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Research Article

Effects of Indoor Air Pollution on Stunting Among Children Aged 1-5 Years in Salyan District of Nepal

Madhu Koirala[1]*, Shalik R Dhital[2], Nabin Regmi[3], Sirjana Gyawali[4], Swikriti Acharya[5] and Prajwal Gyawali[6]

[1]National Open College, Sanepa, Kathmandu, Nepal

[2]National Health Education, Information and Communication Center, Kathmandu, Nepal

[3]Hope International College, Lalitpur, Nepal

[4]Ministry of Health and Population, Kathmandu, Nepal

[5]Tribhuvan University, Manmohan Memorial Institute of Health Sciences, Kathmandu, Nepal

[6]The University of Southern Queensland, Australia

***Corresponding Author:** Madhu Koirala, National Open College Kathmandu, Nepal.

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Abstract

Background: Indoor air pollution is a hidden public health concern at household level in Nepal. In rural Nepal, more than 85% of household's basic cooking facilities producing high level of indoor air pollution. It has been hypothesized that indoor air pollution is linked to childhood stunting among many other negative impacts on health.

Aim: The aim of this study was to measure the effects of indoor air pollution on stunting among children aged 1-5 years in Nepal.

Methods: A cross-sectional study was conducted in Salyan district of Nepal. This study included 179 households selected on convenience sampling principle. Exposure to indoor air pollution was assessed based on type of fuel used. Mothers were interviewed to get basic socio-economic and environmental data of a household, a trained Auxiliary Nurse Midwives monitored child stunting during the household visit. Data were analyzed using STATA 11 software. Multi-nominal logistics regression analyses were carried out to estimate the association between exposure and outcome variables at 95% confident interval with significant level of P value 0.05.

Results: The moderate stunting rate was 27.7% and severe stunting was 25.4% among the children aged 1-5 years in this study area. The Brahmin and Chhetri caste children had higher odds (OR=2.66; 95% CI: 1.04-6.89) with moderate stunting relative to Scheduled caste children. The third birth order of mothers was significantly higher odds (OR=3.37; 95% CI: 1.16-9.70) with severe stunting among children aged 1-5 years compared to first birth order. Risk of stunted growth was higher among children from a family with a kitchen inside house compared to having a separate kitchen.

Conclusion: There was no association of indoor air smoke and stunting among children aged 1-5 years. This study highlighted the need to conduct further study to find out further factors related to stunted growth among children under-five years. This study will be useful to further researchers and public health concern about further research on this area in large scale.

Keywords: Biofuel; Stunting; Children; Indoor Air Smoke; Nepal

Introduction

Indoor air pollution at the household level is a serious public health concern in developing countries. The primary source of domestic energy for cooking, lighting and other energy is biomass such as wood, charcoal, crop, residual of dung and coal. Biomass and tobacco smoke are the main source of indoor air smoke. In 2018, approximately 2·8 billion people used biomass fuels such as wood and coal, and kerosene for cooking or heating [1]. About 90% of them from rural setting in developing countries including Nepal) [2,3]. World Health Organization (WHO) estimated in 2002 the indoor air smoke was responsible for 2.7% of the loss of disability-adjusted life years (DALY) worldwide and 3.7% high-mortality in developing countries [4]. Therefore, indoor air smoke from solid fuel or biomass accounted for the third-highest DALY for children

under-five years [5]. Indoor air smoke disproportionately affects women and children's health since they spend most of the time within their household. Average time spent in the kitchen during cooking is 2.3 hours [6].

In Nepal, about two-third of households (66%) use solid fuel (wood) for cooking, and this practice is more common in rural households (88%) than urban households (52%). Bio-fuels and other types of indoor smoke are associated with a higher incidence of stunting among children under-five years in South-Asian-Region [7]. Therefore, indoor smoke and stunting among children aged 1-5 years in Nepal might be the causes of biomass consumption because the proportion of biofuel user is higher. The aims of this study was to measure the effects of indoor air pollution on stunting among children aged 1-5 years in Nepal.

Methods

Study setting and respondents

A cross-sectional study was conducted in rural area of Nepal. The study site was one of the hill district Salyan which had 47 Village Development Committee (VDC) and two political election regions during the survey period in 2012. Among 47 VDC, Siddeshowri VDC was selected as a study site after adequate discussion and suggestion received from the District Health Office, Salyan. Further, the study site was selected based on high immunization records, effectiveness of micronutrient supplementation of health facilities, details of improved cooking stove program launched in the last five years.

