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Factors Affecting Poverty in Nepal - A Binary Logistic Regression Model Study

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ABSTRACT

One of the key factors in reducing monetary poverty is the identification of its determinants. Using a logistic regression model and considering household poverty status (poor/non-poor) as the response variable, this paper attempts to identify the most promising factors associated with monetary poverty based on nationally representative data of 5,988 households from the Nepal Living Standard Survey (2010/11). The goodness of fit, classification, discrimination, and diagnostics of the fitted model is performed. Six factors, namely illiteracy of household head (OR: 2.20; 95% CI: 1.86–2.61), households receiving no remittance (OR: 1.90; 95% CI: 1.64–2.20), households with no landholdings (OR: 1.53; 95% CI: 1.31–1.78), households with poor access to market centers (OR: 1.77; 95% CI: 1.52–2.07), households having more than two children under the age of 15 (OR: 4.69; 95% CI: 4.06–5.42) and households having no literate persons of working age (OR: 1.29; 95% CI: 1.07–1.56) are significantly associated with the likelihood of poverty. Male-headed households are not better positioned than female-headed households concerning poverty level. The developed regression model has satisfied the test of goodness of fit of the model and reasonably satisfied the regression diagnostics through visual assessment. As several risk factors associated with poverty increase, the likelihood of a household being poor increases substantially. This analysis is expected to be helpful for the concerned authority to reframe the policy.

Keywords: Covariate pattern, diagnostics, goodness of fit, logistic regression, Nepal, poverty

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INTRODUCTION

Poverty reduction in developing countries like Nepal is a central issue. One of the key factors in reducing monetary poverty, poverty conceptualized and measured in economic dimensions (in terms of income or consumption), is the identification of its determinants. Based on empirical studies in several countries, it can be inferred that poverty is partially determined by internal household characteristics and partially by external factors. Internal household characteristics include gender and education level of the household head, number of dependents, household size, place of residence, human capital, remittance, and area of landholdings. The effects of these characteristics on poverty have been researched by many scholars, including Abrar ul Haq et al. (2019), Teka et al. (2019), Imam et al. (2018), R. E. A. Khan et al. (2015), Spaho (2014), Leekoi et al. (2014), Thapa et al. (2013), Omoregbee et al. (2013), Osowole et al. (2012), Achia et al. (2010). In addition, external factors such as access to health care facilities (M. M. Khan et al., 2006; Peters et al., 2008), access to market centers (Obi et al., 2012), access to micro-credit (Chowdhury et al., 2005), access to infrastructure (John & Scott, 2002), economic growth (Adams, 2003), are also reported to be associated with poverty.

Nepal made remarkable progress in the reduction of monetary poverty in very unfavorable situations from 1996 to 2011, a period characterized by a decade long (1996–2006) violent, armed conflict between the State and the Maoist. The conflict was formally ended by signing the Comprehensive Peace Agreement in November 2006 between the State and the then Communist Party of Nepal- Maoist. The prolonged political instability manifested by frequent changes in government, which lasted till a single political party came into power through a general election that took place under the Constitution of Nepal 2015. There was a sluggish economic growth of around 4.0% per annum (Ministry of Finance [MoF], 2013). However, the percentage of the population below the poverty line at the national level declined from 41.8 in 1996 to 30.9 in 2004 and further declined to 25.2 in 2011 (Central Bureau of Statistics [CBS], 2011a), which is still 4 in 1 person remained as poor due to several factors which are not yet known.

The main objective of this paper is to identify the most promising factors influencing household-level poverty using binary logistic regression on the nationally representative sample survey data of the Nepal Living Standard Survey III (NLSS-III) conducted by the Central Bureau of Statistics (CBS) in the fiscal year 2010/11, since to the best of our knowledge, no rigorous work on said data has yet to be done. Since 2010/11, the NLSS has not yet been conducted again for several reasons, such as the devastating twin earthquakes of 2015 and COVID-19. As a result, the NLSS-III conducted in 2010/11 is the latest estimate of poverty based on nationally representative survey data.

In order to identify the potential factors affecting poverty, a review of relevant literature is essential, and it is done in the next section.

LITERATURE REVIEW

A brief review of the literature is made below to identify policy-driven factors affecting household-level poverty in Nepal.

Several drivers were responsible for the amazing progress in the reduction of poverty. The three main drivers identified by the World Bank are a drastic increase in personal remittances received from abroad, a rise in labor incomes, and an improvement in household demographics. These factors contributed to a 27, 52, and 15% reduction in poverty from 1996 to 2011 (Uematsu et al., 2016).

A large volume of Nepalese laborers migrated abroad for employment during the 1996–2011 period. As a result, the absent population reported in 2011 was 1,921,494, a big jump from the number of 762,181 reported in the census of 2001 (CBS, 2014). The outmigration brought many changes in Nepal's socio-economic and demographic sectors.

The two visible economic impacts of remittances are as follows. First, at the micro-level, the nominal average amount of remittance per recipient household in Nepali currency increased from 15,160 in 1996 to 80,436 in 2011 (CBS, 2011b). At the macro level, the percentage share of remittances in GDP increased from 1.8 in 1996 (MoF, 2005) to 18.5 in 2011 (MoF, 2012).

