female	455	44.4	366	80.6
Caste/Ethnic Affiliation ****				
High Hindu Caste	305	29.8	260	82.5
Previously Untouchables	168	16.4	125	74.9
Indigenous	232	31.5	274	84.8
Terai Caste, Muslims	299	22.3	152	66.4
Mother's Education ****				
None	302	29.5	213	70.8
Primary Education	207	20.2	160	77.3
Secondary Education	376	36.7	310	82.4
Higher Education	140	13.7	128	91.4
Wealth Status **				
Poor	484	42.7	318	78.7
Middle	223	21.8	165	74.0

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Rich	318	31.0	265	83.6
Ecological Region ****				
Mountain	87	8.5	63	72.4
Hill	429	41.9	371	86.5
Terai	509	49.7	377	74.2
Place of Residence				
Urban	585	57.1	464	79.3
Rural	440	42.9	347	79.0
Provinces ****				
Province 1	141	13.8	112	79.4
Province 2	198	19.3	130	65.7
Province 3	107	10.4	92	86.0
Province 4	123	12.0	113	91.9
Province 5	178	17.4	141	79.7
Province 6	144	14.0	111	77.1
Province 7	134	13.1	112	83.6
Size of household (Mean; SD)	6.27; 3.01		6.31;3.00	
Mother's age (Mean; SD)	25.15;5.32		25.09;5.27	
No. of living children (Mean; SD)****	2.14; 1.40		2.05;1.36	
Money needed to visit ****				
Not a big problem	416	40.6	361	86.8
Big problem	609	59.4	450	74.0
Distance to health facility ****				
Not a big problem	389	38.0	329	84.6
Big problem	636	62.0	482	75.9

\*p ≤ .10. \*\*p ≤ .05. \*\*\*p ≤ .01. \*\*\*\*p ≤ .001.

Results from multivariate analysis showed that children from Terai Caste and Muslim were 42% (OR=0.58, CI = 0.30 – 1.09, p=.090) less likely to get complete immunization than children from High Hindu caste. At the same time children whose mothers had higher education were 92% (OR=1.92, CI = .92 – 4.05, p=.083) more likely to get complete immunization than children of a mother with no formal education. Similarly, children from the Hill region were more likely to be completely immunized than children from Mountain region (OR = 2.32, CI = 1.26 – 4.27, p = .006). We found that the larger the number of children in a household, the less likely the children were to be completely immunized. Lastly, mothers who needed money to visit health care facilities were less likely to immunize their children (OR = .67, CI = .44 – 1.01, p = .055).

**Table 3. Logistic Regression Analysis for Complete Immunization in Nepal.**

Variables	Complete immunization	
	OR	95% CI
Gender of a child		
Male (ref.)	1.00	
Female	1.13	.82 – 1.53
Caste/Ethnic Affiliation		
High Hindu Caste (ref.)	1.00	
Untouchables	.67	.38 – 1.59
Indigenous	1.03	.62 – 1.72
Terai Caste, Muslims *	.58	.30 - 1.09
Mother's Education		
None (ref.)	1.00	
Primary education	1.07	.68 – 1.68
Secondary Education	1.06	.67 - 1.68
Higher Education *	1.92	.92 – 4.05
Wealth Status		
Poor (ref.)	1.00	
Middle	.93	.60 – 1.45
Rich	1.14	.71 – 1.83
Ecological Region		
Mountain (ref.)	1.00	
Hill **	2.35	1.27 – 4.33
Terai	1.44	.71 - 2.95
Place of Residence		
Urban (ref.)	1.00	
Rural	1.193	.85 – 1.66
Provinces		
Province 3 (ref.)	1.00	
Province 1	.83	.39 – 1.75
Province 2	.77	.33 - 1.77
Province 4	1.56	.65 - 1.78
Province 5	.87	.40 – 1.90
Province 6	.64	.31 – 1.34
Province 7	1.32	.60 – 2.93
Size of household	1.04	.98 – 1.10
Mother's age	1.02	.98 – 1.06
No. of living children *	.86	.73 – 1.01
Money needed to visit		
Not a big problem	1.00	
Big problem *	.67	.44 – 1.01
Distance to health facility		
Not a big problem	1.00	
Big problem	.78	.53 – 1.20
Overall model $\chi^2$	88.43	
Cox & Snell R <sup>2</sup>	.083	
-2 LL	958.915	

\*p ≤ .10. \*\*p ≤ .05. \*\*\*p ≤ .01. \*\*\*\*p ≤ .001.

## 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 health care, including the right to be fully immunized.<sup>23</sup> In line with the UNCRC, Nepal began offering free vaccines in an effort to fully immunize its children but has been unable to do so. Despite high level (90%) of measles immunization of one-year-old children, many children are not immunized against diphtheria, tetanus, and pertussis by age two.<sup>24</sup> The government of Nepal has sought to increase the childhood vaccination rates. In order to ensure that the country can successfully implement programs designed to increase childhood vaccination rates, it is essential to understand who is not being vaccinated. We highlight some of the key findings of this study.

The findings of this analysis are generally consistent with previous research and indicate that mother's educational status, the number of children in a family, and family financial problems (acute poverty; e.g. the money to visit health facility) as well as belonging to low or underprivileged caste status are all related to the likelihood that a child will or will not be immunized. The intersectional effect of poverty, educational deprivation, and belonging to socially excluded caste/ethnic groups impacts the inability to complete childhood immunizations by age 2 even though the childhood vaccines discussed in this paper are free. This finding is consistent with the case of India where children from similar vulnerable intersectional groups are also less likely to be fully immunized.<sup>12</sup>

Caste and ethnic group affiliation also affected the likelihood that a child would be fully immunized. Children from the Terai caste (66%) were less likely to be immunized than children from Hindu caste (82.5%). Although caste-based discrimination was legally abolished, people from the Terai caste (Madhesi and Muslim) are the least privileged cultural group in Nepal and



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3 are the least likely to be educated than people in other castes. The impact of the socio-economic  
4 deprivation on other health and social outcomes for Terai women in Nepal has been well  
5 documented.<sup>25, 26</sup>  
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10 Consistent with previous research<sup>12</sup>, higher levels of maternal education were significantly  
11 correlated with higher child vaccination rates. This study found that nearly 30% of mothers in  
12 Nepal lacked any formal education. Among this group, only 70.8 percent of children were fully  
13 vaccinated. Among the children born to the most highly educated mothers (13.7% of the  
14 children in the survey), 91.4 percent were fully vaccinated. As a result, the findings of this study  
15 suggest that strengthening education for girls, particularly those from underprivileged castes,  
16 most of whom will presumably become mothers, might be correlated with an increase in Nepal's  
17 child immunization rates.  
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28 Children in families with many children were less likely to be fully immunized. This finding  
29 is consistent with findings from previous research which has indicated that families with more  
30 children in developing countries are less likely to be able to provide them access to health care.  
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27, 28 Therefore, the finding of the study reinforce the need for family planning programs to  
reduce the number of children born into Nepali families, particularly those families that are  
already vulnerable to low vaccination rates. In addition, the findings suggest that immunization  
campaigns should target households with many children.

