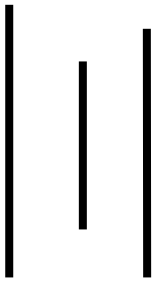
Research Report

on

Assessment of the Disease Burden of Acute Lower Respiratory Infection among Under-five Children due to Indoor Air Pollution in Sindhupalchowk District, Nepal



Submitted to:

Nepal Health Research Council (NHRC)
Ramshah Path, P.O. Box: 7626, Kathmandu, Nepal

Submitted by:

Professor Ramjee Prasad pathak
Principal Investigator
Mobile:9841335501
E-mail: rppathak@gmail.com

Research Management Team

Supervision and Support (NHRC)

- Executive Chairman: Professor Dr Chop Lal Bhusal
- Member Secretary: Dr Shanker Pratap Singh
- Chief Health Research Section: Mr Meghnath Dhimal
- Finance Head: Mr Subodh Kumar Karna
- Program Assistant: Mr Bijay Kumar Jha

Investigators

- Principal Investigator: Professor Ramjee Prasad Pathak
- Co- Investigator: Mrs Basundhara Sharma
- Statistician: Mr Purushottam Dhakal

Field Data Collection

- Mr. Preetam Shrestha – BPH
- Mr Ram Bahadur Shrestha – HA
- Mr Sanjeev Lama Ghising – HA, BPH

Summary

Acute Lower Respiratory Infection (ALRI) i.e. pneumonia, severe pneumonia and very severe disease as per the standard classification protocol of the government of Nepal (GoN) or World Health Organization (WHO), is one of the major killer of under-five children in Nepal. WHO in its global environmental health impact assessment process published a guideline to calculate the Disability Adjusted Life Year (DALY) lost by ALRI and attributable fraction to the exposure to solid fuel smoke in indoor environment. Solid fuel is the most common as it is used by more than 80 percent population for heating, cooking and other household purposes in Nepal and mostly women and young children are exposed to it.

This is a cross-sectional descriptive study following probability sampling method. Thirty clusters (wards) were selected following systematic random sampling technique with equal class interval and the sample represents 449 households and 292 children of under-five years of age.

It is found that the incidence of ALRI is 1.03 episodes per child per year contributing 336 DALY lost annually. And about 52 percent episodes (i.e 175 DALYs) of ALRI were attributed to indoor smoke in the district. The study concluded and made following recommendations:

- Solid biomass fuel is primary source of energy in Sindhupalchok district. Almost all (94.9%) household use bio-mass fuel i.e. dung, charcoal, fire wood, crop residue, etc for heating and cooking purposes; sizable people (4.2%) use mixed fuel i.e. both biomass and clean fuel for household purposes.
- More than four-fifth (83.1%) households use biomass fuel using their traditional stove which emits intolerable amount of smoke and suspended particulate matter in the indoor environment. The study unveiled that nearly four-fifth (79.3%) household still use traditional stove (open hearth) for household use where as 16 percent use Improved Cooking Stoves (ICS). Solely 'Clean fuel' users are negligible (0.9%) however both types of stove users were found to be 3.8 percent.

- It is found that a total 336 DALYs were lost due to AlRI in Sindhupalchok district. Even with the low level of ALRI case fatality rate of .05(ARI Annual Case Fatality Rate, Annual Report -2064/65), the estimated total episodes of ALRI 48302 can contribute 2415 deaths 1,49,738 days lost which is equivalent to 410 Life Year Lost due to U5 ALRI death in the district. We found no death due to ALRI in our sample which is consistent to common consensus that the case detection rate has gone up (as indicative of increasing morbidity status) and the mortality (CFR of .05) from ALRI, probably, has gone down in the recent years.
- About 52 percent of total DALY was attributed by indoor smoke in the district. Switching of fuel from solid biomass to clean fuel or use of improved cooking stoves (ICS) can reduce 175 DALYs (pessimistic one sided estimate) in the district and this disease burden can be avoid by introducing clean fuel and ICS options in the district
- Consistent to the annual report of the government, the study unveiled that the case fatality due to ALRI has gone down in the district (we got no deaths in the sample of 292 U5 children) but the episodes is still high. On an average, a child is getting more than one episode of ALRI annually. Antibiotic management of ALRI should be taken cautiously because it is not the permanent solution to the problem, incurs additional costs with health damaging effect. Besides other, the indoor smoke reduction strategy like ICS could be a better option to reduce substantial burden of disease in the district and enhancing the quality of life of the poor people particularly the mother and the child living in the rural areas.

Acknowledgement

I am grateful to Nepal Health Research Council (NHRC) and Regional Health Directorate (RHD), Central Region for entrusting me and providing financial and technical support to carry out the study.

I would like to extend my thanks to the research team members who have contributed to their best in materializing the study. Special thanks goes to Mr Preetam Shrestha (BPH), Mr Snjeev Lama Ghising (HA, BPH std.) and Mr Ram Kumar Shrestha who ventured hard to obtain quality information despite all the hardship in the difficult terrain.
The members of the study team Mrs Basundhara Sharma (Co-investigator) and Mr Purushottam Dhakal (The statistician) deserves special thanks for their untiring effort in designing the study and analysing the data.

I am indebted to the chairman of NHRC Prof Dr Chop Lal Bhusal and Chief, Health Research Section Mr Meghnath Dhimal for their inspiration and guidance to complete the study.

Last but not the least, the heartfelt thanks goes to the mothers of the children (the respondents) in the study area who willingly participated in the study by providing their valuable time and information.

_____

Professor Ramjee Prasad Pathak
The Principal Investigator

Abbreviations

ALRI	Acute Lower Respiratory Infections
ARI	Acute Respiratory Infections
CO	Carbon monoxide
CB-IMCI	Community Based – Integrated Management of Childhood Infections
DALYs	Disability-Adjusted Life Years
FCHV	Female Community Health Volunteer
HMIS	Health Management Information System
HP	Health Post
IAP	Indoor air pollution
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal
MoHP	Ministry of Health and Population
NBF	Non-Biomass Fuel
OPD	Out patient department
PM	Particulate matter
$PM_{2.5}$	Particulate matter of aerodynamic diameter less than 2.5 µm
PM_{10}	Particulate matter of aerodynamic diameter less than 10 µm
SPSS	Statistical package for social science
VDC	Village Development Committee
WHO	World Health Organization

Content

Pre content

Content

1. Background and Literature

More than three million world's population rely on solid fuel such as dung, wood, crop residue or coal to meet their most basic energy needs. Cooking and heating with such solid fuels on open fires or stoves without chimney leads to indoor air pollution. Thus produced indoor smoke contains a range of health-damaging pollutants including small soot or dust particles that are able to penetrate deeper into the lungs. In poorly ventilated dwellings, indoor smoke can exceed the acceptable levels for more than 100 folds. Exposure in indoor pollutants is particularly higher among women and children, who spend of their most time near the domestic hearth. Every year, indoor air pollution is responsible for the death of 1.6 million people globally- that's one death every 20 seconds.[1]

Biomass fuels are at the low end of the energy ladder in terms of combustion efficiency and cleanliness. Smoke from biomass combustion produces a large number of health-damaging air pollutants including respirable particulate matter, carbon monoxide (CO), nitrogen oxides, formaldehyde, benzene, 1,3 butadiene, polycyclic aromatic hydrocarbons (such as benzo[a]pyrene), and many other toxic organic compounds. In developing countries, where large proportions of households rely on biomass fuels for cooking and space heating, concentrations of these air pollutants tend to be highest indoors.[2]

The World Health Organization (WHO) has assessed the contribution of a range of risk factors to the burden of disease and revealed indoor air pollution as the 8th most important risk factor and responsible for 2.7% of the global burden of disease . Globally, indoor air pollution from solid fuel use is responsible for 1.6 million deaths due to pneumonia, chronic respiratory disease and lung cancer, with the overall disease burden (in Disability-Adjusted Life Years or DALYs, a measure combining years of life lost due to disability and death) exceeding the burden from outdoor air pollution five-fold. In high-mortality developing countries, indoor smoke is responsible for an estimated 3.7% of the overall disease burden, making it the most lethal killer after malnutrition, unsafe sex and lack of safe water and sanitation.[3]

