Assessment of Indoor Air Pollution (IAP) related disease burden especially amongst children in Dhading district

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Dr. Mahesh Kumar Maskey

Principal Investigator

Executive Chairman of Nepal Health Research Council

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Acronyms

AF	Attributable Fraction
ALRI	Acute Lower respiratory Infection
ARI	Acute respiratory Infection
BOD	Burden of Diseases
CB-IMCI	Community Based Integrated Management of Childhood Illness
CI	Confidence Interval
CMR	Child Mortality rate
COPD	Chronic Obstructive Pulmonary Disease
DALY	Disability Adjusted Life Years
DHO	District Health Office
DHS	Demographic Health Survey
DW	Disability Weight
EBD	Environmental Burden of Diseases
FCHV's	Female Community Health volunteers
F/Y	Fiscal Year
HHs	Households
IAP	Indoor Air Pollution
IMR	Infant Mortality Rate
IR	Incidence rate
LE	Life Expectancy
LPG	Liquid Petroleum Gas
MOHP	Ministry of Health and Population
MS-Excel	Micro-Soft Excel
NDHS	Nepal Demographic and Health Survey
NHRC	Nepal Health Research Council
NO2	Nitrogen Dioxide
OR	Odds Ratio
PM	Particulate Matter
RR	Relative Risk
SF	Solid Fuel

SFU	Solid Fuel Users
SPSS	Statistical Package for Social Science
UK	United Kingdom
USA	United States of America
U5	Under five
VDC	Village Development Committee
WHO	World Health Organization
YLL	Year of Life Lost
YLD	Year of Life lost in Disability

Chapter-I

1.1 Introduction

Solid Fuel Use (SFU) is defined as: the household combustion of biomass (such as dung, charcoal, wood, or crop residues), or coal**.** Worldwide, approximately 50% of all households and 90% of rural households utilize solid fuels for cooking or heating. In simple stoves, biomass fuels emit substantial amounts of health-damaging pollutants, including respirable particulates, carbon monoxide, nitrogen oxides, benzene, formaldehyde, 1,3 butadiene, and polyaromatic compounds such as benzo(α)pyrene. Depending on their quality, coal fuels may also emit sulphur oxides and other toxic elements, including arsenic, lead and fluorine. When these fuels are used in poorly ventilated conditions and burned in open fires or inefficient stoves, conditions common in households throughout the developing world, indoor air pollution due to SFU will result in substantial health effects.

The full scale of this environmental health problem is clear when the high pollutant concentrations from SFU are combined with the large amount of time people spend indoors. In particular, few activities involve as much person-time as cooking. Women responsible for preparing meals, and the young children they care for, are most heavily exposed to indoor air pollution from SFU.

The Environment Burden of Disease (EBD) from SFU is likely to be most significant in these situations where biomass is the chief source of fuel and contributes to extensive burden of disease. It has been estimated that indoor exposures to the combustion products of solid fuels are responsible for the majority of non-smoking human exposures to particulates and other major pollutants. As a result, large numbers of people are at increased risk of contracting acute lower respiratory infections (ALRIs), chronic obstructive pulmonary disease (COPD), lung cancer, and other afflictions associated with SFU. According to Nepal Demographic Health Survey (NDHS) 2006, 83% of the households use solid fuel as primary source of energy. So, it can be assumed that there is substantial burden of disease attributable to indoor air pollution due to SFU. Estimating the nature, size and distribution of this impact at more specific local levels is clearly vital for informing regional and national decision-making on environmental health. Based on the guide "*Indoor smoke from solid fuels: Assessing the environmental burden of disease at national and local levels'* developed by World Health Organization in 2004, the present estimate disease burden due to ALRI in children under five years of age (U5 children) at a local level caused by household exposures to indoor smoke from solid biomass fuels. ALRI has been chosen because it is one of the significant public health problem for U5 children in Nepal and responsible for high number of premature deaths.

1.2 Rationale

ARI is a very important public health problem because of climate, terrain, literacy, poverty and living condition of the people. Pneumonia kills more children around the world than any other illness. Many caregivers, however, do not know the key symptoms – fast and difficult breathing – that indicate when a child needs immediate treatment. Using a simple method, Nepal's Female community health volunteers (FCHV's) can identify cases of pneumonia and administer antibiotic treatment which helps to reduce the incidence of childhood respiratory infections in Nepal. ARI is a cause of death globally causing approximately 19% of all deaths before the age of 5 years, according to a World Health Organization estimates. Indoor air pollution from biomass fuels, which is strongly poverty related has been regarded as an important risk factor for ARI morbidity and mortality. An estimated 24% of the global disease burden and 23% of all deaths can be attributed to environmental factors. Of the 102 major diseases, disease groupings and injuries covered by the *World Health Report* in 2004, environmental risk factors contributed to disease burden in 85 categories. The specific fraction of disease attributable to the environment varied widely across different disease conditions. Besides diarrheal diseases, acute respiratory infection (ARI) constitutes one of the major groups of causes of death among children in developing countries. According to estimates for 2000 to 2003 presented in the 2005 World Health Report, acute respiratory disease accounts for 19% of total deaths in children under 5 years of age, making ARI the second most common cause of death in that age group, after neonatal causes. While ARI contributes 2 to 4% of deaths in children under 5 years of age in the low mortality member states, these causes contribute 19 to 21% of child deaths in the Eastern Mediterranean, Africa, and South East Asia regions, and 12 to14% in the high-mortality countries of Europe, the Americas, and the Western Pacific region. Many studies 2–4 have been undertaken to establish the magnitude of the ARI problem in various countries and to study the effects of immunization and improved case management, but fewer have tried to study specific risk factors with a view to intervention at primary stage. This review studies the relation between incidence or mortality from such diseases and one of the most common and most strongly poverty-related risk factors: indoor air pollution The traditional use of biomass fuels (*i.e.*, agricultural wastes, animal dung, and firewood) has repeatedly been identified as a problem, as a cause of soil degradation, of deforestation, and as a major source of indoor air pollution. Annual Report of Ministry of Health and Population of Child health statistics indicate a decrease in the national percentage of pneumonia cases from 42.6 in 2001 to 38.2 in 2004.