Acute poverty (e.g., families which lack the money needed to visit a health care facility even  
when the health care itself is free) is a significant barrier for complete immunization.

Interestingly, household wealth status itself was not a statistically significant predictor for  
childhood immunization. This is likely because the WHO has provided free vaccines in Nepal  
since the inception of the Expanded Program on Immunization (EPI) in 1979.<sup>29</sup> This suggests

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2  
3 that progress has been made in equality in vaccine delivery, availability, and use throughout  
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5 Nepal. Nevertheless, mothers who reported 'money as a big problem' to visit health care  
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7 facilities were less likely to fully immunize their children. Nepal currently provides some  
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9 financial incentives to mothers who deliver babies in hospitals or health centers. We recommend  
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11 that this program be expanded to offer financial incentives to mothers who fully immunize their  
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13 children in an effort to further reduce financial barriers to immunization.  
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17 We found that there are no gender differences in complete childhood immunization. This  
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19 finding is inconsistent with the previous studies that were conducted in South Asian context,  
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21 especially India<sup>15, 16, 17</sup> However, there is a sex ratio imbalance in the overall population; 44% of  
22  
23 children were girls, and 56% were boys. This indicates the male preference in Nepalese societies  
24  
25 and the possibility of sex-selective abortion.<sup>30</sup>  
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### 28 **Strengths and limitations**

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30  
31 The strength of the study is that it used a nationally representative sample. Therefore, the  
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33 findings are robust and can be generalized nationwide. The results should be helpful when  
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35 devising national policies. Despite this, the study has some limitations. It used cross-sectional  
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37 data and relied on the validity of mother's answers to questions about vaccine utilization. Some  
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39 mothers may have been unaware of different doses of vaccines that their children received. Some  
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41 additional limitations are that there was no assessment of the service delivery systems, there may  
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43 be personal and cultural barriers that affected the collection of the data, and there was no  
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45 assessment of the communication between parents and health care service providers in the  
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47 survey. Finally, the survey excluded data on children who may have been vaccinated when they  
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49 were over 23 months old, the typical time at which these vaccines have been provided.  
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## Conclusions

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 (e.g., money is a big problem to visit health care facility) were the least likely to be fully immunized. Based on the findings, more systematic vaccination programs could be designed to specifically target socially excluded children (children from underprivileged castes). As noted above, we suggest an increase use of family planning, more expansive education for girls, and programs that enable children to be vaccinated in their own communities so that they do not have to travel to health clinics as well as financial subsidies for travelling to health clinics. These strategies would likely improve Nepal's immunization rates.

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# BMJ Open

## Inequalities in Complete Childhood Immunization in Nepal: Results from the 2016 Nepal Demographic and Health Survey (the 2016 NDHS)

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**Title Page****Inequalities in Complete Childhood Immunization in Nepal: Results from the 2016 Nepal Demographic and Health Survey (the 2016 NDHS)**

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## Inequalities in Complete Childhood Immunization in Nepal: Results from the 2016 Nepal Demographic and Health Survey (the 2016 NDHS)

### Abstract

**Objective** To investigate the effect of different aspects of inequality on childhood immunization rates in Nepal.

**Design** A population-based cross-sectional study

**Setting** This study used the 2016 Nepal Demographic and Health Survey

**Participants** A total of 1025 children ages 12 to 23 months old

**Outcome measures** The main outcome variable was childhood immunization

**Results** Only 79.2% of children were fully immunized. The complete vaccination rate of ethnic/caste subpopulations ranged from 66.4% to 85.2%. Social inequalities factors such as children belonging underprivileged caste/ethnic groups as well as living in acute poverty were predictors for complete childhood vaccine utilization.

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

**Keywords:** childhood complete immunization; inequalities; caste/ethnicity; Nepal

### Strengths and limitations of this study

- The study used a nationally representative sample, and the findings are robust and generalize nationwide.

## Childhood Complete Immunization in Nepal

- The results are useful to help inform national policies for childhood immunization in Nepal
- The study used cross-sectional data and relied on the validity of the mother's answers to questions about vaccine utilization since some mothers may have been unaware of different doses of vaccines that their children received
- The study excluded data on children who may have been vaccinated when they were over 23 months old.
- There may have been communication issues between parents and health care service providers in the survey as well as personal and cultural barriers that affect the collection of the data.

## Introduction

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

Based on WHO protocols, children are considered to be fully immunized or have complete immunization after receiving a dose of Bacillus Calmette-Geurin (BCG), three doses of diphtheria-tetanus-pertussis (DPT), three doses of oral polio, and a dose of MMR vaccination to protect them from mumps, measles, rubella, polio, and tetanus.<sup>4</sup> Due to international childhood immunization 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,

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3 immunization rates and child mortality rates are unevenly distributed across subpopulations.<sup>3</sup> In  
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5 this study, we sought to understand the specific challenges and the factors that impede or  
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7 facilitate childhood immunization in Nepal.  
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10 Previous research has indicated that social exclusion affects access to health care,  
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12 exacerbates health inequality, and reduces health care service utilization.<sup>2, 3, 6, 7, 8, 9, 10</sup> Previous  
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14 research on childhood immunization coverage in South Asia has examined the effect of a child's  
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16 gender, his/her family's level of wealth and education, regional inequalities, parental knowledge  
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18 and attitudes about immunization, and issues related to mother's empowerment. In South Asia,  
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20 numerous studies have demonstrated that individual factors (a child's gender), family factors  
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22 (area of residence, household wealth, and parental education), demographic factors (religion and  
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24 caste affiliation), and societal factors (health care access and community literacy level) are  
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26 associated with child immunization rates.<sup>2, 3, 6, 7, 8, 9, 10</sup> The majority of immunization studies in  
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28 India have relied on surveys conducted by the National Family Health Survey (NFHS) between  
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30 1992/1993 and 2006 suggested that girls were less likely to be immunized than boys.<sup>11, 12, 13</sup>  
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32 These studies also reported that children were more likely to be immunized if their parents had  
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34 more knowledge about immunization, their mothers had more education, they were raised in an  
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36 urban setting, and their families had more money.<sup>14, 15</sup>  
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42 In Nepal, the majority of research on immunization has emphasized evaluating factors that  
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44 affect access to health care as well as the quality of service delivery, including the vaccination  
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46 rates.<sup>6</sup> Previous research in Nepal has found that poverty, geographic location (difficult terrain),  
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48 being from a low caste or indigenous population, traditional cultural attitudes, being female, and  
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50 low levels of maternal education all reduce the likelihood that a child will be immunized.<sup>2, 6, 7, 10</sup>  
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52 Previous research<sup>6</sup> found that children from indigenous and previously untouchable caste (e.g.,  
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3 *Dalits*) were less likely to be immunized than High caste children. Terai caste and Muslim  
4 children were not included in the study analysis. Indeed, Terai caste and Terai Muslims are the  
5 most underprivileged and under representative communities in the Nepalese social structure.<sup>16, 17,</sup>  
6  
7 In an attempt to build on this research and understand current challenges to immunization in  
8 Nepal, this study not only explored demographic information and many of the factors considered  
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10 above but also examined structural barrier factors that do not exist outside of Nepal.  
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## 19 **Methods**