Mothers were selected those who had children aged 1-5 years and who were participated in the growth monitoring program during Primary Health Care Out Reach Clinic(PHC-ORC) services. However, mothers had twins' baby, orphaned, under the age of 12 months. Children who were not came for growth monitoring with their mothers were also excluded from the study. Children were considered one each mother.

Sampling technique

Purposive sampling was applied to select mothers and the children were selected from the same eligible mothers who completed government had recommended immunization with in under one years.

Study tools and materials

A quantitative survey questionnaire was developed by the first Author. The survey questionnaire was pre-tested in another similar village. Some questions were modified and edited after pre-test. The final questionnaire was administrated to mothers in the study area.

Data analysis

Age, height, weight and sex related data were entered in Epi info to calculate z-score value of stunting (height for age), wasting (weight for age) and underweight (weight for height). After calculation of z-value for stunting, wasting and underweight data of two software were added by identifying individual case with the help of unique identify number of each case. Then, aggregated data were imported in SPSS for descriptive analysis and in STATA for multinomial logistic regression analysis. Variables were recoded, categorized and created new variable name. Anthropometrics date were entered in Epi info and analysis was done using STATA 11 software. Multi-variate logistic regression analyses were carried out to measure the effects of indoor air pollution and stunting among children at 95% confident interval with 0.05% P-value.

Study variables

Outcome variable

Stunting

This variable was divided into three categories: 1 Normal (No stunting), 2. Moderate Stunting; height for age (-2 Standard deviation), 3. Severe Stunting; height for age (-3 standard deviation) from the median of the reference population.

Explanatory variables

- **Age of mother (Year):** The age of mother was calculated in median.
- **Type of family:** 1. Joint, 2. Nuclear
- **Caste of mother:** The major caste were defined according to Health Management Information System. It was considered in three categories. 1. Barhman/Chhetri, 2. Janajati, 3. Scheduled (Dalit)
- **Employment status of mother:** 1. Yes, 2. No
- **Education level of mothers:** The variable was considered into three categories. 1. No education, 2. Primary Level, 3. Secondary or higher Level
- **Number of children of mother:** 1. First, 2. Second 3. Third and 4. Fourth
- **Household head**: This variable was considered into two categories; 1. Male, 2. Female
- **Types of cooking stoves:** This variable considered into two categories; 1. Unimproved Cook Stove (Ageno/chulho), 2. Improved Cook Stove (sudhariyako chulho)

- **Location of kitchen:** This variable was divided into three categories; 1. Separate Kitchen, 2. Inside the House (sleeping and cooking together), 3. Outdoor Cooking
- **Ventilation in the kitchen**: 1. Window, 2. Small hole (Dabby), 3. No
- **Child exposure during cooking:** 1. Yes, 2. No.

Resuts

Socio-demographic and biofuel used characteristics of mothers

A total of 179 mothers were participated in this study. The median age of mothers was 24 years. The mothers had a Nuclear and Joint family by 48% and 52%, respectively. The caste of respondents was Barhman/Chhetri, Janajati and Scheduled (Dalit) by 44%, 28% and 28% respectively. Large proportion of household head was male which 85% is. The Education Status of women was illiterate 62%, primary level education 16% and secondary or higher education 21%. Only six percent of respondent were employed. The Birth Order of respondent were first 66%, second 28%, third 6% and fourth or more 18%. The Household Head were male by 85% and Female were only 15% in this study. Approximately 31% respondent have enough food in a year.

The percentage of improve cook stove user respondent were low 23% while unimproved cook stoves user was 77% in the Types of cooking stove. Location of kitchen was divided into three categories separate building, inside the house (cooking, sleeping and sitting room together) and Outdoor kitchen (outside the house). Majority of respondents (79%) were cook inside the house, only 15% respondents had separate building for kitchen and six percent respondents cook outdoor.

Ventilation as kitchen was divided into three categories Window, Small hole at kitchen and No any ventilation at kitchen. Kitchen outside the home 10 respondents (out of 179) was excluded from analysis. Majority, 78% respondent had window at kitchen, Small hole was eight percent and no ventilation was 8% households. Approximately 94% of children were directly exposed with indoor air smog due to the presence of children with their mothers during cooking.

Malnutrition Status of children aged 1-5 years

The mean age of children is 34 months in this study. The height of child is minimum 60 cm to maximum 106 cm with mean 84 cm (10.42 SD). Based on the demographic variable sex, age and height and weight of children is calculated in Z score value. Below Figure 1 shows 25% of children had moderate stunting and the same percentage of children had severe stunting. The moderate and severe wasting rate were 6% and 2% among children aged 1-5 years. Children who had moderate underweight were 23% and severe underweight were only 2% of children aged 1-5 years.