The EBD method provides a formalized, explicit approach, in which the choices of inputs are apparent. This allows the effects of different assumptions to be readily displayed (e.g. DALYs due to indoor air pollution from unvented fires can be calculated with and without age-weighting). This study will provide rationale for prioritizing actions in health and the environment, planning for preventive action, assessing performance time and over, comparing action and health gain, identifying high-risk populations, planning for future needs, assessing future scenarios, setting priorities in health research and Relevancy to policy-making.

1.3 Study objective

To estimate the environmental burden of diseases due to ALRI in Under 5 children due to indoor smoke in Dhading district.

1.4 Limitations

- This research was conducted within short duration of time.
- Sometime mother could not remember the exact episode of pneumonia during last fiscal year(F/Y)
- Secondary data from FCHV's was not so reliable.
- The result of the findings may not be generalized in other districts of Nepal.

Chapter-II

2.1 Literature Review

According to Pandey MR; et al research report on "Domestic smoke pollution and ARI in a rural community of hill region of Nepal" it shows that among infants the episodes of ARI per child increases with the increased level of exposure to smoke. Among infants the result indicate that the relationship is strong consistent between life threatening ARI grades III and IV episodes and exposure to domestic smoke pollution. This study shows that exposure to solid biomass fuel is an important risk factor in ARI which is a leading cause of infant and child mortality of developing countries like Nepal.[1]

Davidson et. al 1986 in their study indoor and outdoor air pollution in the Himalayas states that biomass fuel produce high NO2 and other toxic substance and these have high range of effects on child's respiratory organs. And this research shows that there is high level of NO2 in homes using biomass fuel as compared to house using cleaner fuels like gas, kerosene etc. of USA and UK. [2]

Boleij et al 1987 in their study report on Indoor air quality in the Maragua area, Kenya reports that acute respiratory infections among children under five years of age has shown no relation between ARI incidence and pollution levels or housing characteristics.[3]

Global medium term programme Acute respiratory infections document by WHO in 1983 reports that domestic smoke pollution is very common in many parts of developing countries, and appropriate technology such as smokeless stove or cleaner fuel is available to reduce this type of pollution. Out of 15 million children under five deaths all over the world Acute Respiratory Infections cause about one-third of total deaths and among them most of the death are caused by pneumonia. [4]

Study conducted by Pandey M.R.et al in 1985 on domestic smoke pollution and respiratory function in rural Nepal states that difference on respiratory function values could be attributed to the effect of indoor air pollution (IAP). This study shows that environmental air pollution (indoor and outdoor) causes deterioration in lung function. In this study positive correlation between domestic indoor air pollution and lung function was observed.[5]

Publication of World Health Organization (WHO) on "Burden of disease due to indoor air pollution from solid bio-fuel for the year 2002" estimates that the percentage of population using solid biomass fuel is 81%, ARI deaths attributable due to solid fuel use (<5 years) is 4820, total death attributable to solid fuel use is 7500, total DALY's attributable to use solid fuel use is 204400 and percentage of national burden of disease attributable to solid fuel use is 2.7.[6]

Situation Analysis of Indoor Air Pollution and Development of guideline for Indoor Air Quality Assessment and House Building for Health by Ishwori Lal Shrestha's study reveals that the smoke pollution is highest in kitchen having traditional indoor clay stoves. The mean smoke level in kitchen using bio-mass fuel is three times higher than in kitchen using cleaner fuels like kerosene. By comparing smoke according to ecological regions; hill kitchens with solid bio fuel is more polluted as compared to Himalayas and Terai and rural kitchen using solid bio-fuel is more polluted as compared to urban kitchen using cleaner fuel. This study also shows 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 to be 16.8% as compared to processed fuel which is 7%.[7]

According to census conducted in 2001 4.14 % of total death is contributed by pneumonia and the number of pneumonia is 4429 during last 12 months (in the duration of 2000-2001).

According to survey "Nepal Demography and Health Survey 2001" the prevalence of ARI for children below 5 years old is found to be 23% where the total population of children below 5 years old is 12.1%. [8]

A study conducted by Joshi H.D; on "Indoor air pollution and its health impact on people of Malikarjun village development community, Darchula district" shows that more the time spent near fireplace more the chance of ARI. Children spending 0-0.9 hrs a day has chance of 1.0 ARI episode of grade I while children spending 4+ hours a day has chance of 1.90 ARI episode of grade I in 0-1 years child in under 1 year child and same is the case for grade II and in child aged 1-2 years old.[9]

According to Ezzati M and Kammen D. study on "Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study". Showed the best estimate of the exposure-response relation, they found that ARI and ALRI are increasing concave functions of average daily exposure to PM10, with the rate of increase declining for exposures above about 1000–2000 µg/m3. After they included high-intensity exposure episodes, they found sex was no longer a significant predictor of ARI and ALRI.[10]