### 20 ***Data***

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22 We used data from the 2016 Nepal Demographic Health Survey (the 2016 NDHS), a  
23 nationally representative sample of Nepal. The data was collected by the MEASURE  
24 Demographic and Health Survey (DHS) project.<sup>16</sup> The DHS project has collected the most  
25 comprehensive health data available in developing countries, including Nepal. The data is  
26 publicly available through the Ministry of Health and Population of Nepal, New Era Kathmandu,  
27 and ICF International USA. The survey is conducted every five years with support from the US  
28 Agency for International Development (USAID) through its mission in Nepal and was supported  
29 by the Ministry of Health and Population of Nepal. We used data from the Children's Data  
30 Section (i.e., Child Recode File) of the Nepal Demographic Health Survey the 2016 NDHS. The  
31 data provides health information on every child who was born in the five years preceding the  
32 survey. The survey also provides information about children who received specific vaccine  
33 based on vaccination card and/or mother's report. We only analyzed data for children from 12-23  
34 months (n=1025). We selected this data because most children are completely immunized by the  
35 age of 24 months.<sup>18</sup>  
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### ***Dependent Variable***

As per the WHO recommendation, a child was considered to be fully immunized 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 immunized; 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 five. These demographic, biological, and socioeconomic characteristics were based on factors that had been previously shown to be associated with childhood immunization.<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 (e.g., structural barrier factors for health care service utilization) we considered were distance to a health facility and immediate financial situation (e.g. money as a big problem to visit health care service, and distance to health care facility).

## Childhood Complete Immunization in Nepal

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3 All independent variables in the study were categorical variable, except the number of  
4 children under the age of five. A boy was coded as “1” and a girl was coded as “2”. The NDHS  
5 provides mother age groups in 5 year interval (15-49). We recoded creating a mother’s age group  
6 into 4 categories as 15 to 19, 20 to 29, 30 to 39, and 40 to 49.  
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12 There are 125 registered caste/ethnic groups in Nepal and one’s caste/ethnicity is determined  
13 by birth. Within such heterogeneity of caste/ethnic groupings, the NDHS provides 11 different  
14 categories of caste/ethnicity affiliation, which we further grouped into four categories based on  
15 previous studies<sup>21</sup> as high Hindu caste, previously untouchable caste (e.g., Dalits), indigenous  
16 (Newars and Janajati), and other Terai caste (i.e., Madeshi and Muslims). The NDHS provides  
17 mother’s educational attainment as illiterate, primary school attainment, secondary school  
18 attainment, and higher education attainment. We recoded again and coded as “0” for those  
19 mother who have never attended any schooling, “1” for primary education completion, and “2”  
20 was coded for secondary and higher education attainment. The NDHS provides 5 categories of  
21 wealth index based on household’s cumulative living standard and it was recoded as poorest,  
22 poor, middle, rich, and richest. .  
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38 Nepal has three distinct geographical regions (Mountain, Hill, and Terai) and we coded  
39 geographical regions into three categories. The Mountain region includes areas with elevation of  
40 3,000 meters above sea level to Mount Everest (elevation 8,848 meters), the tallest Mountain in  
41 the world. The Hill region lies between elevations of 700 and 3,000 meters above sea level, and  
42 the Terai region is relatively flat and borders of India. Similarly, cities and towns were grouped  
43 into urban area which were coded as “1”; villages were grouped under the rural area which were  
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54 In 2015, according to the Constitution of Nepal 2015, seven provinces were formed as  
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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 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 a big problem were coded as “1”. Similarly, those who reported distance to health care facility was not a big problem was recoded as “0” and those who responded “big problem” was coded as “1”.

### ***Data Analyses***

The statistical analyses were performed using the software SPSS for Windows (version 25). We first ran descriptive and bivariate statistical analyses. To identify factors that are significantly associated with complete childhood immunization, 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.

### ***Ethical Approval***

For the 2016 Nepal Demographic Health Survey (the 2016 NDHS), ethical approval was obtained from the Nepal Health Research Council, Kathmandu, Nepal, and ICF Macro Institutional Review Board, Maryland, USA.

### ***Patient and Public Involvement statement***

Patients and the public were not involved in the research.

## Childhood Complete Immunization in Nepal

## Results

Overall, 79.2% of the children were fully immunized 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 1. Childhood Immunization by the Vaccine Type**

Vaccination	A BCG vaccine	Three Polio vaccines	Three DPT vaccine	A Measles vaccine	Complete Immunization
% 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 & 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

## Childhood Complete Immunization in Nepal

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 health care 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

Note: SD = Standard Deviation

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% 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 five, money to pay to get to a health care facility, and distance to health care facilities were significantly associated with complete childhood immunization. We also found that only 66.4% of Terai Caste and Muslim children were fully immunized whereas 82.5% of high Hindu caste children were fully immunized. Similarly, 65.7 % of children who live in Province 2 were fully immunized whereas almost 92% of children living in province 4 were fully immunized. (Table 2).

## Childhood Complete Immunization in Nepal

**Table 2.** Descriptive Characteristics of the Sample and Bivariate Association between Independent Variables and Complete Childhood Immunization (N=1025)

Variables	All Population		Three Polio vaccines		Three DPT vaccines		A Measles vaccine		Completely Immunized	
	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 & 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			***		****		****		****	
Province 1	141	13.8	120	85.1	121	85.8	136	96.5	112	79.4

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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; .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

Note: N. = Number  
 \*p ≤ .10. \*\*p ≤ .05. \*\*\*p ≤ .01. \*\*\*\*p ≤ .001.

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3 Results from the multivariate analysis showed that children from the previously untouchable  
4 caste (OR = .58; CI = .33 – .99) and the Terai caste (OR=0.54; CI = .29 – .99) were less likely to  
5 be fully immunized than children from the high Hindu caste. Similarly, children from the Terai  
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Children living in Hill region were more likely to be fully immunized 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 immunization. Similarly, children from mothers reporting immediate financial problems (e.g., money is a big problem) were less likely to be fully immunized, including a complete dose of DPT and measles, than their counterpart (See Table 3).

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Table 3. Logistic Regression Analysis for Complete Immunization in Nepal.