In India, nearly 75% of the household energy consumption is accounted by traditional biomass fuels - wood, crop residues, and animal dung. These fuels are used in inefficient stoves, which emit substantial amount of fuel carbon as products of incomplete combustion. This includes

GHGs such as methane and total non-methane organic compounds, as well as health-damaging pollutants (HDP) such as respirable particles carbon monoxide (CO), benzene, and formaldehyde. Measured levels of health-damaging pollutants from biomass stoves are more than 10 times higher than corresponding standards for outdoor air. Exposures to these pollutants has been shown in many recent studies to be causally linked with several health effects including acute respiratory infection, chronic obstructive lung disease, adverse pregnancy outcomes, and eye diseases. Women who cook with these fuels and children living in these homes face high risks from such exposures. Recent estimates of the burden of disease attributable to use of bio-mass fuels in India put this figure at 5-6 percent of the national burden of disease. Given the wide spread prevalence of solid-fuel use, and the emerging scientific evidence of health impacts associated with exposures to emissions from solid-fuel use, indoor air pollution issues in rural households of developing countries, are of tremendous significance from the stand point of population health[4].

Child mortality is a major public health problem in the developing countries like Nepal. Nepal Demographic and Health Survey (NDHS), 2006 reports that infant and child mortality are, respectively, 48 and 61 per thousand live births in Nepal[5].

June 1984, the World Health Organization announced that respiratory diseases had become the chief cause of death in developing countries. Domestic smoke pollution is an important contributing factor for two major classes of respiratory diseases, which are:

- Acute respiratory infections (ARI) among infants and children
- Chronic obstructive lung disease (COLD) in adults.[6]

Acute lower respiratory infections, in particular pneumonia, continue to be the biggest killer of young children and cause more than 2 million annual deaths. Dependence on polluting solid fuels to meet basic energy needs is one of the underlying causes of pneumonia among children. Every year, indoor air pollution is responsible for nearly 800000 deaths due to pneumonia among children under five years of age.[7]

Young children living in households exposed to solid fuel (BMF) have a two to three times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in households using cleaner fuels or suffering less exposure to smoke.[8]

World Health Organization (WHO) estimates that 81 percent populations are using solid fuel in Nepal. The effect of using biomass fuel is responsible for 4820 death due to ALRI, 2680 death

from COPD making the total of 204400 disability adjusted life years (DALYs) lost. And the percentage of national burden of disease attributable to solid fuel use is 2.7[9]

In Nepal, the highest percentage of "severe pneumonia" was found in MWDR (2.4 percent) followed by FWDR (1.4 percent), WDR (1.3 percent) and EDR (1.0 percent). The lowest percentage of severe pneumonia was found in CDR (0.8 percent). The percentage of severe pneumonia cases at the national level in FY 2063/64 is 1.2 percent, which were 2.1 percent in FY 2061/62 and 1.6 percent in 2062/63. This decline of severe pneumonia cases at the national as well as at regional level for three fiscal years is a positive indication of a reduction in ARI-related mortality and morbidity due to better management of ARI cases by the health workers as well as by CHWs and FCHVs[10].

A study conducted by Migendra Medical Trust in rural community of the hill region of Nepal reported that the episode of ARI per child increases with the increased level of exposure to smoke. The result shows that the relationship is strong between episodes of moderate and severe ARI and exposure to domestic smoke pollution, and solid biomass fuel is an important risk factor in ARI. [11]

A perspective study was conducted by Mirgendra Samjhana Medical Trust in Jumla and ARI incidence density was calculated based on the cohort of children followed fortnightly for one year. The study reported that the frequency and severity of pneumonia episode was significantly more for the children without the smokeless stove. Parental tobacco smoking was found to be a confounder since it increased the risk of pneumonia.[12]

A cross-sectional assessment of indoor air quality in Nepal and its health effects revealed that solid biomass fuels (animal dung, crop residue, and wood) were the main sources of indoor air pollution affecting health. The average smoke level (PM_{10}) in kitchens using biomass fuels was about three times higher than that in those using cleaner fuels (kerosene, LPG, and biogas).This study also showed that persons exposed to solid bio-fuel smoke show higher prevalence of respiratory abnormalities as compared to clean fuel users and ARI prevalence is found 16.8 percent as compared to processed fuel which is 7 percent.[13]

A research conducted in Darchula District of Far Western region revealed that more time spend near fireplace have more chance of ARI. Children spending 0-0.9 hour a day has chance of ARI

episode of grade I while children spending 4+hours a day have a chance of 1.90 ARI episode of grade I in 0-1 year children in under 1 year child and same is the case for grade II and in child aged 1-2 years old.[14]

Analysis of data from Zimbabwe Demographic and Health Survey (ZDHS) in Zimbabwe found that about two-third (66 %) of children lived in households using biomass fuel and 16 percent suffered from ARI during two weeks preceding the survey interview. After adjusting for the child's age, sex, birth order, nutritional status, mother's age at child birth, education, household living standard, and region of residence, children in households using wood, dung, or straw for cooking were more than twice as likely to have suffered from ARI as children from households using LPG / natural gas or electricity (OR =2.20; 95% CI: 1.16-4.19).[15]

A hospital based study conducted in Kenyan pre- school children shows that about four-fifth (79%) subjects were exposed to the combustion products of kerosene stoves, 16 percent to wood smoke and 5 percent to the products of cooking gas combustion. A highly significant association ($p < 0.005$) was shown between household cooking fuel and the outcome of hospitalization due to acute lower respiratory infections. Five out of the eight who died were potentially exposed to wood smoke.[16]

A hospital based case control study conducted in India to determine the risk factors for severe acute lower respiratory infection in under five children showed that use of cooking fuel other than LPG was associated with 2.5 times greater risk (OR 2.5;95% CI 1.59-5.00) of ALRI.[17]

A rural cohort of under five years old children were followed for one year in Gambian. Stratified analysis of this study revealed that the risk of pneumonia in association with smoke exposure was increased among those babies who were carried on their mother's back while cooking.[18]

A systematic review and meta-analysis demonstrated sufficient consistency to conclude that risk of pneumonia in young children is increased by exposure to unprocessed solid fuels by a factor of 1.8.[19]

Extensive literature search and meta-analysis was done on selected eight studies on indoor smoke and health. The results indicated that the relative risk for ALRI in children under five years of age was 2.3 (95% confidence interval (CI): 1.9-2.7. Thus it was concluded that the young children living in households exposed to solid fuel have a two to three times greater risk of developing acute lower respiratory tract infection compared with those living in households

using cleaner fuels or using smokeless stove. They also came up with sequential steps for the calculation of disease burden in regional and local context [20]

A study conducted in Dhading district to assess the indoor air pollution related ALRI disease burden amongst the under five children shows that 87 percent households use solid fuel, 27.72 percent children were accompanied by mother while cooking and the ALRI incidence rate was found to be 1.25. The 637 DALYs were attributed by ALRI due to exposure of indoor smoke.[21]
A recent cross-sectional study in Dhading found that 1284 DALY's were lost due to ARI and pneumonia in Dhading district and about 50 percent of DALYs were attributed to indoor smoke[22].

2. Objectives of the Study

General

To estimate the disease burden of acute lower respiratory infection among under-five children due to indoor smoke pollution in Sindhupalchowk district.