According to Kumar S., Mehra S. case control study on "ARI and Indoor Air Pollution: Its Burden and Correlation". Published in 2007 marks clearly that solid fuel use for cooking (OR 3.97) was associated with high-risk after adjusting for confounders. Children under 5 years have the highest risks for the acute respiratory disease thought to be affected by air pollution and of course do not smoke. This study also estimates that particularly in the first few years, children spend much time with their mother and thus receive higher exposures than older children, who may spend much time away from the household. The Indian portion of this one disease ARI, which affects mainly one age group accounts for 2.5% of the entire global burden of ill health.[11]

“Indoor air pollution in developing countries and acute lower respiratory infections in children” study conducted by Smith et al in California, Baltimore, U.K. etc states that indoor air pollution (IAP) from household using biomass fuels are reasonably consistent and, show a strong significant increase in risk for exposed young children compared with those living in households using cleaner fuels or being otherwise less exposed.[12]

Study conducted by Kurmi O.P; on “Particulate Matter Exposure during Domestic Work in Nepal” conducted on the basis of the small amount of evidence available, peak and daily exposures to indoor particulate levels in villages in developing countries seem to be about 20 times greater than in developed nations. The results of a semi-quantitative epidemiological study conducted in Nepal showed a direct relation between reported hours/day spent near the stove by infants and children aged under 2 years and episodes of life threatening acute respiratory infections.[13]

Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis conducted by Dherani M et al 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.[14]

Annual Report of Ministry of Health and Population (MOHP) of Child health statistics indicate a decrease in the national percentage of pneumonia cases from 42.6 in 2001 to 38.2 in 2004. Immunization coverage is 96.3% BCG, DPT-3 90.3%, Polio-3 90.2% and measles 85.4% (MOHP[15]

Across Nepal, respiratory infections like pneumonia caused the deaths of 11,000 children under age five in 2004.Treatment coverage for major childhood diseases, such as pneumonia and malaria, has been slow to expand. Pneumonia and malaria together account for 27 per cent of all under-five deaths each year

Researcher included the case of acute respiratory disease and mortality among children within a health and demographic surveillance project in Butajira in central Ethiopia. In a study from Butajira published in1994, Shamebo et al reported ARI as cause of death as determined by verbal autopsy (VA) in 28% of 306 deaths in children 5 years old between October 1988 and September 1989. A later study in Butajira to evaluate VA procedures in demographic surveillance reported pneumonia/sepsis as cause of death in 25% of deaths in the 1-to 14-year age group from 2003 to 2004.[16]

Research study conducted by Mishra V; in 2003 on "Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe**"** found that About two-thirds (66%) of children lived in households using biomass fuels and16% suffered from ARI during the 2 weeks preceding the survey interview. After adjusting for child's age, sex, birth order, nutritional status, mother's age at childbirth, education, religion, 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). He analyzed that Household use of high pollution biomass fuels is associated with ARI in children in Zimbabwe. The relationship needs to be further investigated using more direct measures of smoke exposure and clinical measures of ARI.[17]

Chapter-III

3.1 Method of Estimating Environmental Burden of Diseases

The method is based on information of SFU exposure-response relationship and exposure levels. The method utilizes relative risks for exposure-response relationships and a binary classification scheme for exposure levels

Brief description of estimating burden of disease due to ALRI in U5 children from SFU is as follows:

Step 1 – Obtaining key data

Obtain estimates of the local assessment's key data:

Exposure levels: This was measured using binary classification method (those exposed to SFU and those not) from a household (HHs) sample survey of the district. Each household was asked about the primary source of fuel, number of U5 children in the house. Then, accordingly percentage of the U5 children exposed to SFU was estimated.

In addition, data of the type of stove used for cooking was obtained, and accordingly the recommended ventilation coefficient given in the WHO guide will be applied:

− Ventilation coefficient of 1.00 to the population that uses traditional stoves;

− Ventilation coefficient of 0.25 to the population that uses improved stoves, or cooks outdoors.

The final equation for determining the population exposed to SFU become:

Population of U5 children exposed to SFU = (Population size of U5 children) x (% of households using solid fuels with traditional stoves) x (ventilation coefficient of 1.00) + (population size of U5 children) x (% of households using solid fuels and either improved stoves or cooking outdoors) x (ventilation coefficient of 0.25)

Burden of Disease due to ALRI in U5 children: ALRI in U5 children was assessed through questionnaire survey and health examination of all the under 5 children in the sampled households. Burden of ARI in U5 children was calculated in terms of DALY. The general formula for the calculation of DALY is:

DALY= YLL+YLD

where,

YLL= years of life lost due to death $= N * \frac{1-e^{-0.03LE}}{0.03}$

YLD= years of life lost due to disability $= I * DW \frac{1-e^{-0.03Le}}{0.03}$

N= number of deaths due to ALRI in U5 children

LE= Standard life expectancy at particular age

IR= incidence rate of ALRI in U5 children= Number of episodes of ALRI/ Total Number of children at risk

DW= disability weight

Le= length/duration of illness in the children

Step 2 – Calculation of the attributable fractions

The relative risk for exposure to SFU and ALRI in children under five years of age is 2.3. The given relative risk is recommended by the WHO guide which is derived from a review and meta-analysis of the global literature relating SFU exposure to health impacts. The rationale for using these relative risks in local assessments is that the nature and level of indoor air pollution caused by SFU is similar across settings. Thus, using all the internationally available evidence for relative risks in a local assessment helped to provide the most reliable results.