Table 1: Sociodemographic and biofuel used characteristics of mothers (n = 179).

Variables	Options	N (%)
Basic information		
Age of mother (Year)	Median	24
Type of family		
	Nuclear	86(48)
	Joint	93(52)
Caste		
	Scheduled (Dalit)	51(28)
	Janajati	50(28)
	Brahmin and chhetri	78(44)
Household head		
	Male	153(85)
	Female	26(15)
Education of mothers		
	No education	113(62)
	Primary Level	28(16)
	Secondary or higher Level	38(21)
Employment		
	Yes	7(4)
	No	172(96)
Birth order of child		
	First	63 (35)
	Second	55 (31)
	Third	28(16)
	Fourth	33 (18)
Enough food in a year		
	Yes	56(31)
	No	123(69)
Indoor Air Pollution		
Types of cooking stoves		
	Unimproved (Open fire)	138(77)
	Improved (Sudhariyako chulho)	41(23)
Location of kitchen		
	Separate building	27(15)
	Inside the home	142(79)
	Outdoor	10(6)
Ventilation at kitchen		
	No Ventilation	14(8)
	Small hole (Dabby)	15(8)
	Windows	150(78)
	Outdoor cooking (missing)	10(6)
Child exposure during cooking		
	Yes	168(94)
	No	11(6)

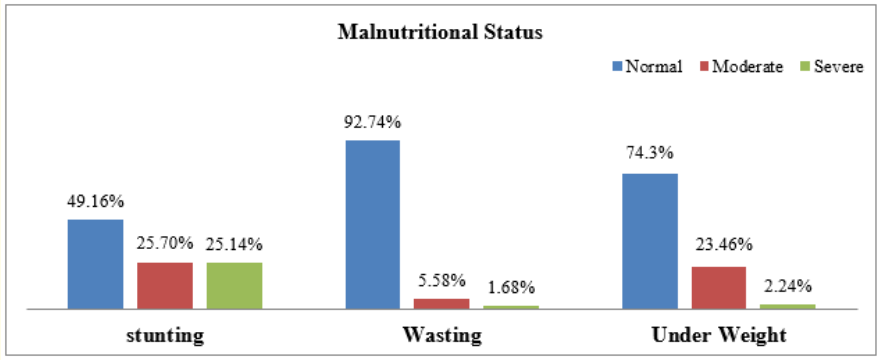

Figure 1: Malnutrition Status of Children aged 1-5 years.

Effect of explanatory variable on stunting

Respondents who were represented from Brahmin and Chhetri caste were higher Odds of having Moderate Stunting among children aged 1-5 years (OR=2.66; 95%CI: 1.04 – 6.80) compared to Scheduled caste. Mothers who had 3rd or more birth order had higher Odds of having severe stunting among children under five years (OR=3.37; 95% CI: 1.16-9.70) compared to 1st birth order. However, Mothers' Employment, Types of Family, Households head, 2nd and 4th birth order, Education status and Household Food Availability in year did not have any significant association with stunting. Also Types of Cook Stove, Kitchen Location, Ventilation at kitchen and Child exposure during Cooking, none of the factors were statistically significant with both Moderate and Severe stunting.

Discussion

This study was carried out to measure the effects of indoor air pollution on stunting among children aged 1-5 years in Nepal. Structure questionnaire were administered with mothers of children aged 1-5 years who participated for anthropometric measurement. The prevalence of stunting among children aged 1-5 years was 51% which was 16% higher than National Micronutrient Status survey in 2016 [8]. This difference rates might be possible due to the time space since the nutrition status was improving in Nepal. Also, this present study was carried out in the remote district where health indicators were poor than other districts of Nepal. Sample size could be also affected to show differential this result.