Specific

To assess socio-demographic factors of the study population
To appraise the type of fuel and stove used by households of the study population
To calculate the incidence of ALRI of the study population
To calculate the DALYs of ALRI of study population
To calculate the attributable fractions of ALRI from SFU of the study population

3. Statement of the Problem

In June 1984, the World Health Organization announced that respiratory diseases had become the chief cause of death in developing countries. Domestic smoke pollution is an important contributing factor for two major classes of respiratory diseases: Acute Respiratory Infections (ARI) among infants and children and Chronic Obstructive Lung Disease (COLD) in adults.[10]
Acute lower respiratory infections, in particular pneumonia, continue to be the biggest killer of young children and cause more than 2 million annual deaths. Dependence on polluting solid fuels to meet basic energy needs is one of the underlying causes of pneumonia among children in

developing countries. Every year, indoor smoke is responsible for nearly 800000 deaths due to pneumonia among children under five years of age.[2]

World Health Organization (WHO) estimates that 81 percent populations are using solid fuel in Nepal. The effect of using biomass fuel is responsible for 4820 death due to ALRI, 2680 death from COPD making the total of 204400 disability adjusted life years (DALYs) lost. And the percentage of national burden of disease attributable to solid fuel use is 2.7[9]

Indoor smoke pollution and health related studies have been done in Jimla[13] Darchula[14] and Dhading [21, 22]. About 86 percent people used biomass fuel in Dhading district which is greater than national average (83%). More than 80 percent household rely on solid fuel like dung, charcoal, wood or crop residues in a traditional stove, the smoke of which may be the risk factor for most of the respiratory diseases. Young children living in households exposed to solid biomass fuel (BMF) have two to three times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in households using cleaner fuels or with less exposure to smoke.[13]

4. Rationale of the study

Nepal is committed to meet the Millennium Development Goal of under five mortality rates of 38 per 1000 live birth by 2015. The Ministry of Health and Population (MoHP) recognizes that ARI is as one of the major preventable public health problems in Nepal among children under-five years of age. ARI problems rank 2nd position among top ten diseases in Nepal. It is also estimated that morbidity from ARI is 3-5 episode per child per year. So the problem of ARI is particularly important in the context of Nepal, perhaps because of the climate, terrain and living condition of the people.[10]

More than 90 percent population use solid biomass fuel (BMF) for household purposes and more 80 percent people burn it in a traditional stove with little or no ventilation. Young children living in households exposed to solid fuel smoke have two to three times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in households using cleaner fuels or suffering less exposure to smoke.[13]

Domestic smoke pollution is a major public health problem of developing countries like Nepal requiring greatly increased efforts in the areas of research and policy making. Some efforts have been made from governmental, non-governmental and academic institutions to improve indoor

air quality but with minimal follow up and continuity. The actual situation of the clean energy technology is not known.

A few studies related to indoor air pollution is available in Nepal while no epidemiological study is evident in Sindhupalchwok district where the people heavily rely on low quality (solid) fuel for household purposes. The study is primarily intends to assess the existing ALRI condition and biomass fuel use situation in the district and find out the proportion of ALRIs among children attributable to indoor smoke in order to and to calculate the disease burden due to solid fuel use in the district. The findings of this study will provide a guideline for the policy makers to plan and implement alternative energy programs to reduce the effects of indoor smoke pollution in the district.

5. Research Questions

What is the disease burden of acute lower respiratory infection among under-five children due to indoor air pollution in Sindhupalchwok district?

6. Research Design and Methodology

A cross-sectional study was conducted in Sindhupalchok district of Nepal from January to March 2009. Ethical clearance was obtained from Ethical Review Board of NHRC and National Ethical Guidelines was strictly followed. The study populations were under five children residing in Sindhupalchok district at least for six months. A list of ward-wise population was obtained from the Central Bureau of Statistics (CBS) following the 2001 census survey. In order to make it more representative to the district, wards-wise 30 clusters corresponding to Village Development Committees (Each VDC has 9 wards and there are 80 VDCs in Sindupalchok district) were identified. And 15 household from each cluster (ward) were interviewed by randomly locating the first eligible house in an unbiased manner and following the specific pattern of direction. The VDCs, wards, households and corresponding under-five population under study is given in Annex 3 (Table: 1). Reliability of data was maintained by collecting it from experienced and specially trained health professionals- Health Assistant and BPH graduates. Interview guideline was developed, extensively discussed and made available with them (Annex 2). On-the-spot supervision was carried out during data collection. The information was edited and coded on

daily basis. The data was entered in Epi info 'Make View' and analyzed using PASW18 software. Further analysis to calculate the disease burden was done following the WHO global burden of disease assessment guideline [20]. In the nutshell:

- The analysis was based on 30 clusters (Wards), 449 household and 292 under-five children which is more than the proposed sample size of 231(Table: 1)
- Semi-structured questionnaire (Annex 1) and face to face interview was done strictly following Interview Guideline (Annex 2)
- The questionnaire were pre-tested in similar localities in rural community of Lalitpur district
- Regular data editing was done on the same day in the field
- Information was validated with CB-IMCI registers of FCHVs and VHWs record whenever available.
- Disease burden due to ALRI in the district was calculated following the WHO guideline[20]

7. Limitation of the Study

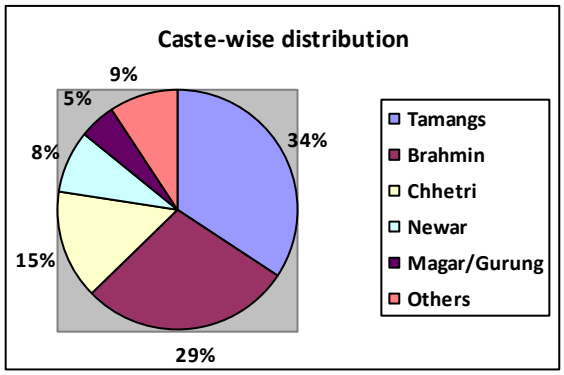
The incidence of ALRI (i.e. Pneumonia, Severe Pneumonia and Very Severe Disease as per the WHO classification) are based on the verbal autopsy as reported by the respondent and is subjected to recall bias.

8. Results

a. General characteristics of the population

Socio-economic characteristics

The district is mostly inhabited by Tamangs (34%), Newar (15% aprox), Magar/Gurung (5%) - a Tibeto-Burmese ethnic group followed by Brahmin (29%), Chhetri (16%) and others (9%) – the Indo-Aryans. Others represent Damai, Sarki, Kami, and Danuwar (n=449 households with total study population of 2615 - Table 2).



About five percent population in the district does not have enough to eat for six months and only about 27 percent reported that they have some saving and majority (46%) have just enough to eat for 12 months a year.

Nearly 70 percent (69.71%) family were having family size more than or equal to five. Average family size is 5.8 which is very close to the estimated district average[5]. More than half (56%) of the family hold Nuclear structure however 5 percent of the family still holds the Extended structure which is in the verge of extinction.

Nearly three fourth (74%) were Kachha houses i.e. walled with mud and stone and roofed with thatch or tin while about two-third (65%) houses had only 1-3 rooms and three percent houses were open dormitories with no rooms at all.

Paternal characteristics (Table: 3)

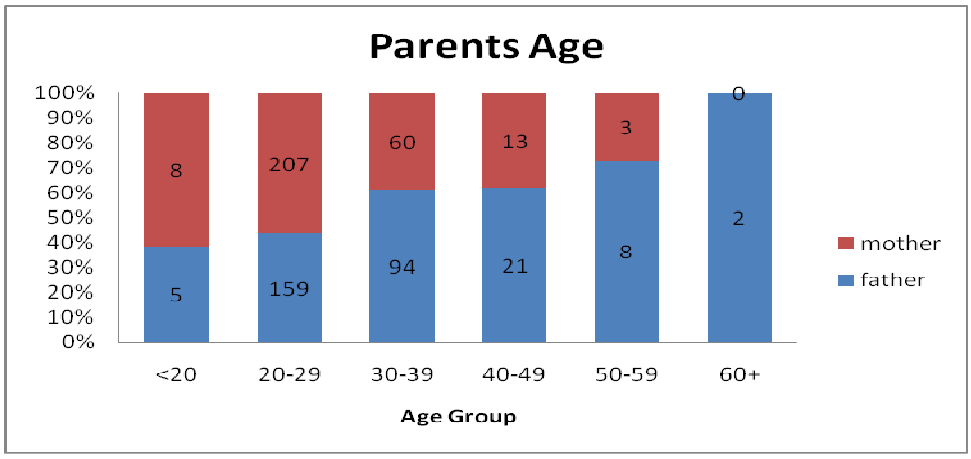
More than half (55%) fathers were of age 20 to 29 years as compared to 71.1 percent of the mothers in the same age interval. Nearly one-third of fathers were in the age group between 30 to 39 years. The father's age was rather older than the mothers' age. They were having children even after the age of 60 years.