To estimate the attributable fraction, the relative risk and the exposure level are inserted into the equation for the attributable fraction, as shown below:

AF= ((% population exposed × relative risk + % population unexposed × 1) – 1)
/ (% population exposed × relative risk + % population unexposed × 1)

Step 3 – Calculation of the attributable burdens

The attributable fraction is then multiplied by the measure of disease burden to estimate the attributable burden.

Attributable burden of disease due to ALRI in U5 children from SFU = attributable fraction × Burden of Disease due to ALRI in U5 children

Step 4: Identification and discussion of sources of uncertainty in the data

Uncertainty in exposure, particularly the variations in conditions and practices that affect ventilation, cannot be easily quantified. Though relative risk has been calculated after extensive analysis, there is some element of uncertainty. Calculating relative risk at ninety-five percent confidence intervals will help us to estimate the low and high scenarios. However, these low and high scenarios cannot be interpreted as the lower and upper statistical bounds around the central estimates. They serve simply to illustrate what other results are possible.

Chapter IV

4.1 Assessment Methodology

4.1.1 Study Site

The study site was selected as Dhading district. It lies in Central Development Region. It consists of about 2 electoral constituencies, 14 Illakas and 51 VDC's. The total population of the district is 338658 with sex ratio 0.98:1. The total child under 5 years is 12.3% of the total population. The population growth rate is 2.0. The average household size is 5.4. The total dependency ratio is 0.48 with child dependency ratio 0.40 and elderly dependency ratio 0.08. The major caste living in Dhading district is Brahmin/Chettri group with 33.45% of total population and percentage of total marginalized group is 23.98. The major religion is Hinduism with 73.9%. The life expectancy at birth is 58.6 years. The total literacy rate of the district is 43.7% with female literacy rate 34.0%. The Infant Mortality Rate (IMR) is 80.8 per 1000 live birth. Incidence of diarrhea among U5 children per 1000 population is 210. Incidence of diarrhea among U5 children per 1000 population is 195. Chronic malnourished among U5 children is 43.4. Among top five most common diseases, ARI lies in second position. The case fatality rate due to ARI and diarrhea is 0.2 and 0.3 respectively. Out of total 6 death occurred in children, 3 deaths are due to neonatal death.

4.1.2 Study population

The study population was the children aged 59 months of Dhading district.

4.1.3 Study duration

The duration of the study was three months (October-December, 2008). The data were collected in December 2008**.**

4.1.4 Sampling unit

The sampling unit was the children under aged 5 years old who are currently living in selected ward and VDC of Dhading district.

4.1.5 Sampling method

The sampling method applied was multistage cluster sampling technique. In first stage, thirty clusters were selected using PPS. Each ward was considered as cluster. In second stage 50% of the total under 5 children population was selected. The sampling frame of under 5 children was obtained from the vitamin A register of particular ward's FCHV. The total estimated child of selected ward of selected VDC was 1875 but the collected child was 2011 which is more than estimated. It will help to get more precise result.

4.1.6 Data collection tools and technique

The primary data was collected by using structured questionnaire. The technique applied was face-to-face interview and the respondents were parents/ guardian of the child but mother is more preferred because mother takes care after her child. The secondary data was collected using recording format. The data was collected by cross matching CB-IMCI register and master register for finding out the ARI cases of that particular ward. The FCHV's ward register of selected ward was also recorded. As well data from treatment register of MCHW and VHW was also recorded. For finding out the total number of under 5 children, Vitamin A register was used.

The record of CB-IMCi register and CB-IMCI register was cross checked. We found that the name and date written in master register did not matched and vice-versa in many health institutions we visited. We found FCHV's were lying about her children cases of pneumonia. The data was collected by CB-IMCI trained personnel.

4.1.7 Pre-testing

The questionnaire and recording format was modified after pre-testing in Syabru-besi and Thulo Bharku V.D.C.'s of Rasuwa district which has similar location like that of Dhading district.

4.1.8 Data management

Data editing was done at every night of the data collection and possible errors was omitted. As well after data entry the errors was detected in MS-Excel and corrected by taking the help of filled questionnaire. Some data are coded like male=0, female= 1, yes=0and no=1 etc. the graph, charts and table was made according to the variables and kept uniformity in tabulation. Data was analyzed using SPSS and some were cross tabbed, some variables mean, maximum, minimum, frequency and percentage was calculated. Data was presented in tables and graphs. After analysis and interpretation, report was prepared.

4.1.9 Data analysis

Data was entered in MS-Excel but analysis was done in SPSS. The file of MS-Excel was tranfered into SPSS. Some variables were cross-tabbed and some variables were analyzed generally. Based on the result, interpretation was done. Mean age of under 5 child, % of male and female child, % of mothers literacy, % of mothers occupation, % of household using solid fuel(SF), cleaner fuel or mixed, % of child suffering from pneumonia etc. the exposure to solid fuel and prevalence of pneumonia was cross-tabbed to show the relation between solid fuel and pneumonia. The type of stove and episode of pneumonia was also cross-tabbed to show the relation of traditional indoor stove and pneumonia episode. The data was also analyzed by modulation for finding out the incidence of pneumonia, calculate attributable burden of disease and calculate attributable fraction.

4.1.10 Reliability and Validity

Reliability and validity was maintained by following things:

- Data was collected by personnel trained on CB-IMCI.
- Timer was used for counting respiratory rate to diagnose Pneumonia cases.
- Data collected from FCHV's was cross-checked with health institution register and their reporting register.
- Data from CB-IMCI register like name of child was cross-checked with master register of each health institution to find out the exact number of child from that ward.

- Data was entered in MS-Excel using data validation technique to avoid error that could occur during data entry.