Mostly, indoor air pollution refers to the exposure with solid fuel (fire wood). Household characteristics related to indoor air pollution such as Types of Stoves, Location of kitchen, and Ventilation at kitchen and Child exposure during cooking beside their mother. Environmental factors such as poor housing and bio-fuel use are known to be associated with stunting [9,10]. Bio-fuel consumption in developing countries is one of the factors affecting child mortality and morbidity. This study found that the practice of bio-fuel is predominantly with the use of wood which is used 100% for cooking and heating. Using bio-fuel especially wood was 73% in rural and 27% in urban area of Nepal [11]. This prevalence was comparative with the Ethiopian study where 97.4% of the total populations dependent on farming for their income [12]. Another study in Nepal showed the similar rates of bio-fuel consumption (97%) with this study [13]. The prevalence of wood user is higher in rural areas where the education and employment is lower [10,11]. Choice of bio-fuel is associated with the cost of fuel, stove type, accessibility to fuel, technical characteristics of stove and cooking practices and cultural preferences [14]. This study leads to assume that bio-fuel used is associated with accessibility and availability of technology. Based on district information from District Health Office and District Forest Office, Salyan about improved cooking stoves, even though 420 improved cooking stoves were installed during this research only 41 households were found using this improved cooking stoves.

Table 2: Effect of explanatory variable on stunting.

Variables	Moderate Stunting		Severe stunting	
	OR	95% CI	OR	95% CI
Family types				
Nuclear	1		1	
Joint Family	1.3	0.63 - 2.66	1.04	0.51 - 2.14
Household head				
Male	1		1	
Female	0.34	0.09 - 1.24	1.05	0.41 - 2.71
Caste				
Scheduled	1		1	
Janajati	0.97	0.32 - 2.89	0.57	0.23 - 1.42
Brahman and Chhetri	2.66	1.04 - 6.8	0.61	0.25 - 1.44
Mothers' education				
No education	1		1	
Primary	0.89	0.31 - 2.55	0.93	0.34 - 2.54
Secondary and higher	2.08	0.87 - 4.93	1.2	0.46 - 3.06
Employment mothers				
Unemployed	1		1	
Employed	0.75	0.14 - 4.04	-	-
Birth order of child				
Birth order first	1		1	
Birth order second	0.94	0.4 - 2.22	1.43	0.55 - 3.69
Birth order third	0.86	0.25-2.85	3.37	1.16 - 9.7
Birth order fourth+	1.13	0.41 - 3.09	1.85	0.63 - 5.4
Food secure for a year				
Yes	1		1	
No	1.75	0.82-3.79	1.82	0.84-3.04
Types of cooking Stove				
Unimproved	1		1	
Improved	0.74	0.32-1.72	0.49	0.19-1.25
Location of kitchen				
Separate building	1		1	
Inside the home	1.1	0.41-2.98	1.33	0.47-3.73
Outdoor cooking	0.57	0.09-3.5	0.33	0.03-3.33
Ventilation at kitchen				
No	1		1	
Yes	2.00	0.41-10.55	0.68	0.2-2.33
Child exposure during cooking				
No	1		1	
Yes	0.76	0.33-1.77	3.8	0.45-31.9

Caste and birth order was associated with stunting. Other explanatory variables were not associated with stunting which might be affected by small size. Based on the context, it could be assumed that bio-fuel is not the single causal factor for stunted growth in children, but rather it can be associated with other contextual factors. Evidence showed that poor housing and location of kitchens is associated with childhood nutritional status [9]. More than two-thirds (68%) of households, cooking inside the home while 26% of households have a separate building for cooking [11]. However, the present study indicated that the prevalence of Location of Kitchens inside the home slightly different by 11% while separate building for kitchen was 15%. This study did not find any significance association between stunting and indoor air pollution related factor. The proportion of separate buildings and/or outside kitchens, the sample is very low.

This study represent the picture of remote part of Nepal. Data collected by women about children are more valid since they replied as per true. Child height and weight were measured by a trained health staff which provide accurate results which reduce errors. However, this study has limitations such as there was no causal relationship because of cross-sectional study. The low sample of this study affect the results. There might be confounding effects but we have not considered any confounder, this might effects result. Therefore, further study is recommended to estimate the relationship between indoor air pollution and stunting.

Conclusion

The prevalence of stunting among children aged 1-5 years was found to be higher in the study. Bio-fuel users were found to predominantly select wood as their fuel of choice. It is the conclusion of the authors this study has identified a need to conduct further study to find out the level of pollution at household level and factor child diseases, and food consumption practice, frequency of child feeding in every day.

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Author Contributions

The first author contributed for designing, conceptualization, data collection, data analysis and manuscript writing. Other co-authors provided constructive feedback, necessity correction made and editing the manuscript. All authors read and approved the final version of this manuscript.

Participants Consent and Ethics

Written consent was obtained from all participants prior interview. District Health Office Salyan has given official permission to collect information from the community.

Competing Interest

Authors declared that they have no any competing interest.

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