The average annual population growth rate had sharply declined from 2.25% during the census period of 1991–2001 to 1.35% during the census period of 2001 to 2011 (CBS, 2014); the total fertility rate had decreased from 4.6 births per woman in 1996 to 2.6 births per woman in 2011, (Ministry of Health, 2011); the percentage of female-headed households had increased from 13.6 in 1996 to 26.6 in 2011; the percentage of children under 15 had declined from 42.4 in 1996 to 36.7 in 2011 (CBS, 2011c).

Such demographic changes and many more others had several intertwined implications on the socio-economic life of millions of Nepali peoples. First, the outmigration of millions of literate youths had created a shortage of productive labor (or loss of human capital) within Nepal. The other positive and negative impacts of the outmigration of labor are discussed elsewhere (International Organization of Migration, 2019; Kunwar, 2015; Uematsu et al., 2016).

In addition to households directly benefitting from remittances sent by migrant members, non-migrant households also benefitted from the spillover effects of migration (Uematsu et al., 2016). As a result, household income increased by almost fivefold over a decade and a half: the nominal average household income in Nepali currency increased from 43,732 in 1996 to 202,374 in 2011 (CBS, 2011c).

Correlates of poverty are also reported in CBS (2005, 2011a). For example, the poverty rate increases with an increase

in household size, such as increasing the number of children. Conversely, the poverty rate decreases with an increase in the level of education of the household head. Households headed by someone working in the agricultural sector, self-employed persons, or wage workers are poorer than those headed by people in other sectors or professions.

The land has multidimensional roles: key factors in production, collateral in credit markets, security against natural disasters or shocks, and symbol of social, economic, and political prestige (Kousar et al., 2015). This statement also holds in the context of Nepal. Further, the computation based on the NLSS-III data showed that 28.8% of households have no land. The problems of the landless are discussed elsewhere (Wickeri, 2011).

Without good access to markets, a poor household cannot market its products, obtain inputs, sell labor, obtain credit, learn about, or adopt new technologies, insure against risks, obtain consumption goods at low prices, or use its scarce resources like land and labor efficiently (Taylor et al., 2009). For example, CBS (2011a) shows the link between poverty and access to facilities, including a market center in Nepal, where the percentage of poor living within 30 minutes of the market center is 16.3, while the remaining 83.7% live beyond 30 minutes of a market center.

Using multinomial logit regression on 962 household-level panel data between NLSS-I and NLSS-II, Bhatta and Sharma (2006) identified factors affecting chronic and transient poor households under three scenarios. The relative risk ratio (base category non-poor [= 0]) of each of the two factors—household size and % of individuals under 15 or over 59 years of age—was significantly greater than 1 for the chronic poor. On the other hand, the relative risk ratio for a percentage of the household adults who can read and write and the value of livestock owned each was significantly less than 1 for the chronic poor.

Thapa et al. (2013), using a binary logistic regression model on data obtained from 279 households from six districts of western Nepal, reported that the literacy of the household head, family size, family occupation, size of landholding, females' involvement in service, occupation of household head and social involvement was significantly associated with the rural poverty.

R. E. A. Khan et al. (2015) studied the factors affecting rural household poverty in one district of Pakistan based on 600 households' data. The probability of poverty decreases considerably in households with members having only an agricultural occupation, households with higher socio-economic empowerment indexes, and remittance-receiving households. In contrast, the probability of poverty increases significantly with an increase in the female to male ratio and the number of household members.

Abrar ul Haq et al. (2018a) assessed the role of household empowerment (developed by Abar ul Haq in his Ph. D. dissertation) in alleviating participatory poverty of

600 rural households in Pakistan. Their assessment suggested that participatory poverty can be reduced by improving household empowerment in the studied area. Abrar ul Haq et al. (2018b) provided a detailed framework for measuring the household empowerment index (HEMI) and measured the index using the data of 42 variables collected from 600 rural households in Pakistan. Abrar ul Haq et al. (2019) found that household empowerment has a significant positive impact on monetary poverty in the studied area. This series of studies open a new window in poverty analysis in a developing country like Nepal and the monitoring and spatial comparison of household empowerment. In the present study, the 42 variables selected in constructing HEMI are useful in justifying the reason for the selected covariates in our study.

After an extensive literature review, seven factors were tentatively identified, and the rationale for their selection in the context of Nepal is elaborated in the next section.

Selection of Factors

The factors selected in this paper are directly or indirectly related to some of the items Abrar ul Haq et al. (2019) used to develop the household empowerment index (HEMI). For example, the two items 'status of landholding' and 'sex of household head' selected in this study correspond to the variables 'land owned' and 'gender of household head' selected in the development of HEMI. The other three factors 'literacy status of household head,' 'number of literate members of working age' and 'number of children under 15' selected in this study are modified versions of the items 'education of household head,' 'average education of the household' and 'size of the house' selected in the development of HEMI. These modifications are necessary due to the unavailability of data and need in the context of Nepal, as described below.

The NLSS-III data showed that the average number of children under 15 among poor households is almost two times higher than among non-poor households (2.81 versus 1.43). Likewise, the average working age population (15–64) among poor households is slightly higher than among non-poor households (2.95 versus 2.79). On the contrary, the average number of elders (65+) among poor and non-poor households in the same (0.24). These results indicate that instead of investigating the effect of household size on household poverty, it is more realistic from a policy perspective to investigate the effect of 'number of children' and 'number of literate working age members (or human capital)' separately. Investigating the effect of human capital on poverty is essential since a huge number of skilled or semiskilled individuals have out-migrated. Likewise, investigating the effect of children on poverty is essential since it is a perennial problem in Nepal.