4.1.11 Ethical Consideration

Ethical clearance was taken from Ethical Review Board of Nepal Health Research Council (NHRC) and research was conducted following National Ethical Guidelines of Nepal. Verbal consent was taken from research participant and upon their approval interview was taken. Written consent from District Health Office (DHO) was taken and gained data from health institutions under DHO.

4.1.12 Formation of Steering Committee and Periodic Meeting

A steering committee consisting of following members was formed in order to guide the study team.

1. Dr. Mahesh Kumar Maskey, Executive Chairman, NHRC
2. Dr. Mrigendra Raj Pandey, President, Indoor Air Pollution and Health Forum-Nepal
3. Dr. D.S Manandhar, President, MIRA Nepal
4. Dr. Sharad Raj Onta, Public Health Expert
5. Dr. Shri Krishna Giri, Member-Secretary, NHRC
6. Dr. Bandan Pradhan, Associate Professor of Environmental Health, IOM, T.U
7. Mr. Han Heijnen, Enviornmental Health Advisor, WHO
8. Mr. Purushotam Dhakal, Biostatician, NHRC
9. Mr. Meghnath Dhimal, Environmental Health Research Officer, NHRC

There was periodic meeting of steering committee which guided the study team especially for research design and data collection techniques.

Chapter V

5. Results

5.1 Background Information

The total house hold visited during survey for primary data collection was 1170 and the total child was 2011. The respondent of our study were mother (priority), followed by father and other member of the HH.

a. Occupation of mother

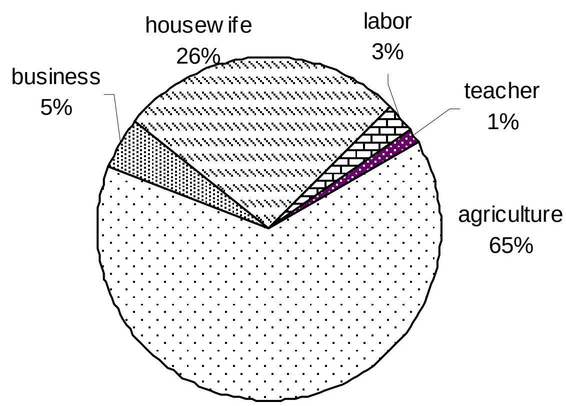


Figure 1Occupation of mother

Among 1170 HH under survey 65% women were dependent on agriculture followed by the housewife.

b. Education status of mother

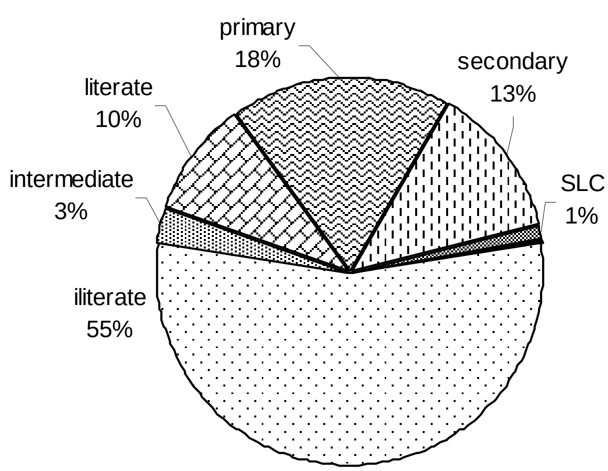


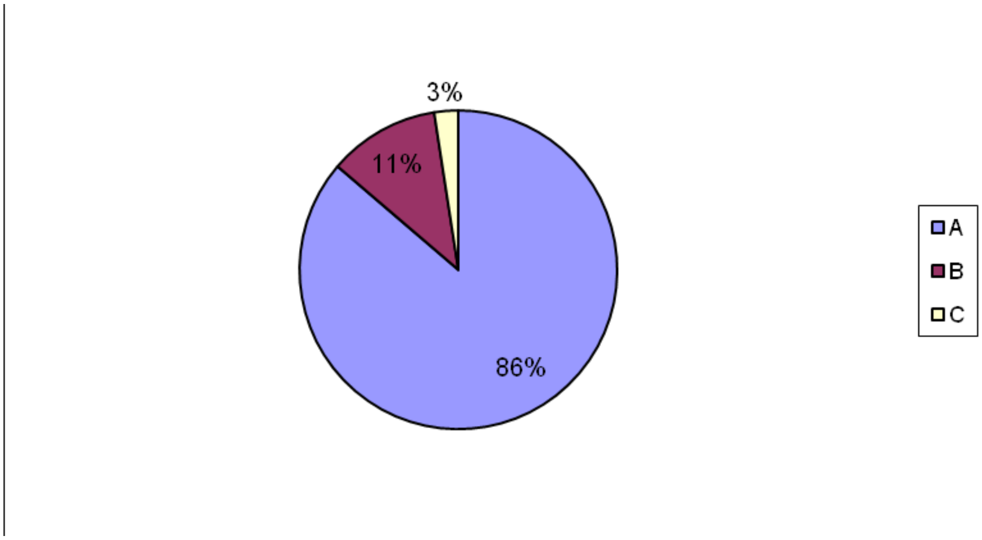
Figure 2 Education status of women

The education status of mother shows that more than 50% women are illiterate. The literate only here refers to that status of women who answered their education as *Praud.* Less than 5% women have completed intermediate level.