Every nine father out of ten (89.7%) were literate which is higher than the national average. Significant number of fathers have achieved 10+ education and more than one-tenth (11.2) are just literate without any formal schooling.

Father's primary occupation was agriculture. Nearly half (45.3%) of them were engaged in agriculture. At the same time it is interesting to note that one-third of them were service holders More than one-fourth (29.8%) fathers smoke More than one-third fathers (39.1%) smokes ten or more times a day

Maternal characteristics (Table: 4)

About two-third (71.1 %) mothers were of age between 20 to 39 years. The mean age of mother was 27 years with the SD of 6.2. The analysis was based on 291 mothers.



More than two-third (69.8%) mothers were literate relatively less than that of the fathers' (89.7%)

More than one-fifth mothers were just literate without having any formal education and 17.2 percent have achieved higher education (10+) which is remarkable in the female education status however it is still less than the fathers' education level or desired level in the international context

As against the fathers' main occupation as 'service', most of the mothers' occupation is 'home making' (62.2%) followed by agriculture (27%), service (6.9%) and business (2.4%)

About one-fifth (19.6%) mother smoke which is less than the father's status of smoking (29.8%) however very high as compared to other countries in the region like Sri Lanka where female smoking is less than 2 percent.

More than two-fifth (42.1%) of the women smokers smokes more than 15 times per day. On an average, a mother smokes about 10 times a day with the SD of 5.6 ($\bar{x}$ 9.47 & δ 5.6) which may also be responsible for high incidence of ALRI i.e. 1.03 per child per year.

Child's Characteristics

There were 155 (53.1%) boys and 137 (46.9 %) girls. The boys and girls ratio was 1:1.3.

More than two-fifth (42.8%) children were 3 to 5 years of age; 59 (20.2%) were infants. (Mean: 30.58 months with the SD of 17.84 months)

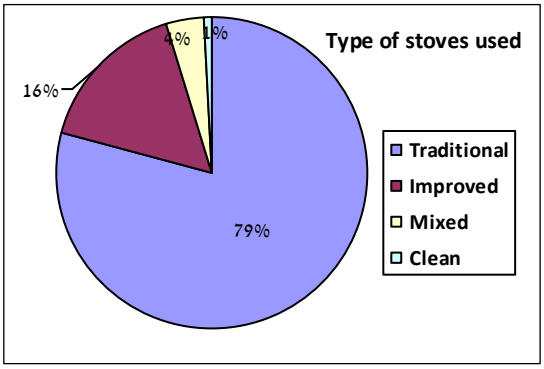
Almost all (98%) children were immunized against tuberculosis

More than nine-tenth (93.4%) children have received all three doses of DPT and Polio indicating satisfactory immunization status

92 percent children have received measles immunization sufficient enough to achieve heard immunity

b. Fuel and Stove

Different types of fuels were used in the district. The fuel used for cooking, heating and preparing animal feeds were categorized as: Biomass fuel (BF) i.e. dung, charcoal, fire wood, crop residue, coal etc; Clean fuel (CF) i.e. Kerosene, LPG, Biogas, electricity and Mixed fuel (MF) i.e. both biomass fuel and clean fuel (Annex 2). Almost all (94.9%) household used bio-mass fuel i.e. dung, charcoal, fire wood, crop residue, coal etc for heating and cooking purposes; sizable people (4.2%) used mixed fuel i.e. both biomass and clean fuel. Nearl6y four-fifth (79.3%) household still use traditional stove (open hearth) for household use where as 16 percent use improved cook-stove (ICS). Solely 'Clean fuel' users are negligible (0.9%) however both types of stove users are found to be 3.8 percent (Table 5).



About three-fifth of the household (59.7%) possess separate kitchen for human purpose (food preparation etc). Most of such kitchens (96.3%) are located inside the house. Whereas every third house out of five (60.1%) have separate kitchen for preparation of animal feed and most of them (91.9) are located outside the house. The remaining households either do not keep the animal or do not have separate kitchen for the preparation of animal fed (Table 5).

More than half of the ICS (56%) were installed 3 years ago and about one-fifth were installed recently - less than a year ago. The ICS is defined as 'stove having chimney' however condition of the ICS is not known. Non-biomass fuel (NBF) indicates clean fuel such as kerosene, LPG,

biogas or electricity. There are only 4 households (0.9%) solely using NBF and about 4.2 percent are using both type. The use of NBF, however low, is spread over time (Table 5).

c. The Disease Scenario in the District (ARI & ALRI)

More than half (54.1%) under-five children got simple ARI – 'No Pneumonia' during the year. On an average 'No-pneumonia' Episode 0f 2.8 was observed i.e. a child experienced in an average 2.8 episodes of simple flue - cough and cold requiring home remedies (with no antibiotic management) during the year (Table 6). The recall of such evidence is questionable and it is not taken for calculating the disease burden due to ALRI.

About two-fifth (40.8) children experienced pneumonia in one year recall period. Out of those who had pneumonia, more than four-fifth (84%) children experienced 1-3 episodes of pneumonia and nearly one-third episodes were contributed by children who experienced 3 episodes of pneumonia. On an average 0.997 pneumonia episodes were experiences by each under five children in the district. There were 8 cases (9 episodes) of pneumonia in the district (Table 6)

The sum of the individual cases or the episodes of 'Pneumonia' and 'Severe disease' as per the WHO classification and CB-IMCI protocol (Annex 1) represented the Acute Lower Respiratory (Tract) Infection (ALRI). There were 127 cases and 300 episodes of ALRI in the study population. On an average 1.03 episodes per child was observed in the study population (Table 6).

d. Calculation of Disease Burden

This estimates burden of diseases attributable to indoor air pollution from meta analysis of many developing country studies relating solid fuel use to health impacts (Smith, Mehta & Feuz, 2004). The same relative risk can be used for local assessments as the nature and level of indoor air pollution caused by solid fuel use is similar across settings.

Calculations involved the following steps

The data on exposure (percentage of the population exposed to biomass fuel) and deaths and DALYs is collected from the primary data sources (Verified by the FCHV register wherever possible).

Attributable fraction is calculated using the following equation

AF = ((% population exposed*Relative Risk + % Population Unexposed*1) – 1) /

(% Population exposed*Relative Risk + % Population Unexposed*1)

Attributable burden is calculated by multiplying the AF with corresponding ALRI burden.

An example of the steps of calculation of burden of disease estimates for ALRI for under-five children in district exposed to indoor air pollution is given below:

i. Calculation of the population of children exposed to SFU

Population using mixed fuels was also taken as population using solid fuels with traditional stoves and total Population of under 5 years children was taken from DOHS Annual Report 2063/64). The ventilation coefficients were taken from WHO Guide for Environmental Burden of Diseases series No.4.

Box 1: Equation for determining the population exposed to SFU

Population of under five exposed to SFU =
(population size) x (% of households using solid fuels with traditional stoves) x (ventilation coefficient of 1.00)

+

(population size) x (% of households using solid fuels and either improved stoves or cooking outdoors) x (ventilation coefficient of 0.25)

= (46896 x .831 x1) + (46896 x .169 x 0.25) = 38971+1981 = 40952

ii. Calculation of Disability Adjusted Life Years (DALY)

The incidence rate (IR) of ALRI in U5 children = 1.03 episodes per child per year (Table 6)

The disability weight (DW) for ALRI morbidity = 0.28 rounded to 30 percent (Adopted from Global Burden of Diseases study[20])

Length or duration of illness (Le) in the child with ALRI = 10 days[20]

No life was lost so the Years of Life Lost (YLL) turned out to be Zero and should be taken with caution

Years Lived with Disability (YLD) with 3% discounting and uniform age weights was calculated as 336

iii. Calculation of Attributable Fractions (AF)

To estimate the attributable fraction (AF), the relative risk (RR) and exposure level was inserted into equation as shown below:

Step 2 – Calculate the attributable fractions

Attributable fraction =
((% population exposed × relative risk + % population unexposed × 1) – 1)
/ (% population exposed × relative risk + % population unexposed × 1)
Attributable fraction =
(83.1% population exposed × 2.3 + 17.9% population unexposed × 1) – 1 /
(83.1% population exposed × 2.3 + 17.9% population unexposed × 1)
= .831× 2.3 + .169 × 1) – 1 / .831 × 2.3 + .169 × 1) = 1.08 /2.08 = **0.52**

iv. Calculation of Attributable Burdens of Disease

The attributable burden of ALRI in U5 children form SFU is thus calculated by multiplying attributable fraction by estimate total years of life lost due to ALRI. Since we do not have death in our sample it is the year lived with disability (YLD) with 3 percent discounting and uniform, age weights

Box 3 – Calculation of the attributable burdens of ALRI in Sindhupalchok district

Attributable burden = attributable fraction × current disease level
Attributable burden = 0.52 ×336= 175 DALYs lost (with 3% discounting and uniform age weight) attributed to biomass/solid fuel use.

