Indoor Air Pollution and its Health Impact on People of Malikarjun Village Development Community, Dharchula District

(A Case Study)

Submitted by

Hari Datt Joshi (PI)

Ravindra Pandeya (I)

Bhuwan Dhakal (I)

Shiv Datt Joshi (I)

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Research Advisor

Dr. Mahesh Kumar Maskey

(Chairperson, Executive Board, NHRC)

Research Team Members

Key Members

1. Data Collection and Management

Principle Investigator	:	Hari Datt Joshi
Investigator	:	Ravindra Pandeya
Investigator (Health Survey supervisor)	:	Shiv Datt Joshi

2. Data Analyst

Investigator	:	Bhuwan Dhakal

Field Survey Members

Data collector	:	Gopal Singh Dhami
Data Collector	:	Bimala Dhami

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Executive Summary

Indoor air pollution in Nepal is causing deleterious effects for its people, living in the rural households, who have to depend on the low quality of energies. Kitchen pollution, in these households, is so high that the frequencies of respiratory diseases are prevalent. With this condition, it is of no surprise that, Acute Respiratory Infection (ARI), in Nepal, is the second leading morbidity in 2006/2007.

This study carried out in Malikarjun VDC of Darchula District is intended to link the kitchen characteristics and exposure duration of locals (especially children and their mother) with the disease prevalence. This kind of study is itself first of its own in the VDC and will be highly relevant in finding out the situation of the rural village. This study was a field-oriented program, which was supported by medical check up, measurement of kitchen characteristics and households survey, Measurement of Respiratory Functions, Episode identification of Acute Respiratory Infection in children below two years of age, Informal discussion and Key Informants.

The result confirmed that, exposure duration, smoking habit and indoor environment of the households are causing different types of diseases in the VDC including respiratory disorders in the adults and prevalence of ARI in the children up to two years of age. Further, it was found that the use of clean energy was minimal in the households and all kitchens were characterized by the presence of smoke because of the use of low quality energy sources including fuel wood and the lack of proper ventilation system. In addition, the area of the kitchen and doors in them were not up to the recommended level.

In conclusion, the study was able to determine that the prevalence of diseases in the households in the rural Malikarjun VDC of Darchula District was the result of indoor air pollution initiated by the use of low quality energy and poor kitchen characteristics. Thus, this study recommends for promoting the efficient energy systems in the households as well as remanufacturing of the kitchen and the building with proper ventilation.

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LIST OF ABBREVIATIONS

µg/m^3	Microgram per Cubic Meter
ANOVA	Analysis of Variance
ARI	Acute Respiratory Infection
BA	Bronchial Asthma
CHW	Community Health Worker
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
ENT	Ear Nose Throat
GoN	Government of Nepal
HHS	Households Size
IAP	Indoor Air Pollution
ICS	Improved Cooking Stoves
mg/m^3	Milligram per Cubic Meter
NESS	Nepal Environment and Scientific Service
NHRC	National Health Research Council
NOx	Nitrogen Oxides
PFR	Peak Flow Rate
PM_{10}	Particulate Matter with Aerodynamic Size less than 10 Micron
$PM_{2.5}$	Particulate Matter with Aerodynamic Size less than 2.5 Micron
SOx	Sulphur Oxides
TWC	Tear While Cooking
VDC	Village Development Committee
WHO	World Health Organization

CHAPTER 1
INTRODUCTION

1. Background

Indoor Air Pollution

Indoor air pollution is responsible for a large burden of disease among the world's poorest and most vulnerable populations (DCPP, 2007). The major sources of indoor air pollution worldwide include combustion of fuels, tobacco, and coal; ventilation systems; furnishings; and construction materials (Balakrishnan et. al., 2004). In the energy ladder, biomass fuels namely animal dung, crop residues and wood, which are the dirtiest fuels, lie at the bottom and are used mostly by very poor people (Saiyed et. al, 2001). In developing countries, indoor air pollution from using open fires for cooking and heating may be a serious problem. It has been estimated that in developing countries, about 1.9 million people die annually due to exposure to high concentrations of suspended particulate matter in the indoor air environment of rural areas (WHO, 2000).

Thanks to the newer technologies and awareness, the population using biomass fuel around the world has been decreased somewhat. Nevertheless, this data has been highly controlled by the developed countries, while those who are under-developed still fall behind in using higher qualities of energies, as a result, the indoor environmental health in the rural areas of the developing parts like Africa and South Asia are ghastly. An ever-changing world adds to the challenge. Globally, 840 000 more people were using cleaner fuels in 2003 than in 1990, corresponding to a drop in solid fuel use from 58% to 52% of the population. Yet, because of population growth, the actual number of people using solid fuels has not gone down but rather gone up by 170 000. Energy poverty goes hand in hand with lack of energy infrastructure, such as a distribution network for LPG or an electricity grid. Moreover, lack of energy infrastructure is a common feature of isolated rural communities and rapidly growing urban slums (WHO, 2006). Studies from Asia, Africa and the Americas have shown that indoor air pollution levels in these homes are extremely high, many times the limits set by the U.S. Environmental Protection Agency (EPA) and WHO (WHO, 2000).

Mortality and morbidity rates, especially among children and women are alarmingly high in Nepal. Acute respiratory infection (ARI), tuberculosis and other chronic obstructive pulmonary diseases (COPD), complications in childbirth, and vector borne diseases continue to prevail at high rate (WI, 2004). The country having more than 75% of its population residing in rural areas, lack access to the higher qualities of energies. Census carried out in 2001 suggests that the indoor air pollution has been detrimental for the people and their children (Deaths due to Pneumonia: 4.15%; Deaths due to Asthma/Bronchitis: 6.71%; Prevalence of ARI: 23%).

Pollutants causing Indoor Air Pollution and their effects

The indoor air pollutants include carbon monoxide, nitrogen oxides, tobacco smoke components, suspended particulate matter - both total suspended particulate matter (TSP) and respirable particles (RP), asbestos, formaldehyde, ozone, radon (Ra-222), carbon dioxide, and organics viable particulate matter.

1. Carbon monoxide (CO)

It is a chemical asphyxiate gas. Its affinity for hemoglobin in red blood cells is 200-250-times that of oxygen, which can result in significant reduction in oxygen-carrying capacity.

2. Nitrogen oxides (NOx)

Most health effects associated with NOx have been attributed to nitrogen dioxide NO2. Levels of NO2 above 282 mg/m3 (150 ppm) can be lethal, while concentrations in the range of 94-282 mg/m 3 (50-150 ppm) can produce chronic lung disease.

3. Tobacco smoke

Tobacco smoke contains both particulate matter and gaseous components. Other components include phenols, naphthalene, trace metals, hydrogen cyanide, ammonia, and radioactive polonium 210. Parental smoking appears to be a cause of increased respiratory disease in children in the first year of life.

4. Asbestos

Asbestos applies to several naturally occurring, hydrated mineral silicates. Asbestos particles in the ambient air appear as fibers.

5. Formaldehyde

Formaldehyde is one of the reaction products of atmospheric photochemical smog. It is also present in tobacco smoke, emissions from combustion processes, and most dangerous for people in their homes. Burning of the eyes, lacrimation, and general irritation of the upper respiratory passages are the first signs experienced at HCHO concentrations in the 0.1-5 ppm range.

6. Suspended particulate matter (SPM)

It is generally considered to consist of all airborne solid and low-vapor-pressure liquid particles less than a few hundred micrometers in diameter. In general, the concentration of total suspended particulate matter is significantly lower indoors than outdoors. As it is contained in cigarette smoke, consumer spray products, and other indoor sources, the potential health implications are of concern.

7. Ozone

Ozone is a pulmonary irritant that affects the mucous membranes, other lung tissues, and respiratory function. Indoor sources that may contribute significant amounts of ozone include copying machines and electrostatic air cleaners.