5.2 Information about fuel type and cooking stove

a. Type of fuel used

Table 1 Type of Fuel used



Among total HH 87% use type A fuel, 11% use type B fuel and 2% use type C fuel.

b. Type of cooking Stove

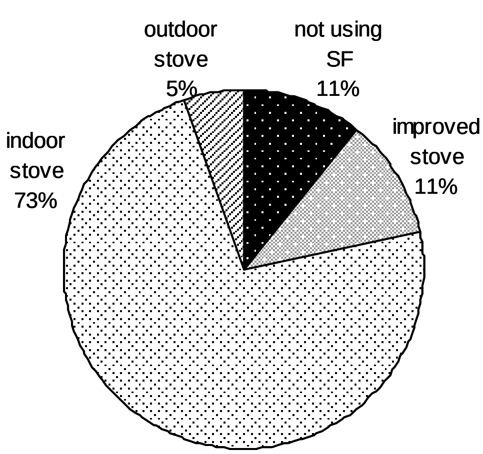


Figure 1 Type of Stove

The type of stove used for cooking purpose in maximum HH is indoor stove i.e. 73% followed by not using any type of Solid fuel, HH using improved stove and only 5% HH has stove outside home.

c. **Under 5 children accompanying during cooking**

Table 2 under 5 children accompanying during cooking

	Total	%
Always	499	27.72
Most often	313	17.39
Rarely	261	14.50
Sometime	727	40.39
Total	1800	100.00

Among total children 2011, 89.5% (1800) children fall under study criteria as their HH use type A stove and rest 211 children did not fall under study criteria as their HH use other than solid fuel for cooking purpose. Among 1800 children 40% accompanied their mother sometime where as about 28% accompanied their mother always during cooking.

5.3 Information on Pneumonia

Among total HH 1170, children contracted with pneumonia since last one year is 59.05% (691) children and not contracted with pneumonia since last one year is 40.94% (479).

a. **Place of treatment for Pneumonia**

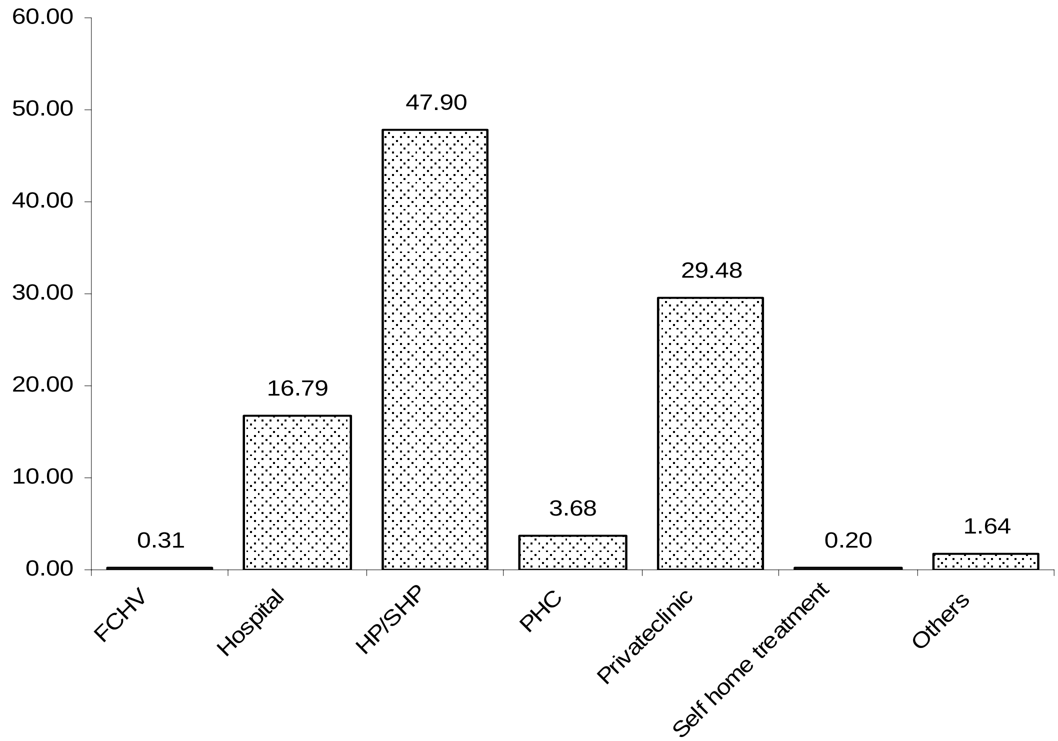


Figure 2 Place of treatment for pneumonia

Most of the cases of Pneumonia was treated in HP/SHP (47.90%), followed by private clinic (29.48%), hospital (17%) and PHC (3.5%). Less than 1% visit to FCHV's for treating Pneumonia.

b. Child contracted with Pneumonia within last one year

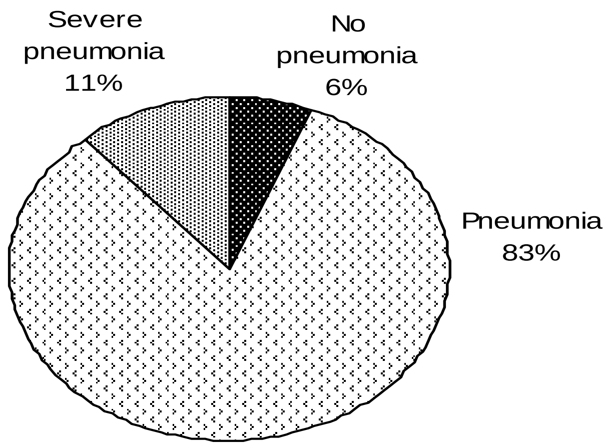


Figure 3 Type of pneumonia

The above pie explains the types of pneumonia contracted to a child, the total pneumonia cases was 83%, no pneumonia cases was 6%, and severe pneumonia cases was 11%.

c. Death

During our survey, we found one death case due to pneumonia of female aged 1month.

d. Result of diagnosed child for Pneumonia

Table 3 Result of diagnosed child

	Total
Total child (N)	2011
No pneumonia	659
Pneumonia	107
Severe pneumonia	6
Total Diagnosed child as Pneumonia	**772**

The children with the symptoms of common cold, cough, or fever were selected for the diagnosis of pneumonia. Hence the total children diagnosed for pneumonia were 772. During diagnosis the result obtained is shown in the table above.