This means that175 DALYs were attributed by ALRI due to exposure of indoor smoke pollution among under-five children in the district.

9. Discussion

In developing countries, ALRI constitutes 98% of all deaths from ARI and poses the greatest risk of mortality, although it is not so developed countries. ALRI belongs to a class of infections that result from a wide range of viruses and bacteria, but exhibit similar symptoms and risk factors and are typically diagnosed on a symptomatic basis, rather than by identification of a specific pathogen[24].

The study unveiled that more than half (54.1%) under-five children got simple ARI – 'No Pneumonia' during the year. On an average 'No-pneumonia' Episode of 2.8 was observed i.e. a child experienced in an average 2.8 episodes of simple flue - cough and cold requiring home remedies (with no antibiotic management) during the year i.e. 1,31,308 episodes in the district (Table 6). The recall of such evidence is questionable and it is not taken for calculating the disease burden due to ALRI.

About two-fifth (40.8%) children experienced pneumonia in one year recall period in Sindhupalchok district. Out of those who had pneumonia, more than four-fifth (84%) children experienced less than 3 episodes of pneumonia. On an average 0.997 pneumonia episodes were experiences by each under five children in the district. There were 8 cases (9 episodes) of pneumonia in the district (Table 6)

The sum of the individual cases or the episodes of 'Pneumonia', 'Severe pneumonia' and 'Very severe disease' as per the WHO classification and CB-IMCI protocol (Annex 1) represented the Acute Lower Respiratory (Tract) Infection (ALRI). There were 127 cases and 300 episodes of ALRI in the study population. On an average 1.03 episodes per child was observed in the study population (Table 6). This indicates that there are more than 46,755 episodes of pneumonia in the district. The total episodes of ALRI (i.e. sum of pneumonia, severe pneumonia and 'very severe disease') are 46,395 with the incidence (for episodes) of 1.03 in the district.

We observed no deaths due to ALRI in the study population but this does not mean that the death due to ALRI is Zero in the district. At national level, the percentage of severe pneumonia has declined in the recent paste with increased case detection and accessibility to services at the community level as more and more MCHWs/VHWs and FCHVs are trained every year in ARI case management under the CB-IMCI program[10]. In spite of the substantial increase in ARI incidence (Probably due to better access to service), the trend of ARI Case Fatality is almost constant in most of the regions but it has further declined to 0.05 from 0.1 per 1,000 in Central Development Region (CDR) in FY 2061/62 and 2062/63[10].

Comparison of mortality data from the three DHS surveys conducted in Nepal confirms a declining trend in under-five mortality. For example, infant mortality declined from 79 per 1,000 live births during the period 1991-1995 to 64 per1000 live births during the period 1996-2000 and to 51 per 1,000 live births during the five year period (2001-2005)[5].

Different types of fuels were used in the district however the dominating role of biomass fuel use is evident in the study as in many other studies in rural scenario in the country. The fuel used for cooking, heating and preparing animal feeds were categorized as: Biomass fuel (BF) i.e. dung, charcoal, fire wood, crop residue, etc; Clean fuel (CF) i.e. Kerosene, LPG, Biogas, electricity and Mixed fuel (MF) i.e. both biomass fuel and clean fuel (Annex 2). Almost all (94.9%) household used bio-mass fuel i.e. dung, charcoal, fire wood, crop residue etc for heating and cooking purposes; sizable people (4.2%) used mixed fuel i.e. both biomass and clean fuel. Nearly four-fifth (79.3%) household still use traditional stove (open hearth) for household use where as 16 percent use improved cook-stove (ICS). Solely 'Clean fuel' users are negligible (0.9%) however both types of stove users are found to be 3.8 percent (Table 5). Those households who use both type of stove are taken as 'traditional stove' users since they have almost the same level of exposure to indoor smoke with the ventilation coefficient of 1[20]. With reference to this definition of stove use, the household using traditional stove and biomass fuel were 83.1 percent which is close estimate consistent to recent publications [20,21,22]. The implication of the finding is that more than four-fifth (83.1%) population of the district are using traditional stove for household purposes which emits high level of smoke in the indoor environment and is thus responsible for a range of reparatory infection including ALRI. There was the total 336 DALYs lost due to ALRI in Sindhupalchok district and about 52 percent of total DALY was attributed by indoor smoke. And switching of fuel from solid biomass to clean fuel or use of improved cooking stoves (ICS) can reduce about 175 DALYs in the district.

The projection is based on the mid-point assumption that the relative risk of ALRI due to smoke use is 2.3 and days lost per an ALRI episode is 10 days. As indicated by Desai MA et al we can calculate the disease burden assuming the lower and upper limit of relative risk of ALRI among under-five children which is 2.3 with 95% CI of 1.9-2.7[20]

Since, no death was found in the study, the estimated disease burden is probably under estimate to the actual situation in the district. Even with the low level of ARI case fatality rate of .05, the estimated total episodes of ALRI 48302 can contribute 2415 deaths 149738 days lost equivalent to 410 Life Year Lost due to ALRI death of U5 children. The morbidity due to ALRI was found to be quite high i.e. 1.03 which is comparable to 'ARI and Pneumonia' incidence of 1.25 in Dhading district[22].

10. Conclusion and Recommendation

- Solid biomass fuel is primary source of energy in Sindhupalchok district. Almost all (94.9%) household use bio-mass fuel i.e. dung, charcoal, fire wood, crop residue, etc for heating and cooking purposes; sizable people (4.2%) use mixed fuel i.e. both biomass and clean fuel for household purposes.
- More than four-fifth (83.1%) households use biomass fuel using their traditional stove which emits intolerable amount of smoke and suspended particulate matter in the indoor environment. The study unveiled that Nearly four-fifth (79.3%) household still use traditional stove (open hearth) for household use where as 16 percent use ICS. Solely 'Clean fuel' users are negligible (0.9%) however both types of stove users are found to be 3.8 percent.
- The study unveiled that a total 336 DALYs were lost due to ALRI in Sindhupalchok district. Even with the low level of ARI case fatality rate of .05, the estimated total episodes of ALRI 48302 can contribute 2415 deaths 1,49,738 days lost which is equivalent to 410 Life Year Lost due to U5 ALRI death in the district. We found no death due to ALRI in our sample which is consistent to common consensus that the case detection rate has gone up (as indicative of increasing morbidity status) and the mortality (CFR of .05) from ALRI has gone down in the recent years.
- About 52 percent of total DALY was attributed by indoor smoke in the district. Switching of fuel from solid biomass to clean fuel or use of improved cooking stoves (ICS) can reduce 175 DALYs (pessimistic one sided estimate) in the district and this disease burden can be avoid by introducing clean fuel and ICS options in the district.
- Switching to higher level fuel in clean energy ladder may take longer time. Solid biomass fuel is the easy option available with the people in the community. The installation and use of improved cook stove (ICS) can reduce unacceptably high incidence of ALRI (1, 03 per child per year). The study unveiled that the case fatality due to ALRI has gone down dramatically in the recent years which is consistent to the Annual Report 2064/65, probably due to CB_IMCI, FCHV activities in the district however the incidence is still quite high which is likely to deteriorates the quality of life of the mother and the child contributing 175 DALYs lost in the district. And the use of less expensive smoke reduction option like ICS use not only address the problem of ALRI but a range of health problems like COPD, Eye problems, mental problems etc. and should be promoted.