Considering the contribution of remittance to Nepal's GDP and the source of income of most households in Nepal, the factor, 'status of remittance recipient,' has been included in this paper. Moreover, many scholars in contemporary studies have

included it as a covariate; for example, see Abrar ul Haq et al. (2018b), R. E. A. Khan et al. (2015).

Considering over 50% of Nepal's population were reported to dwell beyond a 30 minutes reach of the nearest market centers (CBS, 2011a), and realizing the direct/indirect role of market centers (Joshi & Joshi, 2016; Shively & Thapa, 2017; Taylor et al., 2009) in reducing poverty, the factor 'access to nearest market' has been included in this paper.

In summary, based on the extensive review of the literature and empirical evidence, the present study identified seven factors, each of which is related to two pillars—economic empowerment and social empowerment—of household empowerment, formulating the hypothesis that each of these factors will have a significant effect in reducing poverty in Nepal.

The source of data, the process of dichotomization of four tentatively identified quantitative factors, the appropriate statistical model with its goodness-of-fit test, the diagnostic criteria of the fitted model, and the risk assessments of the identified factors are discussed in the next section.

METHODS

The main data source for this study is NLSS-III which provides household-level data on several variables of 5,988 households and individual-level data on several variables of 28,670 individuals. The available data on the variable "household poverty status" (poor/non-poor) was taken as the response variable by assigning code values 1 for poor and 0 for non-poor. In this study, a household is defined as *poor (non-poor) if the per capita expenditure of the household members falls below (above) the poverty line of Nepali currency, 19,261*. The unweighted and weighted proportions of poor households were correspondingly 18.5% and 20.0%.

The available data on three household level dichotomous variables—sex (male/female) and literacy status (literate/illiterate) of household head and the remittance-receiving status (yes/no)— were used as one set of covariates in this study. Also, the available household level numeric data on two variables—area of landholding measured in hectares and access to the nearest market center measured in walking distance time in minutes to reach the nearest market was also used as covariates after converting them into dichotomous variables.

The available data on the variables "age" and "literacy status" of individuals were used to construct the two household-level numeric variables—the number of children under 15 and the number of literate members of working age (15–64 years) within each household. These two numeric variables were also used as covariates after converting them into dichotomous variables. The main reason for dichotomizing each of the four numeric variables is to make a meaningful comparison between the two mutually exclusive and exhaustive households, namely the *disadvantaged* and *advantaged groups*. The process of dichotomizing, particularly choosing the demarcating value for each of the four quantitative variables, is described below.

Households Dichotomized by Area of Land Holding

Considering the importance of land possession in households in Nepal, the demarcating value for the area of landholdings (numeric variable) was chosen to be 0, which demarcates households into two groups—one group of households in which each had no land (disadvantaged group) and the other group of households in which each had land (advantaged group).

Households Dichotomized by Access to Nearest Market

Realizing the importance of access to markets in poverty reduction, the demarcating value of this numeric variable was chosen to be 30 minutes of walking distance, which demarcates the households into two groups—one group of households in which each was beyond 30 minutes reach of the nearest market (disadvantaged group) and the other group of households in which each was within 30 minutes reach of the nearest market (advantaged).

Households Dichotomized by the Number of Children Under 15

Children under 15 are considered dependents. Therefore, even if families desire to have multiple children, many children in a household create an economic burden that aggravates household poverty. In order to determine the demarcating value for dichotomizing households by the number of children under 15, a little exercise was carried out. The results (Table 1) show that for each group of households with less than or equal to two children, the poverty incidence falls below the national level of 25.2%. On the contrary, the poverty incidence exceeds the national level for each group of households with more than two children. Therefore, the demarcating value was chosen as two, which demarcates the households into two groups—one group of households in which each had more than two children (disadvantaged group) and the other group of households in which each had less than or equal to two children (advantaged group). The poverty incidence of the former group is estimated at 41.4%, and for the latter group is estimated at 13.5%.

Table 1

The rationale for choosing two children as demarcating value

Group of households with several children	0	1	2	3	4	5+
Within-group incidence of poverty (%)	5.9	11.6	19.6	33.5	42.3	55.7

Source: Computed from data of NLSS III

Households Dichotomized by the Number of Literate Members of Working-Age

In order to investigate the impact of the loss of human capital due to outmigration on household poverty, the household level numeric variable "number of literate members of working age" was selected. They are converted into a dichotomous variable by grouping the households into two groups: no literate members of working age (disadvantaged group) and at least one literate member of working age (advantaged group). The rationale behind choosing a demarcating value of 0 is as follows: *a household with no literate member of working age is in a more difficult position than a household with at least one literate* member *of working age in fighting against poverty*.

The Statistical Model and its Goodness of Fit

The seven household level dichotomous variables, namely sex of household head (female vs. male), literacy status of household head (illiterate vs. literate), remittance-receiving status (no vs. yes), market access (poor vs. better), landholding status (no vs. yes), number of children (more than two vs. at most two), number of literate members of working age (none vs. at least one) were identified as potential covariates in this study. The Chi-square test of independence assessed the association of each potential covariate with the response variable. The binary logistic regression analysis included only the covariates significantly associated (at a 5% significance level) with the response variable. The usual binary logistic regression model with a p-number of covariates (yet to be determined) is expressed below. The model is estimated with the aid of a statistical software package.

$$\ln\left(odds\left(\pi\left(x\right)\right)\right) = \ln\left[\frac{\pi\left(x\right)}{1-\pi\left(x\right)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \qquad (1)$$

The model adequacy was assessed by Pseudo R^2 proposed by McFadden (1974), Omnibus test, and Wald χ^2 test. The goodness-of-fit test was carried out by the Hosmer and Lemeshow (H-L) χ^2 test.