5.4 Incidence rate of ALRI in U5 children

The annual incidence rate of ALRI in U5 children was calculated using the household survey data. It was calculated 1.25 which is extremely high. It is due to higher episodes of pneumonia.

5.5 Population of Children Exposed to SFU

Population of U5 children exposed to SFU =

(Population size of U5 children) x (% of households using solid fuels with traditional stoves) x (ventilation coefficient of 1.00) + (population size of U5 children) x (% of households using solid fuels and either improved stoves or cooking outdoors) x (ventilation coefficient of 0.25)

= 54577 x 71.36x 1.00 + 54577 x 17.35 x 0.25

= 41313

(N.B Population using mixed fuels is also taken as population using solid fuels with traditional stoves and Total Population of under 5 children was taken from DOHS Annual Report 2063/64))

Burden of ARI in U5 children was calculated in terms of DALY. The general formula for the calculation of DALY is:

DALY= YLL+YLD
= N*LE+ IR*Le*DW

Where,

YLL= years of life lost due to death

YLD= years of life lost due to disability

N= number of deaths due to ALRI in U5 children =27

LE= Standard life expectancy at particular age= 62.4 Years

IR= incidence rate of ALRI in U5 children = 1.248135

DW= disability weight= 0.28 (Taken from Global Burden of Diseases Study)

Le= length/duration of illness in the children= 10 (Taken from Global Burden of Diseases Study)

The YLL with 3% discounting and uniform age weights was calculated 762

YLD with % discounting and uniform age weights was calculated 522

Hence, DALY was calculated 1284

5.6 Calculation of Attributable Fractions (AF)

To estimate the attributable fraction, the relative risk and the exposure level was inserted into the equation for the attributable fraction, as shown below:

AF= ((% population exposed × relative risk + % population unexposed × 1) – 1)
/ (% population exposed × relative risk + % population unexposed × 1)

= (75.7% x 2.3 + 24.3% x1 -1)/ 75.7% x2.3 + 24.3%x1)

= 0.496

This means that about 50 % cases of ALRI were attributed by indoor smoke in Dhading district

5.7 Calculation of Attributable Burdens

The calculated attributable fraction is then multiplied by the measure of disease burden to estimate total attributable burden of diseases due to ALRI.

Attributable burden of disease due to ALRI in U5 children from SFU
= attributable fraction × Burden of Disease due to ALRI in U5 children
= 0.496 x 1284
= 637

This means that 637 DALYs were attributed by ALRI due to exposure of indoor smoke amongst the under five children in Dhading District.

Chapter VI

6 Conclusion and recommendations

Based on household survey conducted in Dhading District, following are the important conclusions of the study.

- The majority of mother of children were illiterate (55%) and their occupation was agriculture.
- Most of the households (87%) use biomass fuel (*dung, charcoal, wood, or crop residues*) / coal followed by clean fuel such as kerosene/ LPG/ Bio-gas/ Electric Heater and most of them use indoor stove (73%)
- Out of total 1800 study population of children, 27.72 % were accompanied by mother during cooking and 40.39% were accompanied only sometimes.
- Most of the cases of Pneumonia was treated in HP/SHP (47.90%) followed by private clinic (29.48%)
- Most of the child contacted with pneumonia within last one year were pneumonia (83%) followed by severe pneumonia (11%)
- During the survey, one case of death was reported.
- Population of children exposed to SFU was found 41,313 in Dhading District.
- The incidence rate of ALRI was found 1.25 per annum per person
- The YLL with 3% discounting and uniform age weights was calculated 762 and YLD with 3% discounting and uniform age weights was calculated 522. Hence, DALY was calculated 1284. It means total 1284 disability adjusted life years were lost in Dhading district due to ALRI among the children under five years.
- The attributable fraction was calculated 0.496 which means that about 50 % cases of ALRI were attributed by indoor smoke in Dhading district and
- Attributable burden of ALRI in U5 children from SFU was 637 which means that 637 DALYs were attributed by ALRI due to exposure of indoor smoke amongst the under five children in Dhading District.

Based on above concluding facts, following recommendation can be made

- The population at risk must be reduced. For, this instead of traditional stoves, improved cooking stoves must be used and should be in gradual shift from SFU to clean fuel.