Variables	Three Polio vaccines		Three DPT vaccines		A Measles vaccine		Complete immunization	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Caste/Ethnic Affiliation								
High Hindu Caste (ref.)	1.00		1.00		1.00		1.00	
Untouchables	.61	.30 – 1.24	.57	.28 – 1.17	.54	.22 – 1.30	.58**	.33 - .99
Indigenous	.79	.42 – 1.48	.72	.38 – 1.39	.96	.40 – 2.34	.96	.58 – 1.59
Terai Caste, Muslims	.48*	.22 – 1.05	.36**	.16 - .79	.56	.22 – 1.44	.54**	.29 - .99
Mother’s Education								
None (ref.)	1.00		1.00		1.00		1.00	
Primary	1.24	.70 – 2.19	.95	.55 – 1.62	1.77*	.96 – 3.28	1.13	.73 – 1.75
Secondary & Higher	1.07	.64 – 1.81	.78	.47 – 1.30	1.95**	1.04 – 3.63	1.23	.81 – 1.86
Wealth Status								
Poorest (ref.)	1.00		1.00		1.00		1.00	
Poor	1.56	.84 – 2.90	1.14	.60 – 2.16	1.45	.65 – 3.21	1.32	.80 – 2.18
Middle	1.54	.78 – 3.05	1.06	.53 – 2.08	1.12	.49 – 2.54	1.16	.67 – 2.00
Richer	2.70*	1.20 – 6.09	1.25	.59 – 2.62	2.44*	.93 – 6.39	1.71*	.93 – 3.15
Richest	1.44	.57 – 3.58	1.19	.48 – 2.99	1.03	.36 – 2.94	1.19	.57 – 2.45
Ecological Region								
Mountain (ref.)	1.00		1.00		1.00		1.00	
Hill	2.51**	1.23 – 5.09	2.72**	1.24 – 5.99	1.25	.41 – 3.76	2.14**	1.17 – 3.90
Terai	1.32	.56 – 3.07	.76	.31 – 1.88	.58	.16 – 2.10	1.27	.62 – 2.60
Provinces								
Province 3 (ref.)	1.00		1.00		1.00		1.00	
Province 1	.57	.22 – 1.43	.99	.38 – 2.59	2.04	.51 – 8.15	.83	.39 – 1.73
Province2	.67	.23 – 1.94	1.31	.45 – 3.74	.72	.20 – 2.64	.75	.32 – 1.72
Province 4	1.95	.55 – 6.90	1.15	.38 – 3.43	1.66	.37 – 7.49	1.62	.67 – 3.89
Province 5	1.10	.39 – 3.05	2.02	.71 – 5.78	.54	.16 – 1.84	.91	.42 – 1.98
Province 6	.55	.21 – 1.40	.39*	.15 – 1.09	1.02	.29 – 3.56	.65	.31 – 1.36
Province 7	.94	.34 – 2.54	1.67	.59 – 4.74	1.28	.36 – 4.55	1.26	.57 – 2.77
Number of children under 5	1.15	.92 – 1.43	.98	.80 – 1.19	.97	.78 – 1.21	.96	.81 – 1.44
Money needed to visit								
Not a big problem	1.00		1.00		1.00		1.00	
Big problem *	1.14	.69 – 1.88	.47***	.28 - .81	.55*	.28 – 1.09	.66**	.44 – 1.00
Distance to health facility								

## Childhood Complete Immunization in Nepal

Not a big problem	1.00		1.00		1.00		1.00	
Big problem	.65	.39 – 1.09	.81	.49 – 1.32	.63	.34 – 1.18	.81	.54 – 1.22
Overall model $\chi^2$	48.856		71.466		85.663		80.948	
Cox & Snell $R^2$	.047		.067		.080		.076	
-2 LL	679.093		704.311		525.883		966.205	

\* $p \leq .10$ . \*\* $p \leq .05$ . \*\*\* $p \leq .01$ . \*\*\*\* $p \leq .001$ .

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## 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 health care, including the right to be fully immunized.<sup>22</sup> In line with the UNCRC, Nepal began offering free vaccines to vaccinate its children fully. Despite the progress on immunization of one-year-old children, complete childhood immunization has still remained a challenge in Nepal.<sup>23</sup>

The government of Nepal has committed to achieve UN Sustainable Development Goal (Goal 3) and sought to increase the childhood vaccination rates through its National Immunization Program (NIP) by providing childhood immunization to all sections of the population. In order to ensure that Nepal can successfully implement programs 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; e.g. 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 immunized. The fact is that Nepal is one of the lowest income countries in the world with a Human Development Index of 0.58 ranking 147<sup>th</sup> out of 187 countries with about 35.4% of people living in absolute poverty (on less than \$3.19 (US) per day).<sup>24</sup> In 2011, the average mortality rate in Nepal for children under five was 68 per 1,000, much higher for previously untouchable caste (Dalits), 90 per 1000.<sup>16</sup> The finding of the study further supports the Nepal's socio-economic and geographical disparities create challenges to increasing its childhood immunization rates. Despite access to free vaccines throughout the country, intersection of acute

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3 poverty and belonging to socially excluded caste/ethnic groups still makes it less likely to be  
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5 fully vaccinated by age 2.  
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8 Notwithstanding, the abolishment of the caste system in 1990 in Nepal's Constitution, its  
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10 legacy is apparent and the caste/ethnic-based social structure and hierarchy is still intact.  
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12 Previous studies have documented that the caste/ethnicity based social exclusion is deeply rooted  
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14 in Nepalese social structure, specifically people belonging to the untouchable caste as well as  
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16 belonging to Terai caste (including Madeshi and Muslims) face broad-based discrimination and  
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18 are socially excluded from the power structures in society.<sup>17</sup> As consequences of such social  
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20 exclusion, they are more likely to experience other forms of disadvantages such as living in  
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22 poverty and exposure of domestic violence.<sup>25</sup> Consistent with this social context, children  
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24 belonging to previously untouchable and Terai caste are less likely to be fully immunized than  
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26 other children.  
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31 Interestingly, household wealth status itself was not a strong statistically significant predictor  
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33 for childhood immunization. However, acute poverty (e.g., families which lack the money  
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35 needed to visit a health care facility) is a significant barrier for complete immunization. This is  
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37 likely because the government has provided free vaccines in Nepal since the inception of the  
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39 Expanded Program on Immunization (EPI) in 1979.<sup>27</sup> This suggests that though in many places  
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41 in Nepal vaccines are readily available in health care centers, acute poverty affects some  
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43 women's ability to access to these health care centers. Mothers who reported 'money as a big  
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45 problem' to visit health care facilities were less likely to fully immunize their children. Nepal  
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47 currently provides some financial incentives to mothers who give birth in hospitals or health  
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49 centers. We recommend that this program be expanded to offer financial incentives to mothers  
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51 who immunize their children in an effort to further reduce financial barriers to immunization.  
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3 We found that there are no gender differences between children who were fully immunized  
4 in Nepal. This finding is inconsistent with the previous studies that were conducted in South  
5 Asian context, especially India<sup>11, 12, 13</sup> However, there is a sex ratio imbalance in the overall  
6 population; 44% of children were girls, and 56% were boys. This indicates the male preference  
7 in Nepalese societies and the possibility of sex-selective abortion.<sup>28</sup> Interestingly, this sex  
8 preference does not seem to have influenced childhood immunization rates in Nepal. Further  
9 inquiry is needed to understand why.