Classification, Discrimination, and Diagnostics of the Model

The classification of the fitted binary logistic regression model was examined by sensitivity, specificity, and accuracy. Furthermore, the ability of the fitted model to discriminate between the poor and non-poor was assessed through the area under the Receiver Operating Characteristics (ROC) curve.

Among the different diagnostics approaches reported in the statistics

literature, mainly two scatter plots were used for the fitted logistic regression model. Firstly, as an influential statistic suggested by Pregibon (1981), the delta beta statistic $(\Delta\hat{\beta})$ was computed, which measures the changes in estimated regression coefficients for each covariate pattern if we were to exclude that pattern, where (Δ) stands for the difference. A scatter plot was prepared, keeping the values of $(\Delta\hat{\beta})$ in the vertical axis and predicted probabilities based on the fitted logistic regression model on the horizontal axis to identify the large influence on the estimated coefficients. Secondly, the delta Chi-square $(\Delta\chi^2)$ based on Pearson's residuals was computed, which measures the effects of patterns on the model's fit in general. A scatter plot keeping delta Chi-square in the vertical axis and predicted probability in the horizontal axis to examine the influence of pattern on overall fit with symbol size proportional to delta beta was also prepared. Besides these two, the model specification test was attempted to examine whether the fitted model needs independent covariates or not by regressing the original response variable on the model predicted variable $(\hat{y})$ and $(\hat{y}^2)$ with the null hypothesis that there is no specification of error at a 5% level of significance.

Risk Assessment based on Presence of Factors

Finally, after fitting the model and assessing the model diagnostics, the risk assessment of the factors by quantifying their effects presented in the model was attempted by regressing the same response variable used in the finally developed model with the newly generated indicator variable, (x_i, for i = 0, 1, 2, 3, ...), where 0 stands for no factors present, and 1,2,3,…,p stand for the presence of any one or two factors, and finally all factors in the final model respectively. Finally, statistical analysis was performed by using statistical software IBM SPSS version 20 and STATA 13 Stata Corp LP, College Station, Texas, USA.

The empirical results regarding the screening of the tentatively identified factors, the estimated binary logistic regression model with discussion, the classification and discriminating power of the fitted model, the diagnostic outcomes of the fitted model, and the risk assessments of the finally selected factors are discussed in the next section.

RESULTS AND DISCUSSION

The following sub-sections deal with the results and discussions of the association of covariates with the response variable, fitted binary logistic regression model, classification and discrimination, diagnostics of the fitted model, and risk assessment.

Association of Covariates with the Response Variable

Descriptions of the seven covariates, such as their categories, coding schemes, distributions of households over two categories of each proposed covariate, an association of each proposed covariate with the response variable assessed by the Chi-square test, and the effect size of each Chi-square test measured by the phi-coefficient are presented in Table 2.

Table 2

Association of covariates with the response variable

Description of household-level dichotomous covariates	Percentage distribution of households	Association of covariates with poverty			Phi-coefficient
		% of poor households within a category	Chi-square value	p-value	
Sex of household head:					
Male (0)	73.3	18.9	1.7	.193	-0.02
Female (1)	26.7	17.4			
Literacy status of household head:					
Literate (0)	60.2	12.2	240.7	<.001	0.20
Illiterate (1)	39.8	28.1			
Status of remittance recipient:	53.1	15.7	35.7	<.001	0.08
Yes (0)	46.9	21.7			
No (1)					
Status of land holdings:					
Yes (0)	71.2	15.1	114.9	<.001	0.14
No (1)	28.8	27.0			
Access to nearest market:					
Better (0)	52.0	11.6	206.7	<.001	0.19
Poor (1)	48.0	26.0			
Number of children under 15:					
At most two (0)	73.8	10.9	653.0	<.001	0.33
More than two (1)	26.2	40.1			
Number of literate members of working age:					
At least one (0)	80.7	15.6	142.0	<.001	0.15
None (1)	19.3	30.8			

Note. Figures within parentheses are binary codes; Sample size (n) = 5,988. *Source:* Computed from data of NLSS-III

All covariates except the sex of the household head are significantly associated with poverty. Male-headed households were not better positioned than female-headed households concerning poverty level. This finding contradicts the findings of other studies (Kona et al., 2018; Omoregbee et al., 2013). Nonetheless, our finding is analogous to the findings reported by some studies (Bhatta & Sharma, 2006; Edoumiekumo et al., 2014; Spaho, 2014). In order to explore this issue, a chi-square test of independence was also performed to determine whether there is an association between the sex of the household head and the status of the remittance receiver. A significant association was found ($\chi^2(1) = 491.5$, $p < .001$). Among the female-headed households, 76.8% were remittance receivers, while only 44.4% were remittance receivers among the male-headed households. This result partially explains why male-headed households were not in a better position than female-headed households regarding the poverty measurement.

Among the significantly associated covariates, the effect size of remittance is the smallest, and the number of children is the highest. Therefore, the smallest effect size of remittance indicates that remittance alone is not responsible for reducing poverty, which is consistent with the result of the World Bank (Uematsu et al., 2016).