8. Carbon dioxide

Carbon dioxide is produced by human metabolism and exhaled through the lungs. The amount of CO2 produced is a function of food composition and the activity level of an individual. Exposure of healthy individuals for prolonged periods to 1.5% CO2 apparently causes mild metabolic stress, while exposure to 7-10% will produce unconsciousness within a few minutes.

9. Viable particulate matter

Pollen, bacteria, fungal and plant spores, and viruses are all associated with airborne particles. A common measurement of viable particles is called total viable particles (TVP) or colony-forming particles (CFP). Ordinarily this measure reflects bacterial activity, does not include pollen or viruses, and often excludes fungal spores. In general, TVP concentrations are closely related to living conditions and indoor activity.

Sources of Indoor Air pollutants

1. Combustion

The major indoor combustion sources are appliances burning coal, gas, kerosene, wood, and also agricultural waste, even animal waste in some individual places.

2. Smoking

Tobacco smoke contains a great variety of potentially hazardous materials. Many of the pollutants will be filtered out in the smoker's lungs, e.g., 70% of the particulate matter.

3. Building materials

Various types of construction materials have been identified as sources of hazardous materials.

4. Office and domestic electrostatic machine

Tests on photocopying machines and domestic and commercial size electrostatic air cleaners have shown these devices to be indoor ozone sources.

5. Other sources

Domestic activities are one of the sources of hazardous materials. Air fresheners, furniture waxes, and paints are typical of home products delivered in aerosol form. Humans themselves constitute emission sources for various materials.

2. Rationale

Though the world has moved into the cleaner technologies, with the increase in the awareness level about the effects of pollutants on human heath, the residents of rural areas of developing countries are still facing the pollutants coming out of their kitchen. In Nepal epidemiological studies as such is lacking at the moment (NHRC, 2004) but the studies conducted in a rural community of hilly region of country have revealed a significant positive correlation between the prevalence of chronic bronchitis and average amount of time of exposure to domestic smoke pollution both amongst the smokers and non-smokers (Pandey et al., 1988). Similar study conducted in Nepal by Pandey et al., 1987, Davidson et al., 1986, and Reid et al., 1986 suggested that indoor air pollution is the serious risk factor for the respiratory ill health.

Further, no studies were found to be carried out in the far western region of the country, where people heavily rely on the low quality fuels for the cooking purpose. The people of study area spend most of their time inside the ill ventilated (Either a small hole for eliminating smoke or Not even that) house and near the traditional stove where high smoke exposure is one a of the risk factor for diseases. Due to remoteness and lack of alternatives (clean fuels) almost cent percent population of study area depend upon fuel wood. Therefore, this study will provide a database on what is the situation of the health condition of the local people and how it is related to the indoor air pollution and kitchen characteristics. Thus, this study will prove to be a perfect database for a research lacking area.

3. Objectives

General

To study effects of indoor air pollution on respiratory disorders in the population of Malikarjun VDC

Specific

1. Assessment of pollutant-exposure influencing parameters (ventilation, stove types etc.) at kitchen and other places.
2. Assessment of health effects situation to the inmates of the studied households from smoke exposure, particularly, women and children below 2 years of age.

4. Limitations

- This research project was conducted with limited required resources.
- Only one VDC (Out of 41 VDCs in Darchula) was selected due to limitation of time and resources.
- Special clinical investigation (clinical tests, patients cost i.e., Transportation, Reimbursement of travel expenses / Reimbursement of lost income) were not performed because of lack of sufficient resources.
- Direct measurement of pollutants like TSP, PM 10 and PM 2.5 was not included in the study due to limitation of fund and availability of resources.
- Peak flow meter analysis was carried out for only 81 respondents due to the reluctance of other respondents in using the meter.

CHAPTER 2
LITERATURE REVIEW

1. Indoor air pollution and Respiratory Health

An epidemiological study conducted in a rural community in the hilly region of Nepal revealed a significant positive correlation between the prevalence of chronic bronchitis and average amount of time of exposure to indoor air pollution both amongst smokers and non – smokers(men $\chi^2 = 35.70$, df = 1, $p<0.01$: women $\chi^2 = 17.36$, df = 1, $p<0.01$) . The increasing trend of the prevalence rates as the level of exposure is increased, even after elimination of age effect, established a fact that domestic smoke pollution is an important contributing factor in chronic bronchitis (Pandey, 1984).

Chronic bronchitis and chronic obstructive pulmonary disease (COPD) is leading cause of death and disability of human life around the world. An epidemiological study on chronic bronchitis and cor-pulmonale was carried out in different physiographic region of Nepal. These sites were Kathmandu (urban), Sundarijal and Bhadrabas villages of Kathmandu (rural hill), Prassauni of Bara district (Terai plain) and Chandannath on Jumla district (mountain). The study revealed that crude prevalence rate of chronic bronchitis and cor-pulmonale were (11.3%; 1.6%), (13.1%; 0.5%), (18.3%; 1.5%) and (30.9%; 5.6%) in Kathmandu, Prassauni, Sundarijal and Bhadrabas, and Chandannath respectively. Again, there was significant association between smoking habit (as well as past smoking) to the prevalence of chronic bronchitis. Contrasting finding of high rate prevalence on chronic bronchitis in women as in men could be explained in light of the fact that a significant higher proportion of women were exposed to domestic smoke pollution for longer hours (Pandey et. al., 1988).

Chronic obstructive pulmonary disease (COPD) is another major risk factor in many countries, especially among women and has been found to be significantly and strongly associated with smoke exposures from cooking on open biomass stoves; this has been suggested in several verbal studies, although there are difficulties in establishing exposure histories and controlling for suspected kitchen dwellers. In rural Nepal, nearly 15% of non smoking women (20 years and older) had chronic bronchitis, a high rate for non smokers (smith, 1996)

Ellegard, A., 1997, carried out study taking tears at cooking time as indicator of indoor air pollution in three different cities of developing world namely; Lusaka, Maputo, Hanoi. This study showed that Tear While Cooking (TWC) was more prevalent in conditions of higher particulate pollution. Persons experiencing TWC were also found to have more respiratory symptoms.

Bruce et. al. (2000) concluded that the Indoor air pollution is a major global public health threat requiring greatly increased efforts in the areas of research and policy-making. They focused on Research on strengthening its health effects.

ITDG (2002) studied the smoke health and household energy in Rasuwa District and found that the environmental and health problems in the households are caused by the lower quality of energy used. They concluded that respiratory infections are the major source of ill-health in the village.

Uzun et al., 2003 conducted epidemiological cross-sectional investigation of risk factor for the development of COPD and Asthma in Biomass fuel exposed females in five villages of Van city (East Turkey). They divide total 177 sample population into two groups Group A (n: 90, 18-75 years) who cooked on biomass fuel and Group B (n: 87 17-67years) who never cooked on biomass fuel. The prevalence of asthmatic symptoms (AS) was 63.3% in those who used biomass fuel, 12.9% in those who never used biomass fuel. The symptoms of chronic bronchitis (BS) in the biomass fuel used group were significantly higher ($p<0.0001$). They reported that there was no significant difference between smoking and nonsmoking females in terms of AS and BS. Their finding concluded that significant association between symptoms of chronic bronchitis asthma and biomass fuel usage in females living in a rural area.

Balakrishnan et. al., 2004 employed a study, on indoor air pollution associated with house hold domestic energy use, in rural districts of Andhra Pradesh collecting detailed Primary data on several household level exposure indicator (fuel type, housing type, kitchen type, ventilation, stove types etc) through administration of questionnaires in 1032 households together with quantitative air quality monitoring of respirable particulate matter in 420 households of 15 villages of three districts. This study with analytical statistical modeling revealed that average household exposure level of indoor smoke is depend variously on different factors mostly with fuel type, kitchen type and ventilation

2. Indoor air quality

Davidson et al., (1986) studied the indoor air pollution in the 18 houses of several Nepali Villages where biomass combustion was main source of energy. The concern fraction of total suspended particulate and respirable suspended particulates was found to be 8800 μgm/m3 and 4700 μgm/m3 respectively. Similarly, concentration of CO and N_2O was found to be 4700 μgm/m3 and 368 ppb respectively.