11. References

1. World Health Organization. Indoor air pollution and health, Fact sheet N 292, June 2005
2. Bruce N, Perez-Padilla R, Albalak R. Indoor air pollution in developing countries: a major environmental and public health challenge. Bull World Health Organ 2000; 78:1080–92
3. The World Health Report: Reducing Risks, Promoting Healthy Life. Geneva, World Health Organization, 2002.
4. R. Padmavathi, K. Balakrishnan. Estimation of Burden of Disease Attributable to indoor Air Pollution in AP, Department of Environmental Health Engineering, Sri Ramachandra Medical College & Research Institute (DU), Chennai – 116, India.
5. Nepal Demographic and Health Survey, 2006. Kathmandu, Nepal: Ministry of Health and Population, New ERA and Macro International Inc.
6. World Health Organization, WHO annual statistics report reveals major public health killers. Geneva: WHO press release WHO, June 21, 1984
7. World Health Organization, Fuel for Life: household energy and health, 2006
8. Smith KR, Jonathan MS, Romieu I, Bruce. Indoor air pollution in developing countries and acute lower respiratory infections in children, 2000; 55:518–532
9. World Health Organization, Indoor air pollution: national burden of disease estimates, 2002, WHO
10. MOHP/DOHS Annual report, Department of Health Services, Ministry of Health and Population, Nepal 2005/2006.
11. Pandey MR, Neupane RP, Gautam, Shrestha IB. Domestic smoke pollution and acute respiratory infections in a rural community of the hill region of Nepal. Environment International, 1989; 15: 337-340.
12. Pathak RP, The Effect of Cook-stove on the Incidence of Child-hood Pneumonia in Jumla; JNHRC, Vol 1, No 1, P63, 2002
13. Shrestha IL, Devkota S, Shrestha SL. Situation analysis of indoor air pollution and development of guidelines for indoor air quality assessment and house building for health; Nepal Health Research council.2004,p.85

14. Joshi HD, Dhakal B, Joshi SD. Indoor air pollution and its health impact on people of Malikarjun Village development committee, Darchula, District.2008, Nepal Health Research Council.p.40
15. Mishra V**.** Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe, International Journal of Epidemiology 2003; 32:847-853
16. Ezzati M, Kammen DM. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study, The Lancet, 2001,358 (9282) P. 619 - 624
17. Broor S, Pandey RM, Ghosh M, Maitreyi RS, Lodha R, Singhal T et al. Risk factor for severe acute lower respiratory tract infection in under five children; Indian Pediatrics 2001;38: 1361-1369
18. Armstrong JR, Campbell H. Indoor air pollution exposure and lower respiratory infections in young Gambian children. International Journal of Epidemiology 1991; 20: 424-429
19. Dherani M, Pope D, Mascarenhas M, Smith KR, Weber M and Bruce N. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis, Bulletin World Health Organization. 2008 May; 86(5): 390–398.
20. Desai MA, Mehta S, Smith KR; Indoor Smoke from Solid Fuels: Assessing the Environmental Burden of Disease at National and Local Levels, Environmental Burden of Disease Series, No 4, WHO Geneva, 2004.
21. Maskey MK, Dhimal M, Dhakal P, Shrestha N, Shrestha J, Singh S et al. Assessment of indoor air pollution related disease burden especially amongst children under five in Dhading District, NHRC,2008 May, p.21-24.
22. Dhimal M, Dhakal P, Shrestha N et. al.; Environmental Burden of Acute Respiratory Infection and Pneumonia due to Indoor Smoke in Dhading; JNHRC, Vol 8, No1, issue 16, P1-4, 2010.

23. Annexes

Annex 1

Questionnaire
Study of Indoor Smoke and ALRI among U5 Children in Sindhupalchok District

1. General Information		**Form #**			
Name of the VDC	…….	Ward #:…….			
Name of the HH head	……..	Type House:… Room #:….....			
Name of the Respondent/mother	…….. Age: … Sex: … Edn: … Caste:……	Family Size:..… Family Type:…… Socio Economic:…..			

2. Information on Pneumonia and related risk factors						
Particulars		1st child	2nd child	3rd child	4th child	5th child
Age (months)						
Sex						
Mother	Age					
	Occupation					
	Education					
Father	Age					
	Occupation					
	Education					
Measles (from last year)						
Exclusive BF (months)						
Exposure during cooking						
Immunization Status	BCG					
	DPT III					
	Polio III					
	Measles					
Smoking (times/day)	Father					
	Mother					
Times / Year	No Pneumonia					
	Pneumonia					
	Severe pneumonia					
Respiratory rate and other S/S code of the child with pneumonia (Using timer)						
Where did you treat him/her						
Have any of your children died during the last one year? Pneumonia Death:…… Age at death: …… Sex: ……. Other death (Specify):……						

Verify the information with the CBIMCI, FCHV register particularly the Pneumonia

3. Information on Fuel type and cooking stove		**Codes**					
1.	What type of fuel is used for cooking?						
2.	What type of Cooking stove is used for burning Solid fuel?						
3	If ICS & NBF is used, for how long?	ICS:	y	m	NBF:	y	m
4	Do you have separate room for kitchen? Yes /No, If yes;	Inside			Outside		
5	Do you have separate kitchen for animal feed preparation? Yes /No, If yes;	Inside			Outside		

Note: Please follow the Interviewer's guideline very strictly and carefully.

Name of the Interviewer: ……. Date of Interview: ……/……/……

Annex 2

Interviewer's Guideline for collecting data (IAP & ARI)

Please strictly follow the instructions given below

1. **Identifying the cluster:** With the help of the VHW or FCHV or community leader Key informant whoever available in the ground, get to the identified ward number. The ward itself is a cluster however if there are more than one clusters of dwellings in the ward, identify it and interview the proportionate samples of household in each clusters. Then, you have to get to the centre of the cluster, spine a bottle or unbiased article to identify the first house and enumerate at least fifteen households proportionately using systematic random method i.e. divide the total households of the cluster by 15 and follow the class interval. The definition of **household** is people living in the area for more than 6 months and having common kitchen. If the family is separated having separate kitchen but living under the same roof, they should be taken a separate households.
2. **Introduce yourself, build rapport, identify the respondent, get sited properly and get the informed consent:** An example for verbal informed consent: 'Namaste! My name is …… and I'am working for Nepal Health Research Council (NHRC). We are conducting a research to see the impact of indoor smoke on the health of the children less than five years of age. We would appreciate your participation in the survey. The survey will take about half an hour (30 minutes). All the information you provided will be kept confidential. Participation in the survey is completely voluntary. If you came to any question that you don't want answer, please let me know, we will go to the next question or you can stop the interview at any time. But we hope you will participate in the survey since the information is important to figure out how the indoor smoke is causing illness among children and how big is the problem in the district. This will help us in the decision making process to improve the health status of the children in our district. If you have any question about the survey, don't hesitate to ask me.'
3. **Definition of Words and the variables**

3.1. Respondent: Articulate person available at home; particularly mother who often does cooking and having under five baby/ies

3.2. Type of house: There will be three types of houses, **1. Kachha -** wall made up of mud and stone and roof is thatch or tin; **2. Pakka:** wall made up of stones, bricks and with concrete, tin, tile or stone roofing and **3. Hut:** Open wooden plank or bamboo wall

3.3. Family type: Usually there will be three types of family **1. Nuclear** – one couple and their unmarried off springs only, **2. Joint** – More couples and off springs of the same family **3. Extended** – a big family including son-in laws

3.4. Family size: Number of family members living together for more than 6 months **Caste: Specify**…… (Some of the castes available in our communities are Brahmin, Chhetri, Gurung, Magar, Newar, Kami, Damai, Sarki, Sunar …….)

3.5. Socio-economic status : Indicative of means of production to support the family for **1.** Less than 6 months, **2.** Six months to less than 12 months**, 3.** Just for 12 months and **4.** Surplus

3.6. Educational status: illiterate (**I**) and literate (**L**) and if schooling, specify the completed years of schooling ….