The effect size of the number of children being the highest is due to several socio-demographic factors, including the varying fertility levels among different social groups of women educationally disadvantaged groups of women, since the adult literacy rate of women is 44.5% (CBS, 2011c). In the context of Nepal, the level of fertility is inversely related to women's educational attainment, decreasing rapidly from 3.7 births among women with no education to 1.7 births among women with a School Leaving Certificate (SLC) or above (Ministry of Health, 2011). As a result, it will take more years to see the benefits of improvement in household demographics.

Results of Binary Logistic Regression

The six significant covariates obtained from the previous analysis are candidates for the binary logistic regression model. The estimated binary logistic regression model results are presented in Table 3. The estimated model is statistically significant, as shown by the omnibus Chi-square test ($\chi^2(6) = 938.97$, $p < .001$). In addition, each beta coefficient is significant at a level <0.001.

The regression model is fitted well as assessed by Hosmer-Lemeshow Chi-square test ($\chi^2(8) = 7.24$, $p = .51$). A little exercise shows no severe problem of multicollinearity assessed through Variance Inflation Factor (VIF) as it varies from 1.01 to 1.47. Sixteen percent of the variation of the outcome variable (McFadden pseudo $R^2 = 0.16$) has been explained by the variations of independent covariates in terms of log-likelihood.

Table 3

Results of estimated binary logistic regression model

Characteristics	Beta	OR	S.E.	P-value	95% C.I. for OR
Literacy status of household head:					
Literate	0.79	1.00	0.09	<.001	(1.86, 2.61)
Illiterate		2.20			
Status of remittance recipient:					
Yes	0.64	1.00	0.08	<.001	(1.64, 2.20)
No		1.90			
Status of land holdings:					
Yes		1.00			
No	0.43	1.53	0.08	<.001	(1.31, 1.78)
Access to nearest market:					
Better		1.00			
Poor	0.57	1.77	0.08	<.001	(1.52, 2.07)
Number of children under 15:					
At most two	1.55	1.00	0.07	<.001	(4.06, 5.42)
More than two		4.69			
Number of literate members of working age:					
At least one	0.25	1.00	0.10	<.001	(1.07, 1.56)
None		1.29			
Constant	-3.27	0.04	0.09	<.001	

Source: Computed from data of NLSS III

The sign of each regression coefficient is positive, which indicates that each disadvantaged group identified in this study is more likely to be poorer than the corresponding advantaged group. This fact is elaborated on below.

The head of the household in Nepal is considered the household leader and is responsible for the entire household resource management. If the household head is illiterate, he/she is likely to get a low-paying job, have less bargaining power, and not be engaged in other economic activities. Consequently, the household income will be less, and the households' poverty level will be increased. In our study, the households headed by illiterate heads are 2.2 times more likely to be poorer than those headed by literate heads (OR: 2.20; 95% CI: 1.86 – 2.61), keeping the effects of all other covariates fixed. Our finding is supported by the findings of Teka et al. (2019), Imam et al. (2018), and Botha (2010).

The households not receiving remittance are 1.9 times more likely to be poorer than those receiving remittance (OR: 1.90; 95% CI: 1.64–2.20), keeping the effects of all other covariates fixed. Similar findings were found in the study carried out in Pakistan. Majeed and Malik (2015) reported that the risk of poor households was 43% less (OR = 0.57) among remittance-receiving households compared to households receiving no remittance. The findings of our study also aligned with the findings of Abrar ul Haq et al. (2019) and R. E. A. Khan et al. (2015). In this study, the remittance association with each remaining covariate is examined using the Chi-square test, and the results are presented in Table 4. Interestingly, the percentage of households receiving remittance is significantly higher among the five disadvantaged groups than their corresponding counterparts, except for the group of households having more than two children. Despite this fact, the odds ratio for the likelihood of households being poor among the disadvantaged groups continues to be greater than one compared to their counterparts.

Table 4
Role of remittance

		% of households receiving remittance	Chi-square value	p-value
Literacy status of household head	Literate	49.0	59.8	< .001
	Illiterate	59.2		
Status of land holdings	Yes	49.8	62.8	< .001
	No	61.1		
Access to the nearest market	Better	49.3	37.5	< .001
	Poor	57.2		
Number of children under 15	At most 2	53.2	0.1	.739
	More than 2	52.7		
Number of literate members of working age	At least one	51.2	34.5	< .001
	None	60.8		

Source: Computed from data of NLSS III

In order to escape from rural poverty, in the context of Nepal, the availability and access to different resources such as job opportunities, availability of land, and access to loans are very important. A person having (not having) land is directly related to social prestige. A household not having a single piece of land generally has very limited access to getting loans, starting businesses, and getting land on rent, which

brings constraints on the economic activities of such households, and ultimately the household poverty level increases. Our study has indicated that households with no land are 1.5 times more likely to be poorer than those with land (OR: 1.53; 95% CI: 1.31–1.78), keeping the effects of all other covariates fixed. Other studies corroborate this finding (Farah, 2015; Imam et al., 2018; Kousar et al., 2015).