Ried et. al., (1986) monitored personal exposures of women to TSP, and CO during cooking periods in 60 household with traditional stoves (without flue) and improved cook stoves (with flue) in the middle Hills of Nepal, namely, Gorkha, Beni and Mustang. The mean concentration of TSP was found to be 3170 μgm/m3 in Gorkha, 310 ppm in Beni and 64 ppm in Mustang. In the case of improved cooking stoves, the mean concentrations of TSP were 870, 1,370 and 120 μgm/m3 in Gorkha, Beni and Mustang respectively. The mean concentration of CO with improved cooking stoves was not given.

Pandey et. al. (1987) studied the effectiveness of smokeless stoves in reducing indoor air pollution in a rural hill region of Nepal. In this study personal exposure levels of women to Respirable Suspended Particulate (RSP), CO and formaldehyde were monitored during cooking periods in 20 households.

Initially measurement was carried out in household using traditional stoves (without chimney) and again the installment of smokeless stoves between December 1986 to march 1987 in same household led the intervention on study. The analysis indicate that cook exposure to air borne pollutants were markedly lower with the uses of smokeless stove. The average exposure rate to RSP dropped from 8200 μgm/m3 while using the traditional stoves to 3200 μgm/m3 using the improved Tamang smokeless stove. Similarly, CO concentration decreased from 82.5 PPM to 11.6 PPM and HCHO concentration dropped from 1.4 to 0.6 PPM.There was a reduction in CO and HCHO by a factor of 7.1 and 2.3 respectively.

NESS (2001) monitored PM_{10} concentration in different localities of Kathmandu: city core area, outskirt, remote, and industrial area for different fuel types (LPG, kerosene and wood). It was found that PM_{10} concentration in wood burning houses were 6 times greater than LPG using houses and 2.26 times greater than kerosene using households. The same study also compared the PM_{10} concentration levels in two microenvironments in a house: kitchen and living room. The findings show that the PM_{10} concentration level in living room is 1.36 times less in LPG using houses, 1.26 times less in kerosene using houses and 5.5 times less in wood burning houses.

Bhatt (2005) studied the effects of pollution on indoor air quality of Kathmandu valley, and constructed a remark that TSP level in Nepalese kitchens are higher than ambient air standard set by MOPE. Result showed that kerosene stoves are highly pollution emitters with compared to LPG Stoves. In case of ventilation (coefficient 0.0025,) there was maximum TSP concentration 2586 $\mu gm/m^3$, emitted by kerosene stove, while only 646.5 $\mu gm/m^3$ by LPG stove, 25% of Kerosene. However, the case was found different in case (coefficient 0.15) the difference was only 317 $\mu gm/m^3$ and use of exhaust fan further reduced the TSP concentration to 20$\mu gm/m^3$.

3. Acute Respiratory Infection

A qualitative study conducted in July to November 2002 on pneumonia perception and management in two VDC of lalitpur district: Dhapakhel and Bungamatil reported ARI was one of the most prevalent and common disease in rural Nepal (Shrestha, 2003).

Pandey et. al., 1989 conducted a study on domestic smoke pollution and acute respiratory infections among children below two years of age in two contiguous village panchayat, Talku Dundechaur and chhaimale, and the adjacent villages of Dakshinkali and Phakel. They indentified the episode of ARI in relation to the Indoor smoke exposure hours. Episode was classified on the basis of severity. During February to July 1984(Six months), 233 children below 2 years were observed for ARI episode, on the same population (247) similar study was conducted during November 1984 to January 1985 (three months). Episodes of ARI per child increased with the increased level of smoke exposure, life threatening severe ARI episode increased from 0.03 to 0.56 per child when exposure level increased from 0-0.9 hour category to 4+ hours category respectively. Their findings showed consistently positive association between domestic smoke pollution and ARI, especially life-threaten moderate and severe grades, suggesting that domestic smoke pollution is an important risk factor in ARI.

4. Peak flow Rate (Lung Function)

(Pandey et. al., 1985) conducted an epidemiological study on effect of domestic air pollution and respiratory function to 150 randomly selected females, aged 30 - 44 years, in a rural area situated in the two contiguous villages' sundarijal and Bhadrabas of Kathmandu. Study showed a fall of all mean force vital Capacity (FVC), Forced Expiratory Volume (FEV1), and Forced mid Expiratory Flow rate (FMEF 25-75) with increase indoor smoke exposure hours. This finding was found to be statistically significant amongst the smokers but not amongst the non-smokes.

Spirometrical study conducted among Patients with chronic lung diseases have been reported by (Anderson, 1979) in communities heavily exposed to indoor biomass smoke pollution in New Guinea. Adults aged over 45 years had a high prevalence of respiratory symptoms and disease, similar in men and in women, and 20% of men and 10% of women had an FEV1/FVC (forced expiratory volume in one second / forced vital capacity) below 60% of normal faculty of both men and women.

5. Ethno-biology

Panta et. al., 2004, documented the Indigenous knowledge on the use of medicinal plants by different ethnic community of Bhagawati VDC (adjoining VDC of Malikarjun VDC) of Darchula District. Study reported that 78 plant species were used by locals for the remedy of 39 different types of human disorder. Out of 74 medicinal plants, 12 were used in healing respiration related disorder.

Study on the indigenous knowledge of medicinal plants in Gwallek VDC of Baitadi District reported locals to cure 70 different diseases used 101 medicinal plant species. Study revealed that locals used different plant species and their part in respiration and related ailment (Devkota et. al., 2003).

Panta et. al., conducted documentation based research on wild edible plants found on the Lekam region (covers 17 VDC including Malikarjun) of Darchula Districts. They have documented all together 83 wild edible plant species belonging to 45 families. The study also revealed the indigenous knowledge systems of locals about their local resources for multipurpose utilization.

Kala, 2005 conducted study on Tibetan medical system and the ingredients used in preparing various ethno-medicines to cure several ailments by amchis inhabiting Ladakha and Lahaul-Spiti region of Indian Trans-Himalaya. Study documented 337 plant species, 38 species of animals and 6 minerals.