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

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**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 immunization 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 immunization. One way to do this is to improve social inclusion and to provide welfare programs, particularly for socially underprivileged caste/ethnic populations. We also recommend providing financial incentives to

families that immunize their children. Such practices would support UN SDG 3, Article 20 of the United Nations Convention on the Rights, and Rights to Health Care which is also mandated by Article 35 of the 2015 Nepalese Constitution.

## Conclusions

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 (e.g., money is a big problem to visit health care facility) were the least likely to be fully immunized. We recommend working to reduce deep seated social inequalities in Nepal that are correlated with children being less likely to be vaccinated. Nepal 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. Lastly, and perhaps the most easily accomplished, more systematic vaccination programs such as community based education and financial incentives to vaccinate children could be designed to specifically target socially excluded children.

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- d. Data sharing statement: Data are available upon request.

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# BMJ Open

## Inequalities in Complete Childhood Immunization in Nepal: Results from a Population-based Cross-sectional Study

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**Title Page****Inequalities in Complete Childhood Immunization in Nepal: Results from a Population-based Cross-sectional Study**

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## Inequalities in Complete Childhood Immunization in Nepal: Results from a Population-based Cross-sectional Study

### Abstract

**Objective** To investigate the effect of different aspects of inequality on childhood immunization rates in Nepal. The study hypothesized that social inequalities factors (e.g., gender of a child, age of mother, caste/ethnic affiliation, mother's socio-economic 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 immunized.

**Design** Using gender of a child, age of mother, caste/ethnic affiliation, mother's socio-economic 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 ages 12 to 23 months old

**Outcome measures** The main outcome variable was childhood immunization

**Results** Only 79.2% of children were fully immunized. 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 = .58; CI = .33 – .99) and the Terai caste (OR=0.54; CI = .29 – .99) were less likely to be fully immunized than children from the high Hindu caste.

**Conclusion** Given Nepal's limited resources, we suggest that programs which target the families of children who are least likely to be fully immunized, specifically those who are not

only poor but in financial crises and “underprivileged” caste families, might be an effective strategy to improve Nepal’s childhood immunization rates.

**Keywords:** childhood complete immunization; inequalities; caste/ethnicity; Nepal

### 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 socio-economic, demographic and geographic characteristics, and therefore, the findings are robust and generalizable nationwide.
- Another strength of the study is that the results are useful to help inform national policies for childhood immunization 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 utilization 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 health care service providers in the survey as well as personal and cultural barriers that affect the collection of the data.

### Introduction

Full immunization coverage is one of the important agendas for sustainable development goal (SDG 3). However, almost 20 million children under 5 are still not be fully immunized.

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3 This is a particular problem in low income nations such as Nepal.<sup>1</sup> Full immunization for young  
4 children is an instrumental variable for child health and wellbeing which helps reduce infant and  
5 child morbidity and mortality rates as well as prevents the spread of infectious diseases.<sup>2,3</sup>  
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10 Based on WHO protocols, children are considered to be fully immunized or have complete  
11 immunization after receiving a dose of Bacillus Calmette-Geurin (BCG), three doses of  
12 diphtheria-tetanus-pertussis (DPT), three doses of oral polio, and a dose of MMR vaccination to  
13 protect them from mumps, measles, rubella, polio, and tetanus.<sup>4</sup> Due to international childhood  
14 immunization efforts, infant and child mortality rates have fallen throughout the world including  
15 in sub-Saharan Africa and South Asia.<sup>5</sup> However, within targeted countries, including Nepal,  
16 immunization rates and child mortality rates are unevenly distributed across subpopulations.<sup>3</sup> In  
17 this study, we sought to understand the specific challenges and the factors that impede or  
18 facilitate childhood immunization in Nepal.  
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31 Previous research has indicated that social exclusion affects access to health care,  
32 exacerbates health inequality, and reduces health care service utilization.<sup>2, 3, 6, 7, 8, 9, 10</sup> Previous  
33 research on childhood immunization coverage in South Asia has examined the effect of a child's  
34 gender, his/her family's level of wealth and education, regional inequalities, parental knowledge  
35 and attitudes about immunization, and issues related to mother's empowerment. In South Asia,  
36 numerous studies have demonstrated that individual factors (a child's gender), family factors  
37 (area of residence, household wealth, and parental education), demographic factors (religion and  
38 caste affiliation), and societal factors (health care access and community literacy level) are  
39 associated with child immunization rates.<sup>2, 3, 6, 7, 8, 9, 10</sup> The majority of immunization studies in  
40 India have relied on surveys conducted by the National Family Health Survey (NFHS) between  
41 1992/1993 and 2006 suggested that girls were less likely to be immunized than boys.<sup>11, 12, 13</sup>  
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3 Studies also reported that children were more likely to be immunized if their parents had more  
4 knowledge about immunization, their mothers had more education, they were raised in an urban  
5 setting, and their families had more money.<sup>14, 15</sup>  
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10 In Nepal, the majority of research on immunization has emphasized evaluating factors that  
11 affect access to health care as well as the quality of service delivery, including the vaccination  
12 rates.<sup>6</sup> Previous research in Nepal has found that poverty, geographic location (difficult terrain),  
13 being from a low caste or indigenous population, traditional cultural attitudes, being female, and  
14 low levels of maternal education all reduce the likelihood that a child will be immunized.<sup>2, 6, 7, 10</sup>  
15 Previous research<sup>6</sup> found that children from indigenous and previously untouchable caste (e.g.,  
16 *Dalits*) were less likely to be immunized than High caste children. Terai caste and Muslim  
17 children were not included in the study analysis. Indeed, Terai caste and Terai Muslims are the  
18 most underprivileged and under representative communities in the Nepalese social structure.<sup>16, 17,</sup>  
19 In an attempt to build on this research and understand current challenges to immunization in  
20 Nepal, this study not only explored demographic information and many of the factors considered  
21 above but also examined structural barrier factors that do not exist outside of Nepal. The aim of  
22 the study is to examine whether a child's gender, maternal age, caste/ethnic affiliation, mother's  
23 socio-economic status, place of residence, extreme poverty, and distance to health facilities  
24 affect the likelihood of a child being immunized in Nepal.  
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## 44 **Methods**