In rural parts of Nepal, if the market center is far away and roads and feeder roads are not developed, it is very difficult for farmers and smallholders to sell their products and have access to credit. Postharvest food loss due to lack of cold storage centers and inadequate infrastructure significantly affects household poverty (Shively & Thapa, 2017). Our estimates have shown that the households with poor access to the nearest market are 1.8 times more likely to be poorer than households with better market access (OR: 1.77; 95% CI: 1.52 – 2.07), keeping the effects of all other covariates fixed. This finding is similar to the finding reported by Mamo and Abiso (2018).

Children are dependents, and households with more children require more income for education, health, food, and clothing. Because of this, the household poverty level will increase. Regarding this issue, our study has identified that households with more than two children are 4.7 times more likely to be poorer than households with less than or equal to two children (OR: 4.69; 95% CI: 4.06–5.42), keeping the effects of all other covariates constant. This finding is similar to the findings of Myftaraj et al. (2014), who indicated that households that had two children decreased the possibility of being poor by 20% (OR = 0.8) but increasing one more dependent child increased the risk of becoming poor (OR = 1.03) for three children.

Supposed all members of working age in a household are illiterate. In that case, they are likely to get fewer opportunities for good jobs, be less aware of the opportunities provided by the government and market demand and be less familiar with the latest information and technology; consequently, they lag in social and economic activities. In this context, our study has found that households having no literate members of working age are 1.3 times more likely to be poorer than those with at least one literate member of working age (OR: 1.29; 95% CI: 1.07–1.56) keeping the effects of all other covariates constant. A comparable result was reported by Mamo and Abiso (2018) in rural residencies of Ethiopia (OR =1.4). Omoregbee et al. (2013) also found that the odds of less-educated farmers were 1.3 times more likely to be poorer than more educated farmers in Nigeria. Another study conducted in Pakistan concluded that an increase of one educated earner of any level in the household significantly reduces the risk of the household being poor by 11% (OR = 0.89) compared to the households having uneducated earners (Majeed & Malik, 2015).

Results of Classification and Discrimination of the Model

The sensitivity, specificity, and correct

model classification values are presented in Table 5 for two cutoff points, 0.5 and 0.16. The later cutoff point, 0.16, was identified by plotting the sensitivity/specificity in the vertical axis against various probability cutoffs in the horizontal axis, as presented in Figure 1.

Table 5

Sensitivity, specificity, and correct classification value

Cutoff	Sensitivity	Specificity	Correct classification
0.50	20.80%	97.00%	82.50%
0.16	74.12%	65.57%	67.15%

Source: Computed from data of NLSS III

The percentage of poor cases correctly predicted by the model is 20.80 when the cutoff point is 0.50, whereas it is 74.12 when the cutoff point is 0.16. The overall correct classification of the model considering a cutoff value of 0.50 is 82.50%, and it reduces to 67.15% when considering a cutoff value of 0.16.

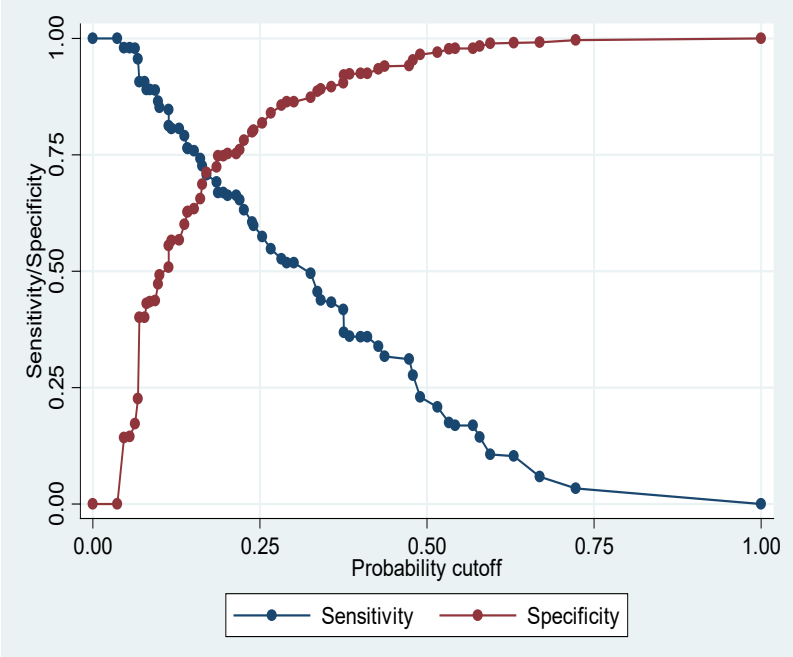

Figure 1. Plot of the sensitivity/specificity against the predicted probability

The ROC curve in Figure 2 shows that the area under the curve (AUC) is 0.78, which can be considered acceptable discrimination of the developed model (Hosmer & Lemeshow, 2000).