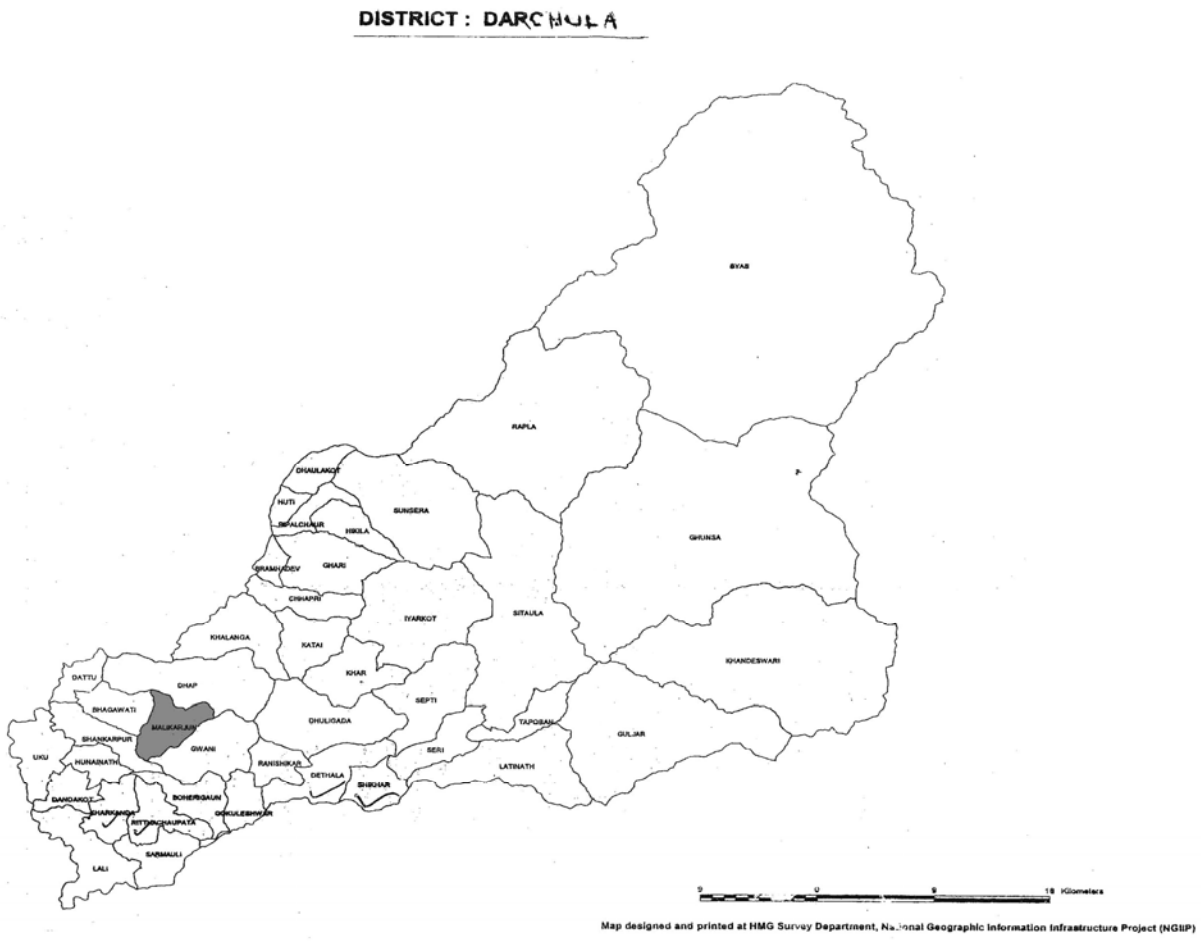
CHAPTER 3
STUDY DESIGN AND METHODOLOGY

1. Study Area

The study was conducted in Malikarjun VDC of Darchula District in Far-Western Development region of Nepal. Darchula is a remote hilly district of Mahakali zone, which lies from 29^{o} 26' – 30^{o}15' N latitude and 80^{o} 22' – 81^{o} 9' E longitude with altitudinal variation ranging from 357m – 7132m covering 2322 sq. km area. The average annual rainfall is 1885.5 mm and average minimum and maximum temperature is 5.7 0C and 37.5 0C respectively (Pant, S. R. et al., 2005).

The study population was poor, rural and ethnically homogenous with more than 90% households were from Dhami (Chhetri) community. The study area is free from Industrial and atmospheric pollution. The houses in village represent typical mountain settlement and made of entirely with stone. The population lives scattered in small settlements, mainly depending on non-monetary economy through subsistence farming. Illiteracy is common, especially among women, and many of them could not speak the official national language, Nepali.

Map 1: Darchula District and Study Area



2. Sampling Method

Sample size

The sample selection was made after thorough review of available population and household statistics of Malikarjun VDC. Population data of census, 2001 and population survey conducted by the sub-health post Malikarjun were considered for the sample size determination. Two levels of samples, household and respondent, were determined for the primary data collection.

Household sample size

There were 422 households and 2249 population in Malikarjun VDC (Census, 2001).Sample size for household was taken to be 62, which was estimated by using statistical formula at 95% confidential level. Formula with calculation is given in the annex I.

Respondent sample size

Respondent sample size for systematic examination for the detection of health effect linked to indoor air pollution was optimized to 10% (225) of the total population of the VDC (2249). This study included women, children and also men for systematic health survey because men in the study area were identified as equally vulnerable to domestic smoke pollution. Most of the married men cook at least once in day for their special notion of having sacred meal (*Rhosyo khane*). Thus, total Respondent sample size was split in three sub-groups, Women, Men and Children with sample size 107, 47 and 71 respectively. Sample size with their selection criteria is given in annex 1.

3. Sampling frame and sampling process

Selection of study household

Two stages of sampling were adopted for selection of household. All nine wards were selected purposively during first stage of selection. From each selected wards, household was selected randomly at second stage. The selection of household was devised with probability proportionate to sample size (PPS) for all wards. The sampling protocol for selecting 62 households was carried out by lottery method in each ward. Population survey conducted by sub-health post, 2006 was taken for lottery formation. To select household from a ward, lottery was formed with household head name and drawn randomly for available number of household in that ward. Similar, lottery was carried out for all nine wards. The sampling scheme and sample size for all nine wards are given in annex 1.

Selection of Respondent for systematic health survey

Out of total sample size (225) of respondent, total adult sample respondents (154) including both men and women were selected from the sample household (62) for health survey on the basis of purposeful sampling approach. Purposeful sampling is a process of choosing samples based on their relevance to the research questions (Hammersley, 1995). There was lack of adequate number of children in selected sample household for fulfilling total sample size of children (71). So, children below two years of age were randomly selected from the all Households within the VDC. There were

151 children below two years of age (population survey sub-health post, Malikarjun). To select 71 children, lottery was carried out in total population of children below two years (151) with in VDC. Children's name was taken as snowball for lottery formation.

Criteria for selection of respondent for systematic health survey

- Kitchen dwelling women having age "between" 15 to 60.
- Man who cooked at least once a day.

Selection of children for identification of ARI episode

- Children below two years of age.

Following respondents were excluded from the survey.

- That, whose residing period in that village was less than six month.
- That, who were not enroll in cooking.

4. Materials and Methods

Data collection

For the collection of data two set of standard questionnaires were employed. Besides, direct observation and measurement; Informal discussion and key Informants were also considered as key research instrument for indentifying traditional aptitude of locals regarding Respiratory disorder healing.

Development of questionnaires

An inventory of national and regional level survey was first prepared to understand the nature of information relevant to indoor air pollution. Various population level questionnaires such as Census, 2001 and other field questionnaires used by various researchers in indoor air pollution research were thoroughly reviewed. Shrestha (2004) used larger inventory of variables as that are likely to affect air pollution levels such as kitchen type and household ventilation. Balkrishnan et al., 2004 consider wide range of variables that are associated with household fuel use and indoor air pollution. Due consideration was given while selecting appropriate variables while designing questionnaire. First set of questionnaires aimed for collecting primary data on household level exposure determinants while, second dealt with health survey. Based on review, primary data collection for household characteristics was undertaken for two categories of information.

- Information from households that parallels the information already collected by demographic survey, including the census, 2001, sub-health post survey. Besides, it also included the information related to individual habits; such as smoking, cooking etc.