### 45 ***Data***

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47 We used data from the 2016 Nepal Demographic Health Survey (the 2016 NDHS), a  
48 nationally representative sample of Nepal. The data was collected by the MEASURE  
49 Demographic and Health Survey (DHS) project.<sup>16</sup> The DHS project has collected the most  
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3 comprehensive health data available in developing countries, including Nepal. The data is  
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5 publicly available through the Ministry of Health and Population of Nepal, New Era Kathmandu,  
6  
7 and ICF International USA. The survey is conducted every five years with support from the US  
8  
9 Agency for International Development (USAID) through its mission in Nepal and was supported  
10  
11 by the Ministry of Health and Population of Nepal. We used data from the Children's Data  
12  
13 Section (i.e., Child Recode File) of the Nepal Demographic Health Survey the 2016 NDHS. The  
14  
15 data provides health information on every child who was born in the five years preceding the  
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17 survey. The survey also provides information about children who received specific vaccine  
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19 based on vaccination card and/or mother's report. We only analyzed data for children from 12-23  
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21 months (n=1025). We selected this data because most children are completely immunized by the  
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23 age of 24 months.<sup>18</sup>

### 24 25 26 27 28 *Dependent Variable*

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31 As per the WHO recommendation, a child was considered to be fully immunized if s/he  
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33 received a BCG vaccine at birth or soon after; three doses each of DPT and polio vaccine at 6,  
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35 10, and 14 weeks of age; and the measles vaccine at 9 months or soon thereafter.<sup>19</sup> We  
36  
37 aggregated the values of a BCG vaccine, three DPT and polio vaccines, and a dose of measles.  
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39 A value of "1" was assigned for children who received all three vaccines and was considered to  
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41 be fully immunized; children who were either unvaccinated or only partially vaccinated were  
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43 grouped together and coded as "0." Similarly, those children who received complete doses of  
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45 DPT and polio vaccines were coded as 1 and those who were unvaccinated or only partially  
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47 vaccinated for DPT and polio were coded as "0." Those who received a measles vaccine were  
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49 coded as 1 and all others values were coded as 0. In further analysis, we did not consider BGG  
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51 vaccination because almost 98% children were BCG vaccinated.  
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### ***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 five. These demographic, biological, and socioeconomic characteristics were based on factors that had been previously shown to be associated with childhood immunization.<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 (e.g., structural barrier factors for health care service utilization) we considered were distance to a health facility and immediate financial situation (e.g. money as a big problem to visit health care service, and distance to health care facility).

All independent variables in the study were categorical variable, except the number of children under the age of five. 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 4 categories as 15 to 19, 20 to 29, 30 to 39, and 40 to 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 (e.g., Dalits), indigenous (Newars and Janajati), and other Terai caste (i.e., 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 5 categories of

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3 wealth index based on household's cumulative living standard and it was recoded as poorest,  
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5 poor, middle, rich, and richest. .  
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7  
8 Nepal has three distinct geographical regions (Mountain, Hill, and Terai) and we coded  
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10 geographical regions into three categories. The Mountain region includes areas with elevation of  
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12 3,000 meters above sea level to Mount Everest (elevation 8,848 meters), the tallest Mountain in  
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14 the world. The Hill region lies between elevations of 700 and 3,000 meters above sea level, and  
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16 the Terai region is relatively flat and borders of India. Similarly, cities and towns were grouped  
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18 into urban area which were coded as "1"; villages were grouped under the rural area which were  
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20 coded as "2".  
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24 In 2015, according to the Constitution of Nepal 2015, seven provinces were formed as  
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26 Province 1, Province 2, Province 3, Province 4, Province 5, Province 6, and Province 7. The  
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28 formation of the provinces was based on the language and caste/ethnic diversity, although there  
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30 is no majority caste/ethnic population in any of these provinces. These provinces were coded as  
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32 categories variable: Province 1, Province 2, Province 3, Province 4, Province 5, Province 6, and  
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34 Province 7. We used Province 3 as a "reference category" because Kathmandu, the capital city of  
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36 Nepal, is in Province 3. We also included two factors that we predicted would be structural  
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38 barriers to accessing vaccines; affordability (money was reported to be as big problem) and  
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40 accessibility (distance to health facility). Those who responded that money was not a big  
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42 problem were coded as "0" and those who responded that money was not a big problem were  
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44 coded as "1". Similarly, those who reported distance to health care facility was not a big problem  
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46 was recoded as "0" and those who responded "big problem" was coded as "1".  
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### 51 *Data Analyses*

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The statistical analyses were performed using the software SPSS for Windows (version 25). We first ran descriptive and bivariate statistical analyses. To identify factors that are significantly associated with complete childhood immunization, 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.

### ***Ethical Approval***

For the 2016 Nepal Demographic Health Survey (the 2016 NDHS), ethical approval was obtained from the Nepal Health Research Council, Kathmandu, Nepal, and ICF Macro Institutional Review Board, Maryland, USA.

### ***Patient and Public Involvement statement***

Patients and the public were not involved in the research.

## **Results**

Overall, 79.2% of the children were fully immunized 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 1. Childhood Immunization by the Vaccine Type***

Vaccination	A BCG vaccine	Three Polio vaccines	Three DPT vaccine	A Measles vaccine	Complete Immunization
% 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

## Childhood Complete Immunization in Nepal

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2						
3	20 - 29	97.9	88.6	87.5	90.4	79.0
4	30 - 39	96.5	88.3	87.7	93.6	80.1
5	40 - 49	95.2	85.7	90.5	81.0	71.4
6						
7	Caste/Ethnic Affiliation					
8	High Hindu Caste	99.7	91.1	92.5	96.1	85.2
9	Previously Untouchables	97.0	88.1	87.5	88.6	74.9
10	Indigenous	97.5	90.4	89.8	95.0	84.8
11	Terai Caste, Muslims	95.6	83.0	77.3	81.2	66.4
12						
13	Mother's Education					
14	None	96.7	84.4	83.8	84.1	70.8
15	Primary	97.1	89.4	87.0	91.3	77.3
16	Secondary & Higher	98.4	90.7	89.7	95.3	84.9
17	Wealth Status					
18	Poorest	98.0	85.8	88.2	92.5	77.6
19	Poor	97.0	88.7	87.8	91.3	80.0
20	Middle	97.8	86.5	83.4	86.5	74.0
21	Richer	98.6	93.3	89.0	94.7	84.6
22	Richest	96.3	89.9	89.9	90.8	81.7
23						
24	Ecological Region					
25	Mountain	98.9	80.5	85.1	94.3	72.4
26	Hill	98.8	92.5	93.2	96.0	86.5
27	Terai	96.5	86.4	82.9	86.6	74.2
28						
29	Place of Residence					
30	Urban	97.8	89.1	87.0	91.1	79.3
31	Rural	97.5	88.0	88.0	91.2	79.0
32	Provinces					
33	Province 1	97.2	85.1	85.8	96.5	79.4
34	Province 2	96.0	82.5	77.8	80.8	65.7
35	Province 3	98.1	92.5	92.5	95.3	86.0
36	Province 4	100	96.7	94.3	97.6	91.9
37	Province 5	98.3	96.1	90.4	87.0	79.7
38	Province 6	97.9	86.1	84.7	94.4	77.1
39	Province 7	97.0	89.6	91.8	94.0	83.6
40						
41	Money needed to visit a health					
42	care facility					
43	Not a big problem	98.6	91.1	93.5	96.2	86.8
44	Big problem	97.0	86.9	83.3	87.8	74.0
45						
46	Distance to health facility					
47	Not a big problem	98.2	92.0	91.3	94.9	84.6
48	Big problem	97.3	86.5	95.1	86.0	75.9
49						