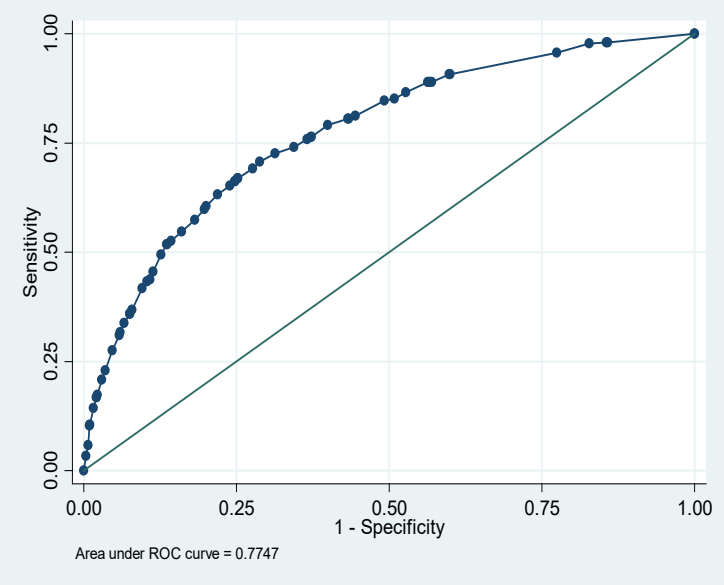

Figure 2. Plot of sensitivity versus 1- specificity

Diagnostics of the Fitted Model

In order to assess the diagnostics of the model, two plots are used. The plot of delta beta $(\Delta\beta)$ versus estimated probability and the plot of delta chi-square $(\Delta\chi^2)$ versus estimated probability with a symbol size proportional to delta beta $(\Delta\beta)$ and the model specification test results are presented below.

Plot of Delta Beta $(\Delta\beta)$ versus Estimated Probability

The influential statistic $(\Delta\beta)$ was plotted with estimated probability based on the fitted logistic regression model with 60 covariate patterns, as shown in Figure 3.

It can be seen clearly that only two data points are falling somewhat far away from the rest of the data. In the scatter plot of delta beta and the estimated probability, if the values of delta beta are greater than 1, there is an indication for an individual covariate pattern to influence the estimated regression coefficients (Hosmer & Lemeshow, 2000). Hence, this curve has indicated that overall, there is not much influence of the individual covariate pattern on the estimated regression coefficients except for two covariate patterns based on visual assessment.

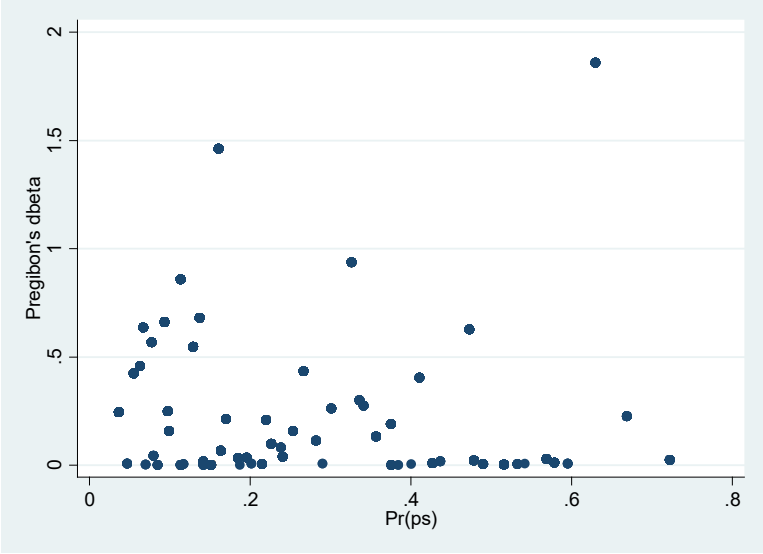

Figure 3. Plot of Pregibon's dbeta $(\Delta\beta)$ versus estimated probability

Plot of Delta Chi-square (Δx^2) versus Estimated Probability with Symbol Size Proportional to Delta Beta ($\Delta\beta$)

A scatter diagram of (Δx^2) versus estimated probability based on the fitted logistic regression model with the size of the symbol proportional to ($\Delta\beta$) is presented in Figure 4. This measure is used to assess the influence of pattern on the overall fit with symbol size proportional to delta beta.

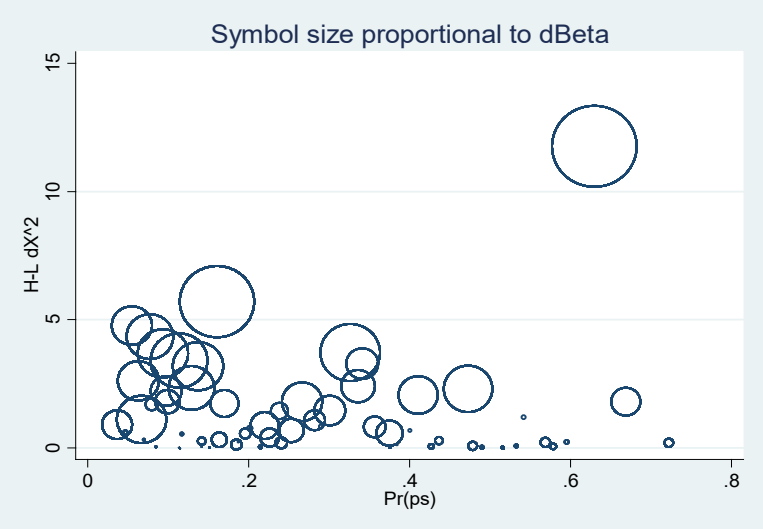

Figure 4. Plot of H-Ldx^2 (Δx^2) versus estimated probability with symbol size proportional to $(\Delta\beta)$

It can be observed clearly in Figure 4 that a few extremely large circles differently appearing are noted in the plot, and for all these circles except one, the value of $(\Delta\chi^2)$ is small. It indicates an influence of the individual covariate pattern on the delta chi-square and the regression coefficients but only for one covariate pattern.