3.7. Occupation: Record the main (primary) occupation of father and mother of the baby such as: **1** Service (including school teacher), **2.** Homemaker**, 3.** Agriculture**, 4.** Business**, 5.** Daily-wage labor, **Others** (specify)…….

3.8. Exposure during cooking: Exposure of the U5 baby who accompany the mother during cooking which will be categorized as : **1**. Always, **2**. Most often**, 3.** Sometimes, **4.**Never

3.9. History of pneumonia: This is as reported by the mother regarding the past one year recall by the mother on you question **'Have any of your child suffered from pneumonia during the last one year?' If yes, how many times ?. Probing** with the major S/S of pneumonia is necessary for example sadharan rugha khoki, or any symptoms of fast breathing, chest in-drawing, very sick – unconscious or unable to breast feed and also, **varify** it with the available (FCHV, HP) records. S/S code for ARI is a sfollows:

[01] History of cough [02] Fever [03] Fast breathing
[04] Chest in drawing [05] Unable to drink [06] Stridor [07] If others, specify……

The information will be indorsed in the corresponding cell under No **pneumonia:** History of cough, cold; **Pneumonia:** History of cough; fever, fast breathing and chest in-drawing; **Severe pneumonia:** S/S of pneumonia and unable to drink

3.10. Current pneumonia: Count the respiratory rate using timer and write down the observed rate in the corresponding cell including the codes for others S/S.

3.11. Type of fuel: The fuel used for cooking, heating and preparing animal feeds are categorized as: **1. Biomass fuel** (BF i.e., dung, charcoal, fire wood, crop residue, coal etc), **2. Clean fuel** (Kerosene, LPG, Biogas, electricity), 3**. Mixed fuel** (Biomass fuel and clean fuel).

3.12. Type of stove: Stoves are used for cooking (human and animal feed) and heating purposes and often placed inside and outside the house. Hence it should generally be taken for the stove which is **commonly used for cooking inside the house.** It could be **1**. Traditional clay stove **2**. Traditional clay stoves fitted with chimneys **3. Clean** fuel stoves. Beside this if you got both types of stove used in the house put another category **4. Both** type of stove.

3.13. Age: Child's age is **'completed months"** and father and mother's age in **'completed years' .Probe and verify** the reported age if possible**.**

3.14. General instruction : Follow the **'1' and '0'** pattern for any, **'Yes' 'no'** question (like **Mesles, BGG**) and enter the '**frequency'** as in the smoking per day or pneumonia times per year and circle the right answer as in DPT and polio.

(Obtain the moble no and address of the VHW,MCHW, FCHV or any community leader who helped you to collect data in the corresponding cluster and note the available demographic information including the under five pneumonia and deaths, whatever possible)

If any problem, call R.P.Pathak (9841335501) and Basundhara Sharma (……

Annex 3

Summary Tables

Table 1: Name of VDC, sampled ward no., sample size and enumerated under five children

Name of VDC	Ward no.	Sample size	No. of U5 children
Bansbari	1	15	8
Baramchi	7	15	10
Baruwa	3	15	8
Bhimtar	4	15	18
Bhotechour	1	15	8
Chautara	7	15	8
Dhuskun	4	15	11
Dubachaur	5	15	8
Fulpingdandagau	7	15	8
Fulpingkot	7	15	9
Gunsakot	9	14	5
Ichowk	1	15	12
Irkhu	9	15	12
Jyamire	8	15	13
Kiwool	4	15	9
Kunchok	9	15	13
Mahankal	6	15	10
Mankha	5	15	4
Melamchi	3	15	4
Nabalpur	9	15	11
Petaku	5	15	9
Ramche	7	15	14
Sanosiruwari	3	15	12
Simple Kavre	1	15	10
Sindhukot	8	15	6
Taramarang	5	15	11
Tekaupur	1	15	9
Thanpalkot	1	15	15
Thulopakhar	9	15	7
Thumpakhar	8	15	10
Total	30	449	292

Table 2: Frequency Distribution of general Characteristics of the Study Population

Population Characteristics	*Frequency (%)*	*Remark*
Type of House (n= 449)		Nearly three fourth (74%) were *Kachha* houses i.e. walled with mud and stone and roofed with thatch or tin.
Kachha	333 (74.15)	
Pakka	114 (25.40)	
Hut	2 (0.45)	
# of rooms (n= 449)		Nearly two-third (65%) houses had only 1-3 rooms and three percent houses were open dormitories with no rooms at all
0	14 (3.12)	
1-3	292 (65.03)	
4-6	119 (26.50)	
More Than 6	24 (5.35)	
Family Size (n= 449)		Nearly 70 percent (69.71%) family were having family size more than or equal to five. Average family size is 5.8 which is very close to the estimated district average of 2008 (6)[s]
less Than Five	136 (30.29)	
More than or equal to five	313 (69.71)	
Mean Family Size	5.8	
Family Type (n= 449)		More than half (56%) of the family hold Nuclear structure however 5 percent of the family still holds the Extended structure which is in the verge of extinction.
Nuclear	250 (55.68)	
Joint	176 (39.20)	
Extended	23 (5.12)	
Caste (n= 449)		The district is mostly inhabited by Tamangs (34%), Newar (15% aprox), Magar/Gurung (5%) - a Tibeto-Burmese ethinic group followed by Brahmin (29%), Chhetri (16%) and others (9%) – the Indo-Aryans
Tamang	153 (34.08)	
Brahmin	129 (28.73)	
Chhetri	66 (14.70)	
Newar	37 (8.24)	
Magar/ gurung	23 (5.12)	
Others: Damai, Sarki, Kami, Danuwar	41 (9.13)	
Socio Economic Status (n= 449)		About five percent population in the district does not have enough to eat for six months and only about 27 percent reported that they have some saving and majority (46%) have just enough to eat for 12 months a year.
Less than 6 months	21 (4.68)	
Six months to less than 12 months	100 (22.27)	
Just for 12 months	207 (46.10)	
Surplus	121 (26.95)	

Table 3: Frequency Distribution of Paternal Characteristics

Paternal Characteristics	*Frequency (%)*	*Remark*
Age of father (n=289)		More than half (55%) fathers were of age 20 to 29 years as compared to 71.1 percent of the mothers in the same age interval. Nearly one-third of fathers were in the age group between 30 to 39 years. The father's age was rather older than the mothers' age. Evidence of child birth even after the age of 60 years
<20	5 (1.7)	
20-29	159 (55.0)	
30-39	94 (32.5)	
40-49	21(7.3)	
50-59	8 (2.8)	
60+	2 (0.7)	
Father's Literacy (n= 289)		Every nine father out of ten (89.7%) were literate which is higher than the national average)
Illiterate	30 (10.3)	
Literate	259 (89.7)	
Father's Education Level (n=259)		Significant number of fathers have achieved 10+ education and more than one-tenth (11.2) are just literate without any formal schooling.
Just literate (No Schooling)	29 (11.2)	
Primary (1-5 gade)	66 (25.5)	
Secondary (6-8 grade)	52 (20.1)	
High School (9 and 10 grade)	69 (26.6)	
Higher (11 & plus)	43 (16.60)	
Occupation of father		Father's primary occupation was agriculture. Nearly half (45.3%) of them were engaged in agriculture. At the same time it is interesting to note that one-third of them were service holders.
Agriculture	131 (45.3)	
Service	91 (31.5)	
Business	37 (12.8)	
Daily wages	30 (10.4)	
Smoking Status of father		
Yes	87 (29.8)	More than one-fourth (29.8%) fathers smoke
No	205 (70.2)	
Frequency of tobacco use (n=87)		More than one-third fathers (39.1%) smokes ten or more times a day
<5 times	27 (31.0)	
5-9	26 (29.9)	
10-15	19 (21.9)	
>15	15 (17.2)	