- Information on household characteristics which may be predictive of indoor air pollution (such as kitchen type, household ventilation, Presence/Absence of chimney, no. of windows/doorways, stove types)

Similarly, for Systematic health survey to individual level a standard British Medical Research Council questionnaire with few modifications was used (shrestha, 2004). Health survey was carried out with direct measurement of health parameters like Blood Pressure, Peak Flow Rate, Pulse Rate, Respiration Rate etc. Other health Aspects data were collected through face-to-face interview with the Respondent. The research lacked the clinical investigation (clinical test for diseases). Prevalence of diseases was identified by the hospital Records of Respondents. Those, who did not have their hospital records but identified as prone respiratory ill health were categorized as the susceptible respiratory ill health. To avoid data entry errors and facilitate data validation all possible answers in each questions was pre-coded, and open ended questions were minimized. In addition, a thorough pre-testing was conducted to check the validation of survey questionnaires in Phakhel VDC of Makawanpur District (21 households).
The complete household and systematic health survey questionnaires are given in the annex (5)

5. Measurement of Respiratory Functions by Peak Flow Meter

A peak flow meter is a portable, inexpensive, hand-held device used to measure how air flows (Expiratory rate) from lungs in one "fast blast". The one, which we used, had following labeling:

Model: D 517 B PM2 Range: (60-900) L/min

Manufacture: Cipla Ltd., Mumbai 400 008

Operating Procedure

The washed and dried mouthpiece was inserted into the Peak Flow Master and pointer or arrow was set at the bottom of the numbered scale (the lowest number on the scale was 60 Lit/Min).The respondent was then asked to hold it without squeezing with chin up position. Deep breath was taken (as deep as respondent can). Mouthpiece of the peak flow meter was then inserted into mouth. The lips of the respondent was sealed around the mouthpiece, in one breath air was blown out as hard and as quickly as possible. It was blown a "fast hard blast" rather than "slowly blowing" until the respondent emptied out nearly all of the air from his/her lungs. The maximum value at which the pointer stopped was recorded and the same process was repeated three times. The highest of three readings was recorded as the peak respiratory flow rate of respondents in liter per minute.

Precautions while handling Peak Flow Meter

Peak Flow Meter was well sterilized by 70 % Isopropyl alcohol after reading of each respondent.

6. Informal Discussion

It is often possible to collect valuable information from informal discussions with local people like farmer, youths, elder persons as well as knowledgeable people of the community (Dhoubhadel, 2003). This method was used in order to obtain the detail information about the plants and animals used in traditional medicine and indigenous knowledge system and techniques on the utilization of plants and animals of medicinal values for curing respiratory illness. Informal discussion with Local healers (Vaidya), elder people and other community people was carried out to know their traditional practice system to heal respiratory disorders.

7. Episode Identification of Acute Respiratory Infection in children below two years of age

The eligible population for this study comprised everyone less than two years of age who was permanently residing in the area. Seventy-one children below two years of age were selected for Acute Respiratory Infection (ARI) study. The study was carried out during three months (March 14 - June 14, 2008). ARI information was recorded based on its severity classified by government of Nepal (IMCD, 2007)

ARI Classification based on severity

No pneumonia (Episode I): Cough or cold, no-chest indrawing and no fast breathing (less than 50 per minute if child 2 to 12months, less than 40 per minute if child is 12 months or greater)

Pneumonia (Episode II): Cough with chest pain, shortness of breath, no chest indrawing, fast breathing (50 per minute or more if child is 2 months to 12 months; 40 per minutes or more if child is 12 months or greater).

Severe pneumonia and Very severe pneumonia (Episode III/IV): Chest indrawing or shortness of breath. Not able to drink, convulsions, abnormally sleepy or difficult to wake stridor in calm child or sever malnutrition.

In order to record different episodes of ARI the following working definition was adopted: If a child suffering from ARI of any grade was reported to be completely free from signs and symptoms of ARI for at least 48 hours and contracted ARI again, then it was considered a new episode of ARI (Miller; Bridges-Webb, 1984; Pandey et al, 1989). All selected children below two years were visited every two weeks by trained community health worker. Exposure to domestic smoke was assessed by asking the mothers about the average amount of time per day spent near the fireplace by infants and children under two years of age. In older children, aged 2 to 4 years, estimates of exposure to smoke could not be made because the children were too mobile. For this reason, no attempt was made to collect data on smoke exposure in this age group (Pandey, et al., 1989)

8. Statistical Design

Study Variable

The data obtained from demography and household health survey was analyzed by using different statistical tools as per the relevancy. The variables used for the analysis was health problems including cough, chest pain, Eye problem, ENT problem, Wheezing, Phlegm and Breathlessness. Further, the variables like COPD, Asthma and Bronchitis were also examined. These health characteristics were examined relative to age, sex, No. of smokers in the house, Ethnicity, Kitchen Characteristics (Kitchen Height, Door and window size and numbers, Type of ventilation etc.). The exposure duration of the patient was taken into account for the analysis of above mentioned health characteristics. Further, the health parameters like systolic pressure, Diastolic pressure, Pulse rate, Respiratory rate, Peak flow meter reading were taken account as the health variables, that were analyzed as per the different demographic parameters (age, sex, height, weight, education etc.) and habits (smoking habit and exposure duration).

9. Statistical Settings

The statistical analysis was carried by using computer software, SPSS-13 (Statistical Package for Social Sciences, Version 13). The use of software is highly relevant in computing the following statistics:

1. Analysis of Variance (ANOVA) to find out the prevalence of disease with exposure duration, kitchen location, ethnicity, kitchen characteristics, Type of fuel used etc.

2. Correlation of disease prevalence with, no. of smokers in the house, Amount of Fuel-wood used, Amount of Ghee/Oil used, No. of Stoves used, Stove Height, Kitchen Area, Kitchen Height, Door Size, window size, No. of window, etc.

10. Reliability and validity of Research

Reliability is the measure of the extent to which random variation may have influenced stability and consistency of the result (Morse et al., 1995; Shrestha, 2003). To check the reliability of research instrument, it was pre-tested (21 households) in the phakhel VDC of the Makawanpur district where prevailing condition was similar to study site. It was used to correct any inconsistencies in the survey instrument before conducting the actual survey. To check any inconsistency in interviewed questionnaire by research assistance and researcher, there was provision of comparing the interviewed instrument for improving reliability. After each interview, the data obtained were verified with the participants to ensure validity. This research comprises data collection through different methods like face-to-face interview, direct measurement, observation and minor health examination for the validating research findings. In survey research, the investigator cannot get information from all prefix number of sample unit because of so many reasons incumbent upon dealing with human being (Dhoubhadel, 2003). Biasness posed by the non-response was tried to minimize through different

research norms. Each selected households were pre-informed through social mediators. Besides that, minor health examination (under supervision of medical supervisor) with supply of some minor medicines was provided as a motivational factor.

Similarly, other non-random errors mingle with direct observation and measurement: like measuring household characteristics (window size, door size, kitchen size etc.) was lessened by using standard calibrated measuring tape. Furthermore, to identify correct information from each selected household, questionnaire was inquired to household head rather than junior members. Some of these data were collated with hospital data to verify especially regarding to age of individual. The health parameters (BP, pulse rate, Peak flow rate, respiratory rate etc.) of individual respondent were measured by the health supervisor of the research project using standard medical equipment.

In addition, to maintain the research sample size of children (71) throughout three months period, each mother of selected child was well-briefed and convinced about three months periodical observation. Moreover, household belonging to selected child were asked if they were heading anywhere (with selected child) in between research period. Meanwhile, periodic data observation was carried out by the well-trained community Health Worker (CHW), which was fortified by the frequent inspection and spot visit by the Health supervisor and myself (PI).

11. Ethical Aspect

While conducting the research, due respect and consideration was given on norms, dignity and protocols of the study community. First, the participants were briefed on the objectives, procedure and importance of the research before asking their verbal consent (written consent was not feasible as most of them were illiterate). Prior to conduct any research instrument, participants were informed that participation in survey was voluntary, they can choose not to answer any question and if they decide not to participate, they were free to refuse participation. All information gathered from the responded has been kept strictly confidential and was not shown to other persons. The research project did not impose any harm to study community as methodology chosen was entirely approached on survey through minor health check up, and questionnaire interview. The research project is accordance with ethical guideline prescribed by Nepal Health Research Council (2002)

CHAPTER 4
RESULTS AND DISCUSSION

1. Demography

1.1 Family Structure

The population size of the sampled households (62) was found to be 495. Following table shows that the VDC is composed of more adult population than any other group, showing highly increasing population. In average, one family had one male smoker, while two families had one female smoker, as shown by following table.