Note: SD = Standard Deviation

## Childhood Complete Immunization in Nepal

1  
2  
3 Table 2 presents the descriptive characteristics of the sample and the bivariate association  
4 between independent and dependent variables. Fifty-six percent of the children were boys and  
5 44% girls. Almost 30% of the children were from high Hindu caste families, 16.4 % were from  
6 the previously untouchable caste, 31.5 % were from indigenous families, and 22.3 % were from  
7 the Terai caste or were Muslim. Nearly 30% of mothers never had any formal schooling. Results  
8 from bivariate analyses indicated that caste/ethnic affiliation, mother's education, wealth status,  
9 ecological region, provinces, number of children under five, money to pay to get to a health care  
10 facility, and distance to health care facilities were significantly associated with complete  
11 childhood immunization. We also found that only 66.4% of Terai Caste and Muslim children  
12 were fully immunized whereas 82.5% of high Hindu caste children were fully immunized.  
13 Similarly, 65.7 % of children who live in Province 2 were fully immunized whereas almost 92%  
14 of children living in province 4 were fully immunized. (Table 2).  
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## Childhood Complete Immunization in Nepal

**Table 2.** Descriptive Characteristics of the Sample and Bivariate Association between Independent Variables and Complete Childhood Immunization (N=1025)

Variables	All Population		Three Polio vaccines		Three DPT vaccines		A Measles vaccine		Completely Immunized	
	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 & 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

## Childhood Complete Immunization in Nepal

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			***		****		****		****	
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; .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

Note: N. = Number

\* $p \leq .10$ . \*\* $p \leq .05$ . \*\*\* $p \leq .01$ . \*\*\*\* $p \leq .001$ .

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3 Results from the multivariate analysis showed that children from the previously untouchable  
4 caste (OR = .58; CI = .33 – .99) and the Terai caste (OR=0.54; CI = .29 – .99) were less likely to  
5 be fully immunized than children from the high Hindu caste. Similarly, children from the Terai  
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Children living in Hill region were more likely to be fully immunized 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 immunization. Similarly, children from mothers reporting immediate financial problems (e.g., money is a big problem) were less likely to be fully immunized, including a complete dose of DPT and measles, than their counterpart (See Table 3).



## Childhood Complete Immunization in Nepal

**Table 3.** Logistic Regression Analysis for Complete Immunization in Nepal.

Variables	Three Polio vaccines		Three DPT vaccines		A Measles vaccine		Complete immunization	
	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	
Untouchables	.61	.30 – 1.24	.57	.28 – 1.17	.54	.22 – 1.30	.58**	.33 – .99
Indigenous	.79	.42 – 1.48	.72	.38 – 1.39	.96	.40 – 2.34	.96	.58 – 1.59
Terai Caste, Muslims	.48*	.22 – 1.05	.36**	.16 – .79	.56	.22 – 1.44	.54**	.29 – .99
<b>Mother's Education</b>								
None (ref.)	1.00		1.00		1.00		1.00	
Primary	1.24	.70 – 2.19	.95	.55 – 1.62	1.77*	.96 – 3.28	1.13	.73 – 1.75
Secondary & Higher	1.07	.64 – 1.81	.78	.47 – 1.30	1.95**	1.04 – 3.63	1.23	.81 – 1.86
<b>Wealth Status</b>								
Poorest (ref.)	1.00		1.00		1.00		1.00	
Poor	1.56	.84 – 2.90	1.14	.60 – 2.16	1.45	.65 – 3.21	1.32	.80 – 2.18
Middle	1.54	.78 – 3.05	1.06	.53 – 2.08	1.12	.49 – 2.54	1.16	.67 – 2.00
Richer	2.70*	1.20 – 6.09	1.25	.59 – 2.62	2.44*	.93 – 6.39	1.71*	.93 – 3.15
Richest	1.44	.57 – 3.58	1.19	.48 – 2.99	1.03	.36 – 2.94	1.19	.57 – 2.45
<b>Ecological Region</b>								
Mountain (ref.)	1.00		1.00		1.00		1.00	
Hill	2.51**	1.23 – 5.09	2.72**	1.24 – 5.99	1.25	.41 – 3.76	2.14**	1.17 – 3.90
Terai	1.32	.56 – 3.07	.76	.31 – 1.88	.58	.16 – 2.10	1.27	.62 – 2.60
<b>Provinces</b>								
Province 3 (ref.)	1.00		1.00		1.00		1.00	
Province 1	.57	.22 – 1.43	.99	.38 – 2.59	2.04	.51 – 8.15	.83	.39 – 1.73
Province2	.67	.23 – 1.94	1.31	.45 – 3.74	.72	.20 – 2.64	.75	.32 – 1.72
Province 4	1.95	.55 – 6.90	1.15	.38 – 3.43	1.66	.37 – 7.49	1.62	.67 – 3.89
Province 5	1.10	.39 – 3.05	2.02	.71 – 5.78	.54	.16 – 1.84	.91	.42 – 1.98
Province 6	.55	.21 – 1.40	.39*	.15 – 1.09	1.02	.29 – 3.56	.65	.31 – 1.36
Province 7	.94	.34 – 2.54	1.67	.59 – 4.74	1.28	.36 – 4.55	1.26	.57 – 2.77
Number of children under 5	1.15	.92 – 1.43	.98	.80 – 1.19	.97	.78 – 1.21	.96	.81 – 1.44
Money needed to visit								

Childhood Complete Immunization in Nepal

Not a big problem	1.00		1.00		1.00		1.00	
Big problem *	1.14	.69 – 1.88	.47***	.28 - .81	.55*	.28 – 1.09	.66**	.44 – 1.00
Distance to health facility								
Not a big problem	1.00		1.00		1.00		1.00	
Big problem	.65	.39 – 1.09	.81	.49 – 1.32	.63	.34 – 1.18	.81	.54 – 1.22
Overall model $\chi^2$	48.856		71.466		85.663		80.948	
Cox & Snell R <sup>2</sup>	.047		.067		.080		.076	
-2 LL	679.09		704.31		525.88		966.20	
	3		1		3		5	

\*p ≤ .10. \*\*p ≤ .05. \*\*\*p ≤ .01. \*\*\*\*p ≤ .001.