Chapter VI

References

1. M.R., P., *Domestic smoke pollution and acute respiratory infections in a rural community of the hill region of Nepal.* 1989. **15**: p. 337-340.
2. Davidson, C.I.L., S.F;Pamdeya M.R.;Rasmussem,R.A.Khalil M.A.K., *indoor and outdoor air polution in the Himalayas* 1896. **20**: p. 561-567.
3. Boleij, J.S.M.e.a. *Indoor air quality in the Maragua area, Kenya*. in *4th International Conference om indoor air quality and climate*. 1987. institue for Water, soil and Air hygiene, Berlin.
4. WHO. *Global medium term programme Acute respiratory infections document.* 1983. geneva.
5. M.R., P., *Domestic smoke pollution and respiratory function in rural Nepal*. 1985, Tribhuwan university. p. 471-481.
6. W.H.O., ed. *Indoor air pollution: National Burden of Disease Estimates*. 2002, WHO press, world health Organuization, 20 Avenue Appia, 1211 Geneva 27, Switzerland. 5.
7. ShresthaL.I., K.S.B., Devkota S., joshi S.K., Shrestha S.L., *Situation analysis of indoor air polution and development of guidelines for indoor air quality assessment and house building for health*. 2004, Nepal Health Research Council kathmandu. p. 85.
8. NDHS, *Nepal Demography and Health Survey 2001*. 2001, Department of Health Services.
9. Joshi H.D, P.R., Dhakal B., Joshi S.D., *Indoor air pollution and its health impact on people of Malikarjun Village development community, Darchula District*. 2008, Nepal Health Research Council. p. 46.
10. M . Ezzati , D.K., *Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study*. p. 619 - 624
11. Kumar S., M.S., *ARI And Indoor Air Pollution: Its Burden And Correlation* Internet Journal of Pulmonary Medicine, 2007. **8**(2).

12. Kirk R Smitha, J.M.S., Isabelle Romieuc, Nigel Bruced *Indoor air pollution in developing countries and acute lower respiratory infections in children* internet journal.
13. Kurmi P.O., S.S., SteinerM., Henderson G.D. and Ayres J.G., *Particulate Matter Exposure during Domestic Work in Nepal.* Internet journal.
14. Dherani M, P.D., Mascarenhas M, Smith KR, Weber M, 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.*, Division of Public Health, University of Liverpool, Liverpool, England.
15. MoHP, *Annual Report, 2003/2004*. 2003/2004.
16. Shamebo D, M.L., Sandstro¨m A, et al., *The Butajira rural health project in Ethiopia: a nested case-referent (control) study of under-five mortality and its health and behavioural determinants.* Chest Journal, 1994. **14**: p. 201-209.
17. Mishra, V., *Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe.* International journal of epidemiology, 2003(32): p. 847–853.

Annexes

Household Questionnaire

Introduction and Consent

Hello. My name is …………………………..and I'm working with the Nepal Health Research Council (NHRC). We are conducting a research study on impact of indoor smoke on children health less than five years. We would very much appreciate your participation in this survey. The survey usually takes between 20 to 30 minutes to complete. All of the information you have provided will be confidential. Participation in the survey is completely voluntary. If you should come to any question you don't want to answer, just let me know and I will go on to the next question, or you can stop the interview at any time. However, we hope you will participate in the survey since your information are important.

At this time, do you want to ask me anything about the survey?

Signature of Interviewer:…………………… Date: ………………………

Sample Cluster Number:

Household serial Number:

District:

Municipality/VDC:

Ward No.:

Village/tole:

Name of interviewer:

Date of interview:

Background Information			
Name of the respondent		Age /Sex of the respondent	
Occupation of mother		Literacy of mother	
Number of children under 5 years (U5 children)		Age/Sex of the children	
Relation(s) to children under 5 years			

2. Information about fuel type and cooking stove			
What type of fuel is used for cooking?	a. Biomass fuel (*dung, charcoal, wood, or crop residues*) / coal b. Kerosene/ LPG/ Bio-gas/ Electric Heater c. Mixed		
If improved stove/ non- biomass fuel is used, from how many years back was it used?	a. < than 1 yr b. > than 1 yr	Before that, what type of stove was used and for how long?	
(if the household do not use Solid fuel for cooking, do not proceed below for type of stoves)			
What type of cooking stove is used for burning SF?	a. Traditional stove (Ageno chulo) outside of the house b. Traditional indoor clay stove c. Improved stove		
Do the U5 children accompanies their mothers during cooking in the kitchen	a. always (सधै) b. most often (प्रायजसो) c. sometimes (कहिलेकाहि) d. rarely (बिरलै)		

3. Information on Pneumonia:[1]					
Have any of your alive children contracted with Pneumonia during last one year?	a. Yes b. No				
Where did you treat him/her?					
a. Self home treatment b. FCHV c. Health/Sub-health Post d. PHC e. Hospital f. Private Clinic g. others……………	1st child	2nd child	3rd child	4th child	5th child
How many times (episodes) he/she contacted with pneumonia last year?					
No Pneumonia…… times Pneumonia…… times Severe Pneumonia…… times	1st child	2nd child	3rd child	4th child	5th child
Have any of your children died due to Pneumonia during					

[1] Information on pneumonia must be verified by the CB-IMCI register of FCHV

last one year?	…………

1. *If there is a child with symptoms of common cold, cough or fever, then she/he will be examined for pneumonia:*

	1st child	2nd child	3rd child	4th child	5th child
No Pneumonia					
Pneumonia (non-severe)					
Severe Pneumonia					

4. Information on Diarrhea

Have any of your alive children suffered from diarrhea during last one year?	a. Yes b. No

Where did you treat him/her?

	1st child	2nd child	3rd child	4th child	5th child
a. Self home treatment b. FCHV c. Health/Sub-health Post d. PHC e. Hospital f. Private Clinic g. Others……………					

How many times (episodes) he/she contacted with Diarrhea last year?

	1st child	2nd child	3rd child	4th child	5th child
No Dehydration…… times Some Dehydration…… times Severe Dehydration… times					

Have any of your children died due to Diarrhea during last one year?	…………