Table1: Family Structure of VDC

Households		Av. Family Size (Per HH)	Av. No. of children <5yrs	Av. No. of Children 5-15 yrs	Av. No. of Adult 16-60 yrs	Av. No. of Old >60 yrs	Sex Ratio (M:F)	No. of Male Smokers	No. of Female Smokers
Total (N=62)		7.98	1.32	1.82	4.32	0.52	1.05	1.00	0.56
As per Ethnicity	Chettris (N=56)	7.86	1.30	1.79	4.23	0.54	1.08	0.96	0.59
	Dalits (N=6)	9.17	1.50	2.17	5.17	0.33	0.77	1.33	0.33
As per Ward	1 (N=8)	8.00	0.88	2.00	4.50	0.63	0.94	0.88	0.75
	2 (N=7)	5.57	1.00	1.71	2.43	0.43	1.17	0.71	0.43
	3 (N=5)	9.20	2.00	1.80	4.60	0.80	1.19	2.00	0.80
	4 (N=6)	8.33	2.33	1.67	3.67	0.67	0.72	0.33	0.33
	5 (N=3)	5.33	1.33	1.00	3.00	0.00	2.20	1.00	0.33
	6 (N=7)	7.57	1.00	2.29	4.00	0.29	1.30	0.86	1.14
	7 (N=8)	8.75	1.00	2.88	4.25	0.63	1.05	1.13	0.88
	8 (N=8)	8.70	1.25	1.13	5.88	0.50	0.89	1.00	0.38
	9 (N=10)	7.98	1.50	1.50	5.20	0.50	1.07	1.20	0.10

Note: In parentheses (N= No. of Households)

1.2 Household and Kitchen Characteristics

The table below shows that the majority of households have their roof made up of Stone/Slate (98.4%), while their wall is made up of Stone/Mud (95.2%). Their house is made up of to lessen the severity of cold in winter season. Concrete, walls and roofs, the sign of affluence was less common (Table 3).

Further, it was found that majority of the Households had kitchen located in the upper stories (62.9%) while only 4.8% of households cooked their food outside. Of them, 41 Households (66.1%) had the separate Kitchen, while 19.4% of the families had partitioned kitchen and 9.7% had the kitchen without partition. The kitchens of only 6.5% of households were facilitated with ventilation window, while 75.8% of the sampled households had no ventilation in their kitchen. Six households of the Dalits had *Aaron* where they used to mould the iron in the fire to make utensils used in agriculture and household.

Table2: Over-view of household and kitchen characteristics of the sampled households

Housing Characteristics	Frequency	Percent
Roof material		
Stone/slate	61	98.4
Lenter (RCC)	1	1.6
Wall Material		
Stone/Mud	59	95.2
Stone/Cemented	3	4.8
Upstairs Floor Material		
Wood Plank/Mud	60	96.8
Slate/Mud	2	3.2
Downstairs Floor Material		
Mud/Dirt	61	98.4
Cemented	1	1.6
Kitchen Location		
Upstairs	39	62.9
Downstairs outside	3	4.8
Downstairs inside	20	32.3
Kitchen Characteristics		
Separate	41	66.1
Partition	12	19.4
Without Partition	6	9.7
Open Air Kitchen	3	4.8
Type of Ventilation		
No Ventilation	47	75.8
Wall roof gap	5	8.1
Hole in Roof	6	9.7
ventilation window	4	6.5
Aaron		
Present	6	9.7
Absent	56	90.3

1.3 Stove and Fuel Characteristics

It was found that only 1 of the 62 sampled households had three stone stoves, while others (98.4%) had simple firewood cooking stove (Three stone plastered with mud). No households were found to be facilitated with Improved Cooking Stoves (ICS). Further, all the households were found to be using fuel wood as their energy source for cooking. As electricity was yet to reach in the VDC, the villagers were found to light up their house by using solar, kerosene and pine. 50% of the households were found to be using both kerosene and solar as their lighting source, while 24.2% of the households only used solar for the lighting purpose. Pine was also found to be used in 8.1% of the households.

Table 3: Overview of the Stove Type and Fuel Types

Characteristics	Frequency	Percent
Stove Type		
Simple Chulo	61	98.4
Three stone	1	1.6
Fuel for Cooking		
Fuel wood	62	100.0
Fuel for Lighting		
Kerosene	9	14.5
Pine	5	8.1
Solar	15	24.2
Kerosene+Pine	1	1.6
Kerosene+Solar	31	50.0
Pine+Solar	1	1.6

Table4: Kitchen Characteristics as per the Ethnic Group

Ward	Ethnic Group	Stove No.	Average stove height (cm)	Average Kitchen Area (m^2)	Average Door Size (m^2)	Average Window Size (m^2)
1	Chettri	2.00	16.69	9.80	0.72	0.23
2	Chettri	2.00	14.86	10.45	0.67	0.21
3	Chettri	2.00	13.63	8.39	0.24	0.28
	Dalits	2.00	10.00	5.72	0.00	0.00
4	Chettri	2.00	17.08	12.52	0.91	0.34
5	Chettri	2.00	11.67	5.58	0.52	0.44
6	Chettri	2.00	17.57	11.82	0.82	0.20
7	Chettri	2.00	15.13	6.08	0.60	0.16
8	Chettri	2.00	17.60	8.82	0.93	0.05
	Dalits	2.00	15.67	4.43	1.19	0.41
9	Chettri	2.00	17.50	10.40	0.89	0.17
	Dalits	2.00	14.25	16.47	0.81	0.33
Total	**Chettri**	**2.00**	**16.10**	**9.56**	**0.73**	**0.22**
	Dalits	**2.00**	**14.25**	**8.66**	**0.87**	**0.31**
	Total	**2.00**	**15.92**	**9.48**	**0.74**	**0.23**

Following figures 1 to 7 revealed the situation of households in Dalits and Chettris households separately. The size of house (stories) in case of Dalits was found to be larger for the reason they had joint family and the family size was comparatively bigger to chettris (Table 1). It was found that both ethnic groups were found to be using the low quality of energy while their households were also same type in almost all cases. However, some Chettris households were characterized by the use of cleaner fuels and also their kitchen was conditioned with proper ventilation system. This shows the affluence of Chettris over Dalits.