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## 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 health care, including the right to be fully immunized.<sup>22</sup> In line with the UNCRC, Nepal began offering free vaccines to vaccinate its children fully. Despite the progress on immunization of one-year-old children, complete childhood immunization has still remained a challenge in Nepal.<sup>23</sup>

The government of Nepal has committed to achieve UN Sustainable Development Goal (Goal 3) and sought to increase the childhood vaccination rates through its National Immunization Program (NIP) by providing childhood immunization to all sections of the population. In order to ensure that Nepal can successfully implement programs 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; e.g. 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 immunized. The fact is that Nepal is one of the lowest income countries in the world with a Human Development Index of 0.58 ranking 147<sup>th</sup> out of 187 countries with about 35.4% of people living in absolute poverty (on less than \$3.19 (US) per day).<sup>24</sup> In 2011, the average mortality rate in Nepal for children under five was 68 per 1,000, much higher for previously untouchable caste (Dalits), 90 per 1000.<sup>16</sup> The finding of the study further supports the Nepal's socio-economic and geographical disparities create challenges to increasing its childhood immunization rates. Despite access to free vaccines throughout the country, intersection of acute

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3 poverty and belonging to socially excluded caste/ethnic groups still makes it less likely to be  
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5 fully vaccinated by age 2.  
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8 Notwithstanding, the abolishment of the caste system in 1990 in Nepal's Constitution, its  
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10 legacy is apparent and the caste/ethnic-based social structure and hierarchy is still intact.  
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12 Previous studies have documented that the caste/ethnicity based social exclusion is deeply rooted  
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14 in Nepalese social structure, specifically people belonging to the untouchable caste as well as  
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16 belonging to Terai caste (including Madeshi and Muslims) face broad-based discrimination and  
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18 are socially excluded from the power structures in society.<sup>17</sup> As consequences of such social  
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20 exclusion, they are more likely to experience other forms of disadvantages such as living in  
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22 poverty and exposure of domestic violence.<sup>25</sup> Consistent with this social context, children  
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24 belonging to previously untouchable and Terai caste are less likely to be fully immunized than  
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26 other children.  
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31 Mothers with at least a secondary education were more likely to vaccinate their children.<sup>26</sup> This  
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33 finding is consistent in the case of measles vaccination in Nepal. However, that was not true for  
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35 other vaccines. The measles vaccine has to be completed between 9 and 12 months, whereas other  
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37 vaccines are usually done earlier. Likewise, household wealth status itself was not a strong  
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39 statistically significant predictor for childhood immunization. However, acute poverty (e.g.,  
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41 families which lack the money needed to visit a health care facility) is a significant barrier for  
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43 complete immunization. This is likely because the government has provided free vaccines in  
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45 Nepal since the inception of the Expanded Program on Immunization (EPI) in 1979.<sup>27</sup> This  
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47 suggests that though in many places in Nepal vaccines are readily available in health care centers,  
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49 acute poverty affects some women's ability to access to these health care centers. Mothers who  
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51 reported 'money as a big problem' to visit health care facilities were less likely to fully immunize  
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3 their children. Nepal currently provides some financial incentives to mothers who give birth in  
4 hospitals or health centers. We recommend that this program be expanded to offer financial  
5 incentives to mothers who immunize their children in an effort to further reduce financial barriers  
6 to immunization.  
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13 We found that there are no gender differences between children who were fully immunized  
14 in Nepal. This finding is inconsistent with the previous studies that were conducted in South  
15 Asian context, especially India<sup>11, 12, 13</sup> However, there is a sex ratio imbalance in the overall  
16 population; 44% of children were girls, and 56% were boys. This indicates the male preference  
17 in Nepalese societies and the possibility of sex-selective abortion.<sup>28</sup> Interestingly, this sex  
18 preference does not seem to have influenced childhood immunization rates in Nepal. Further  
19 inquiry is needed to understand why.  
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30 We found that children living in the Hill region were more likely to be fully vaccinated than  
31 other subpopulations. The people in the Hill region belong to the top and the bottom of the caste  
32 system, and they brought the tradition of caste-based social structure. Such tradition of social  
33 groupings included the Brahmans (priests, teachers, and scholars), the Kshatriyas (kings and  
34 warriors), the Vaishyas (traders and businesspeople, or indigenous people), and the Shudra  
35 (untouchables or occupational castes or Dalits). The majority of people who live in the Hill  
36 region are from high Hindu caste backgrounds, and this population has a more significant  
37 influence on linguistic, socio-political, and cultural aspects in Nepal.<sup>29</sup>  
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### 48 **Recommendations**

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50 The study explored social inequalities in Nepal, such as belonging to the underprivileged  
51 caste/ethnic group, living in acute poverty, and geographical disparities predicted to impede or  
52 facilitate childhood immunization for Nepalese children. Based on the study findings, we  
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3 recommend that it is essential to reduce deep-rooted social inequalities in order to effectively  
4 deliver essential social and health services, including childhood immunization. One way to do  
5 this is to improve social inclusion and to provide welfare programs, particularly for socially  
6 underprivileged caste/ethnic populations. We also recommend providing financial incentives to  
7 families that immunize their children. Such practices would support UN SDG 3, Article 20 of  
8 the United Nations Convention on the Rights, and Rights to Health Care which is also mandated  
9 by Article 35 of the 2015 Nepalese Constitution.  
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### 19 **Conclusions**

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21 Each country has their own issues that limit access to health and welfare services. In  
22 Nepal, we found that children belonging to the underprivileged caste/ethnic groups and those  
23 whose mothers reported being in a financial crisis situation (e.g., money is a big problem to visit  
24 health care facility) were the least likely to be fully immunized. We recommend working to  
25 reduce deep seated social inequalities in Nepal that are correlated with children being less likely  
26 to be vaccinated. Nepal needs to do more than legislate to end the caste system (which has been  
27 done) but also needs to enforce such legislation. Another way to improve access to childhood  
28 vaccines would be to increase educational opportunities for girls. Lastly, and perhaps the most  
29 easily accomplished, more systematic vaccination programs such as community based education  
30 and financial incentives to vaccinate children could be designed to specifically target socially  
31 excluded children.  
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- 49  
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51  
52 IHS designed the manuscript, MSA prepared the dataset and conducted the statistical  
53 analysis under the supervision of IHS and EP. MSA prepared the initial draft of the  
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3 paper. IHS and EP revised the paper and contributed to preparing the final draft for the  
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5 submission.  
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7  
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9

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12 d. Data sharing statement: Data are available upon request.  
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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

**Manuscript: *Inequalities in Complete Childhood Immunization in Nepal: Results from a Population-based Cross-sectional Study***

**ID: bmjopen-2020-037646.R2**

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	2, 9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5, 6, 7, 8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6, 7, 8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5, 6
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6, 7, 8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6, 7, 8
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	n/a
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a

		(e) Describe any sensitivity analyses	n/a
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9, 10, 11, 12, 13
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14, 15, 16
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	17, 18, 19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3,
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	3, 17, 18, 19, 20
Generalisability	21	Discuss the generalisability (external validity) of the study results	3
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).