Both figures (3 and 4) show very few (one or two) covariates outlying patterns. Further, the value of $(\Delta\chi^2)$ is not much higher, and only two covariate patterns have a ($\Delta\beta$) value of more than 1. So, it can be concluded that the overall fit of the developed model based on the considerable data size is not violated in diagnostic prospects.

Model Specification

In order to assess whether the final fitted model may need other independent covariates or not, a new regression model was run considering the model predicted value ($\hat{y}$) and the square of the predicted value ($\hat{y}^2$) as the independent variable with the original outcome variable. The results are presented in Table 6.

Table 6

Model predicted value and the square of the predicted value

	Coefficient	S. E.	Z	p-value	95% C. I.
$\hat{y}$	0.97	0.09	11.26	<.001	(0.80, 1.14)
$\hat{y}^2$	-0.01	0.03	-0.39	.696	(-0.08, 0.05)
Constant	-0.01	0.06	-0.10	.923	(-0.12, 0.11)

Source: Computed from data of NLSS III

The non-significant result of the regression coefficient of $\hat{y}^2$ indicates that the model is correctly specified.

Risk Assessment based on Factors Present in the Model

The risk of a household being poor (in terms of odds ratio) was computed based on several factors identified in the model, shown in Figure 5.

The risk of poor households increases continuously as the number of factors increases. The risk of poor households is six times more for households even only presenting any two factors than households not presenting any factor (reference category). This risk is likely to increase by ten times for households presenting any three factors. The conclusions and recommendations based on the empirical results obtained are presented in the next section.

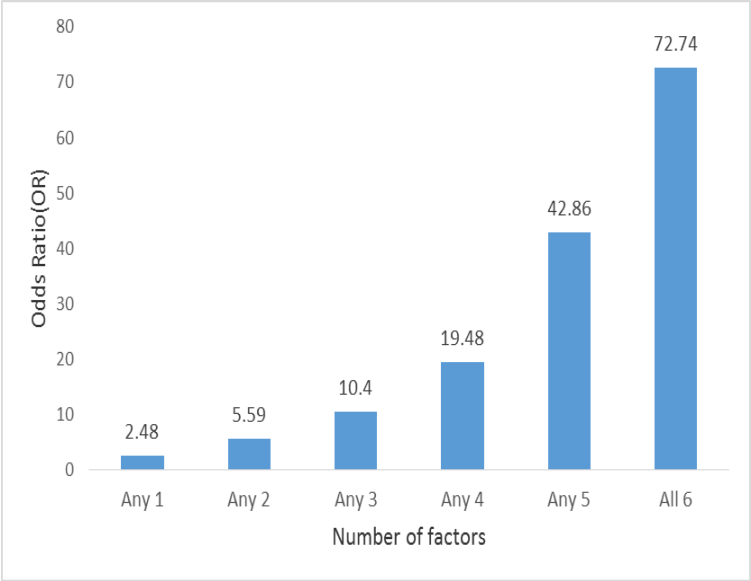

Figure 5. Risk of the household being poor in the presence of several factors

CONCLUSIONS AND RECOMMENDATIONS

This study identified six factors affecting household level poverty by developing a binary logistic regression model on nationally representative sample data of Nepal. The developed logistic regression model with these six covariates has satisfied the test of goodness of fit of the model and reasonably satisfied the regression diagnostics.

The identified factors are related to a broader construct of socio-economic empowerment of households. Moreover, the selected factors being household-level and policy-driven, the concerned authorities can easily implement poverty alleviation programs. Therefore, it can be considered a practical contribution of this study.

The study concludes that even a single literate member of working age in household assists in reducing poverty as much as having a literate household head. It is an indication that many households are suffering from the problem of human capital shortage. Therefore, policies and poverty alleviation programs are to be directed toward building human capital, particularly in those households with inadequate human capital.

It can also be deduced that remittance is an important factor in reducing poverty. The household income increases as the number of remittance recipients increases and reduces poverty. Therefore, the government of Nepal must create a conducive environment where remittance recipients can utilize their money, and foreign-employment returnees can employ their skills in productive areas.

The results further infer that more than two children in a household aggravates household poverty. If the children of poor

households are not given a proper education, then those households may get into the vicious cycle of poverty characterized by an intergeneration poverty cycle. Therefore, the government of Nepal must invest in providing proper education to children of poor households, particularly focusing on those households having more than two children.

In addition, the study identifies a household being landless as a factor that increases household poverty. Therefore, the government of Nepal must address the problems of landless households, either through official government documents or other reliable sources, formulate policies and prepare programs for reducing their problems. We anticipate that these measures will reduce the poverty of landless households.

The results also indicate that poor access to the nearest market center increases the likelihood of household poverty. Therefore, the government of Nepal needs to take the initiative to improve access to markets by developing infrastructure such as road networks, transport networks, cold storage, and electricity, particularly in the rural areas of the country. These measures will increase the connectivity between rural and urban areas and eventually reduce poverty.

This study might have missed incorporating some internal household characteristics (such as the occupation of the household head) and external factors (such as distance to health center) associated with poverty. Future research can be planned with the upcoming NLSS IV data, incorporating other relevant variables. Different composite indices such as the household empowerment index may also be incorporated. The subgroup analysis for different provinces may also be attempted within the same statistical analysis framework based on these indices. Moreover, new studies can also be recommended to capture other community variables associated with poverty and the variables identified in this study in a wider domain using advanced statistical modeling such as multilevel modeling.

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