Table 4: Frequency Distribution of Maternal Characteristics

Maternal Characteristics	*Frequency (%)*	*Remark*
Age of the Mother (n= 291)		More than two-third (71.1 %) mothers were of age between 20 to 39 years. The mean age of mother was 27 years with the SD of 6.2.
<20	8 (2.7)	
20-29	207(71.1)	
30-39	60 (20.6)	
40-49	13 (4.5)	
50-59	3 (1.0)	
Education of Mother (n=2910		More than two-third (69.8%) mothers were literate relatively less than the fathers (89.7%)
Illiterate	88 (30.2)	
Literate	203 (69.8)	
Mother's Education Level (n=203)		More than one-fifth (29.6%) mothers were just literate without having any formal education and 17.2 have achieved higher education (10+) which is remarkable in the female education status however it is still less than the fathers' education level.
Just literate (No Schooling)	60 (29.6)	
Primary (1-5 gade)	52 (25.6	
Secondary (6-8 grade)	25 (12.3)	
High School (9 and 10 grade)	31 (15.3)	
Higher (11 & plus)	35 (17.2)	
Occupation of Mother (n=291)		Most of the mothers' occupation is housekeeping (62.2%) followed by agriculture (27%), service (6.9%) and business (2.4%)
Home maker	181 (62.2)	
Agriculture	80 (27.5)	
Service	20 (6.9)	
Business	7 (2.4)	
Others (Daily wage etc)	3 (	
Smoking Status		About one-fifth (19.6%) mother smoke which is less than the father's status of 29.8 percent however very high as compared to Sri Lanka where female smoking is less than 2 percent.
yes	57 (19.6)	
No	234 (84.4)	
Frequency of tobacco use		Out of the mothers who smoke more than two-fifth (42.1%) smoke more than 15 times a day. In an average a mother smokes about 10 times with the SD of 5.6 ($\bar{x}$ 9.47 & δ 5.6) which may also be responsible for high incidence of ALRI i.e. 1.03 per child per year
<5 times	6 (10.53)	
5-9	16 (28.07)	
10-15	11 (19.30)	
>15	24 (42.11)	
Total	57 (100)	

Table 5: Frequency Distribution of Child Characteristics

Child Characteristics	*Frequency (%)*	*Remark*
Sex of the child		There were 155 (53.1%) boys and 137 (46.9 %) girls. The boys girls ratio was 1.13
Boys	155 (53.1)	
Girls	137 (46.9)	
Age of the child in months		More than two-fifth (42.8%) children were 3 years age and above; 59 (20.2%) were infants. (Mean:30.58 months with the SD of 17.84 months)
<1	3(1%)	
1-11	56(19.2%)	
12-35	108(37.0%)	
36+	125(42.8%)	
BCG immunization (n=291)		Almost all (98%) children were immunized against tuberculosis
Yes	285(97.9%)	
No	6(2.1%)	
DPT/Polio (n=287)		More than nine-tenth (93.4%) children have received all three doses of DPT and Polio indicating satisfactory immunization status
None	5(1.7%)	
Single dose	9(3.1%)	
Two doses	5(1.7%)	
All three doses	268(93.4%)	
Measles (n=263)		
Not Taken	21(8%)	92 percent babies have received measles immunization sufficient enough to achieve heard immunity
Taken	242(92%)	

Table 6: Summary Fuel Use Status

Particulars	Freq (%)	Remark
Type of fuel used (n=449)		Almost all (94.9%) household use bio-mass fuel i.e. dung, charcoal, fire wood, crop residue, coal etc for heating and cooking purposes; sizable people (4.2%) use mixed fuel I.e. both biomass and clean fuel for household purposes.
Biomass fuel (BMF)	426 (94.9)	
Clean fuel	4 (0.9)	
Mixed fuel	19 (4.2)	
Type of stove used (n=449)		Nearly four-fifth (79.3%) household still use traditional stove (open hearth) for household use where as 16 percent use ICS. Solely 'Clean fuel' users are negligible (0.9%) however both types of stove users are found to be 3.8 percent.
Traditional stove	356 (79.3)	
Improved Cook Stove (with chimney)	72 (16.0)	
Clean fuel stove	4 (0.9)	
Both type	17 (3.8)	
Improved Cook Stove (ICS)use (n=449)		More than four-fifth (83.3%) household use traditional stove and 16.7 percent use improved cook stove in the community
Yes	75 (16.7)	
No	374 (83.3)	
Non biomass fuel use		Approximately 95 percent household use bio-mass fuel (BMF) and only 5 percent use clean fuel.
Yes	23 (5.1)	
No	426 (94.9)	
Separate Kitchen for Humans (n=449)		About three-fifth of the household (59.7%) possess separate kitchen for human purpose (food preparation etc)
Yes	268 (59.7)	
No	181 (40.3)	
Location		Most of the kitchens (96.3%) for human purpose are located inside the house.
Inside the house	258 (96.3)	
Outside the house	10 (3.7)	
Separate kitchen for Animal Feed Preparation (n=448)		Every third house out of five (60.1%) household have separate kitchen for preparation of animal feed. The remaining households either do not keep the animal or do not have separate kitchen for the preparation of animal fed.
Yes	270 (60.1)	
No	178 (39.9)	
Location		Most of the fireplace (91.9) made for the preparation of animal feed are located outside the house.
Inside the house	22 (8.1)	
Outside the house	248 (91.9)	
Duration of ICS use (n=70)		More than half of the ICS (56%) were installed 3 years ago and about one-fifth were installed recently - less than a year ago. The ICS is defined as 'stove having chimney' however condition of the ICS is not known.
<1	16 (23)	
1-3	15 (21)	
3+	39 (56)	
Duration of NBF use (n=23)		Non-biomass fuel (NBF) indicates clean fuel such as kerosene, LPG, biogas or electricity. There are only 4 households (0.9%) solely using NBF and about 4.2 percent are using both type. The use of NBF, however low, is spread over time.
<1	8 (35)	
1-3	7 (30)	
3+	8 (35)	

Table 7: Summary ARI Episodes

Particulars	Freq (%)		Remark
No pneumonia (n=292)			More than half (54.1%) under-five children got simple ARI – 'No Pneumonia' during the year
No	134 (45.9)		
yes	158 (54.1)		
No pneumonia Episodes (n=292)			Average 'No-pneumonia' Episode 0f 2.8 was observed i.e. a child experienced in an average 2.8 episodes of first level ARI (i.e. cough, cold etc) during the year.
# of epis/child	**Freq**	**Total Episodes**	
1	4 (2.5)	8 (1.2)	
2	25 (15.8)	50 (7.5)	
3	41 (25.9)	123 (18.5)	
4	34 (21.5)	136 (20.5)	
5	23 (14.6)	115 (17.3)	
6	13 (8.2)	78 (11.7)	
7	6 (3.8)	42 (6.3)	
8	4 (2.5)	32 (4.8)	
9	3 (1.9)	27 (4.1)	
10	3 (1.9)	30 (4.5)	
12	2 (1.3)	24 (3.6)	
Total	158 (100)	665 (100)	
Pneumonia (n=292)			About two-fifth (40.8) children experienced pneumonia in one year recall period
Yes	119 (40.8)		
No	173 (59.20)		
# of Pneu. Episode /child	**Frequency**	**Total Episodes**	Out of those who had pneumonia, more than four-fifth (84%) children experienced 1-3 episodes of pneumonia and nearly one-third episodes were contributed by children who experienced 3 episodes of pneumonia. **On an average 0.997 pneumonia episodes were experiences by each under five child in the district.**
1	35 (29.4)	35 (12.0)	
2	36 (30.3)	72 (24.7)	
3	28 (23.5)	84 (28.9)	
4	13 (10.9)	52 (17.9)	
5	3 (2.5)	15 (5.2)	
6	2 (1.7)	12 (4.1)	
9	1 (.8)	9 (3.1)	
12	1(.8)	12 (4.1)	
Total	119 (100)	291 (100)	
Severe Pneumonia (n=292)			
Yes	8 (2.7)		
No	284 (97.3)		
# of Severe Pneu	Freq	Total Episodes	**There were 8 cases (9 episodes) of severe pneumonia in the sample.**
1	7 (87.5)	7	
2	1 (12.5)	2	
Total ALRI Cases	**127**	**300**	**1.03 episodes per child**