Fig1: Mean no. of Stories

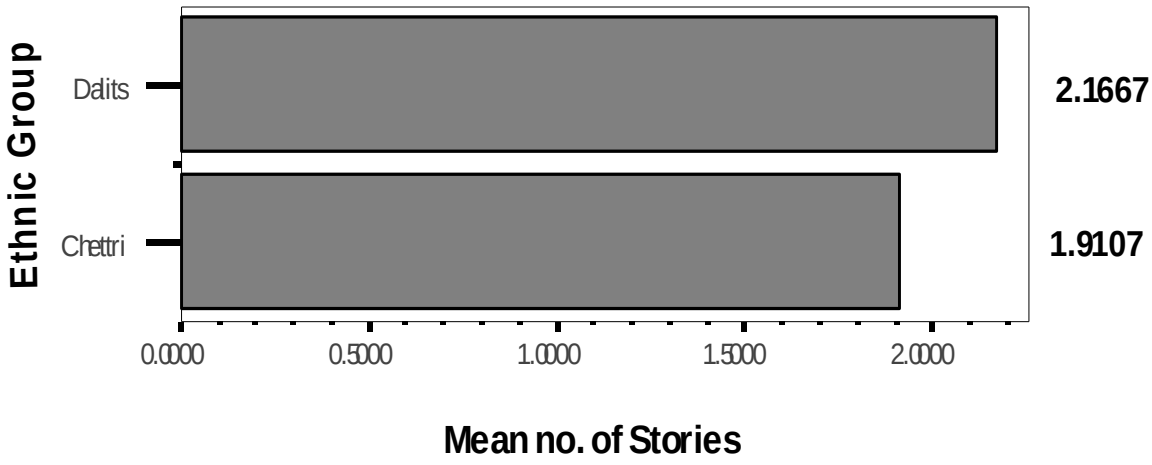


Fig 2: Roof and Wall Material as per the Ethnic Group

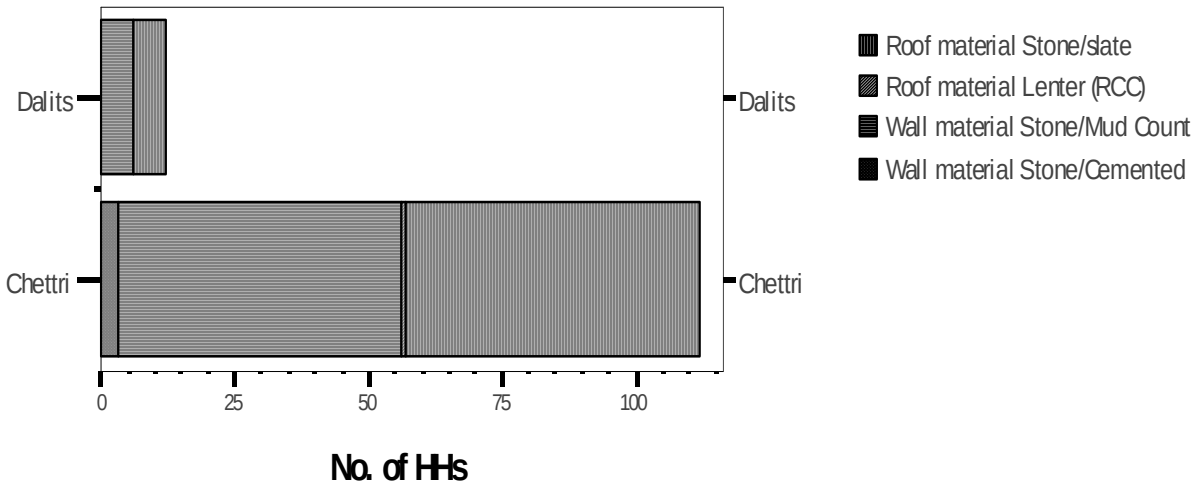


Fig 3: Floor material as per the Ethnic Group

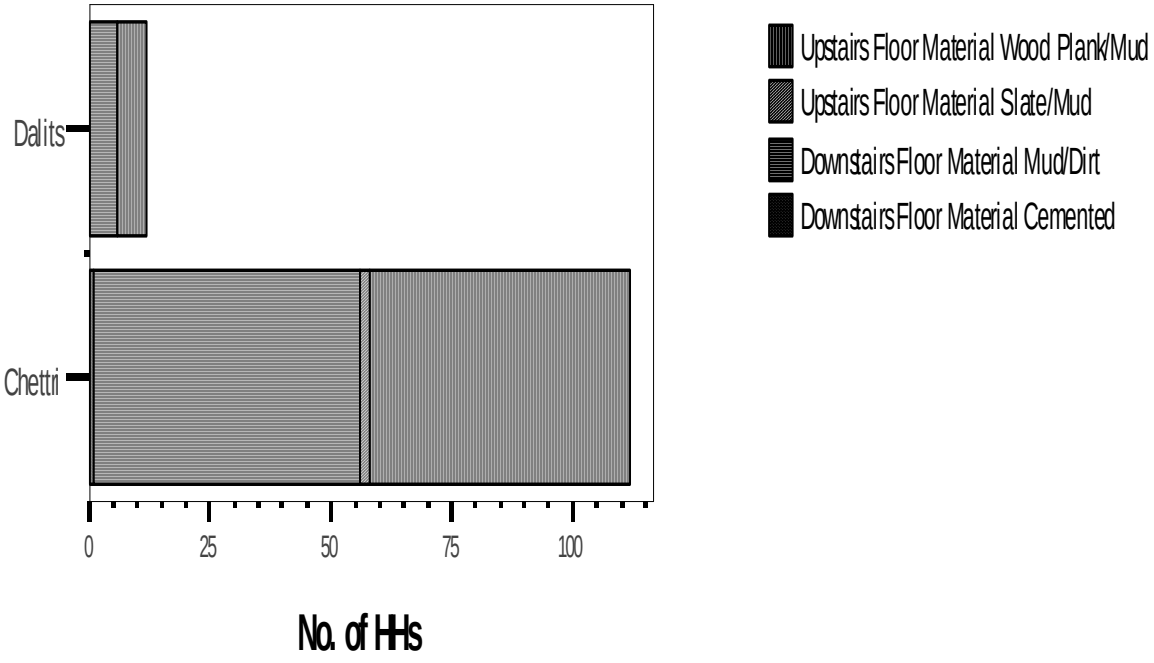


Fig 4: Kitchen Location and Stove Type as per the Ethnic Group

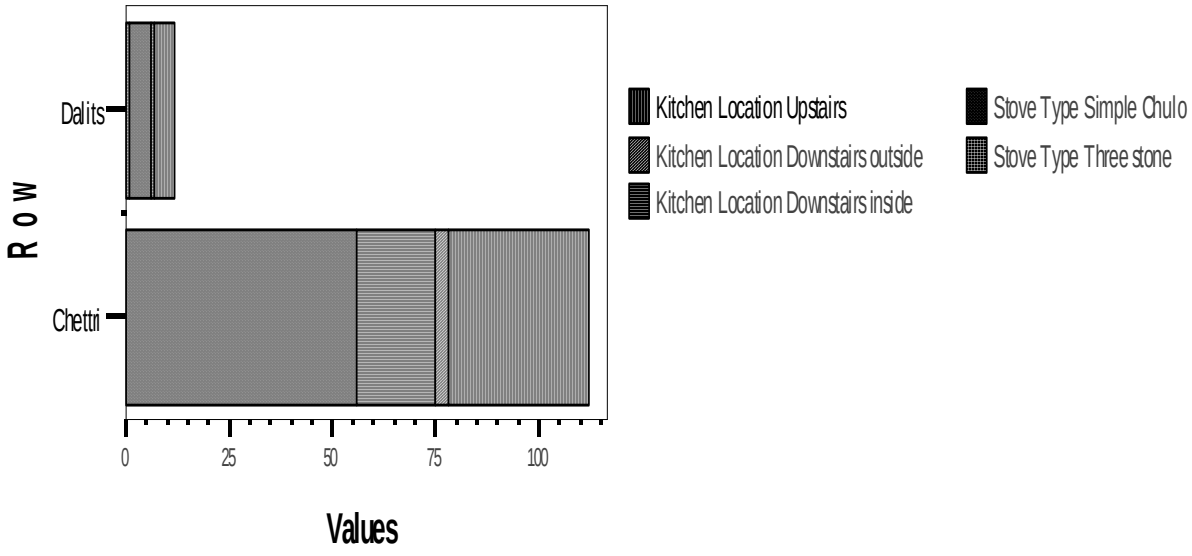


Fig 5: Fuel Type as per the Ethnic Group

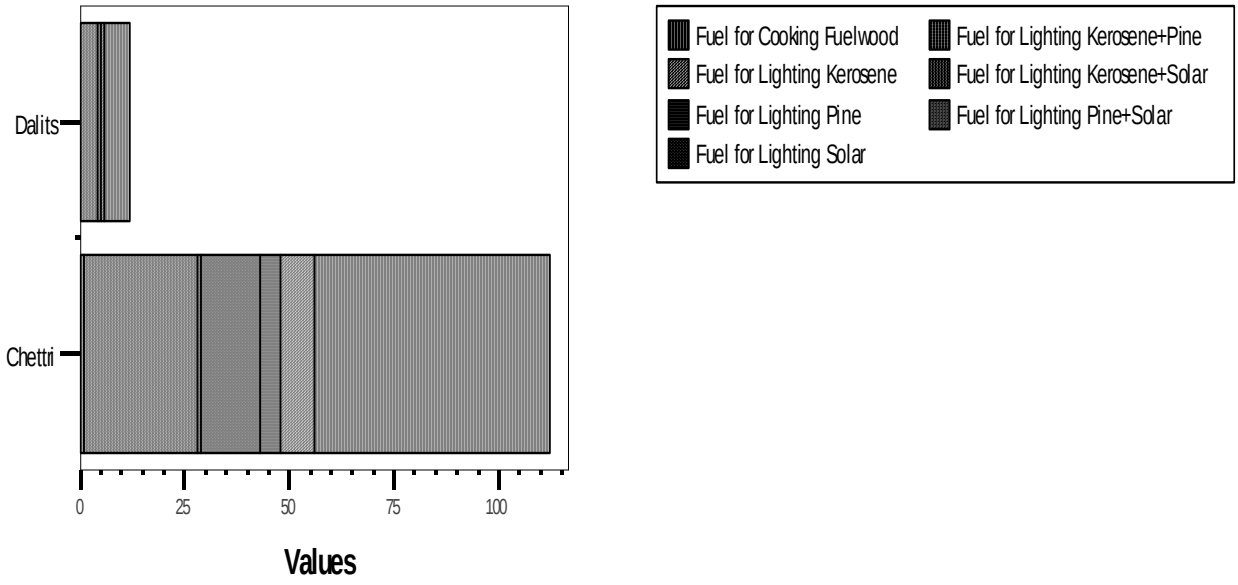


Fig 6: Kitchen Type and Ventilation System

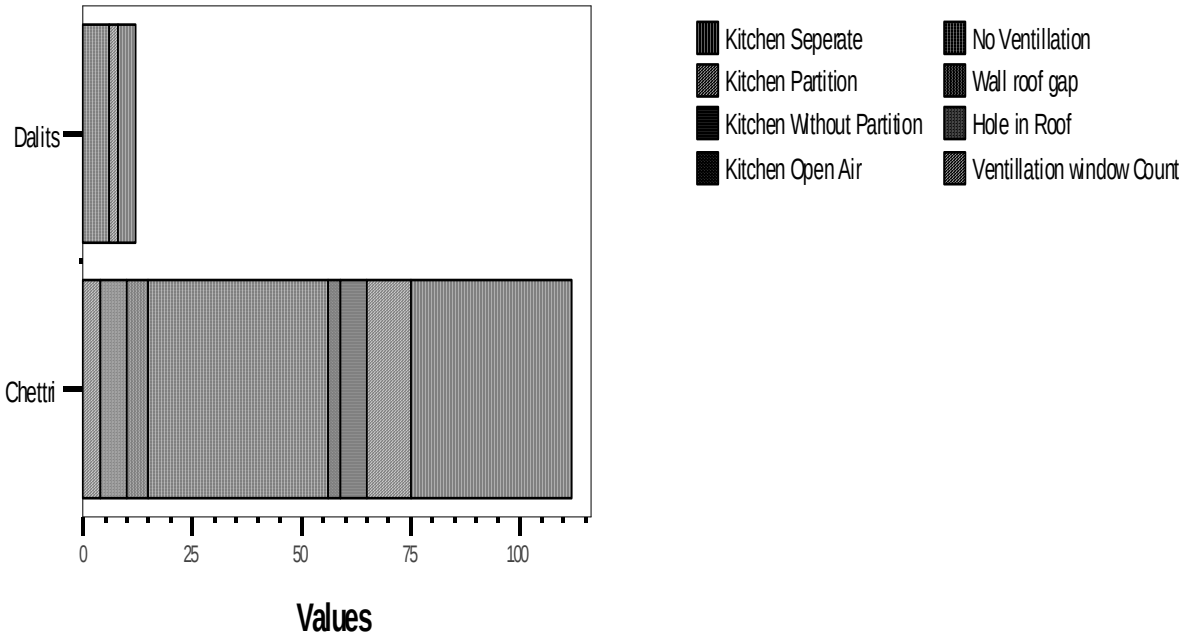
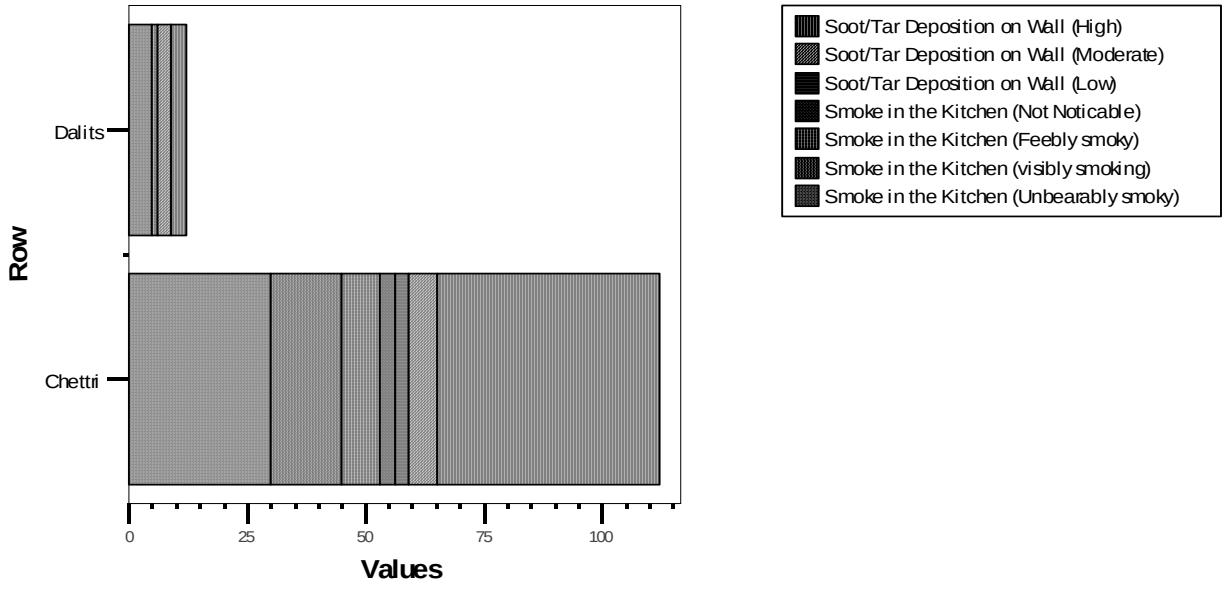


Fig 7: Smoke and Soot/Tar Deposition in the Kitchen



1.4 Amount of Fuel wood and Ghee/Oil used per month

Each of the sampled households was found to be using Fuel-wood as the energy source. The usage of the fuel wood was found to be significantly higher in case of Dalits than the Chettris ($p<0.05$), while the amount of Ghee/Oil used was found to be higher in case of Chettris' than that of Dalits, but has no significant relationship ($p>0.05$).

Table 5: Amount of Fuel wood used as per the Ethnic Group

Ethnic Group	Mean amount of Ghee/Oil usage (l/m)	Mean amount of Fuel wood usage (kg/month)
Chettri (N=56)	2.8304	451.4286
Dalits (N=6)	2.0833	533.3333
Total (N=62)	2.7581	459.3548

2. Health Characteristics

2.1 Overall Health Characteristics

The overall health characteristics (Systolic Pressure, Diastolic Pressure, Pulse Rate and respiration rate) are represented in following figures 9 to 12. Further in 122 respondents (79.2%) pulse rate was found to be 70-79 and the respiration rate was found to be 17/min in 30.7% of the respondents, with the maximum of 21/min (2.6%) and minimum of 13/min (3.3%).

Fig 8: Systolic Pressure

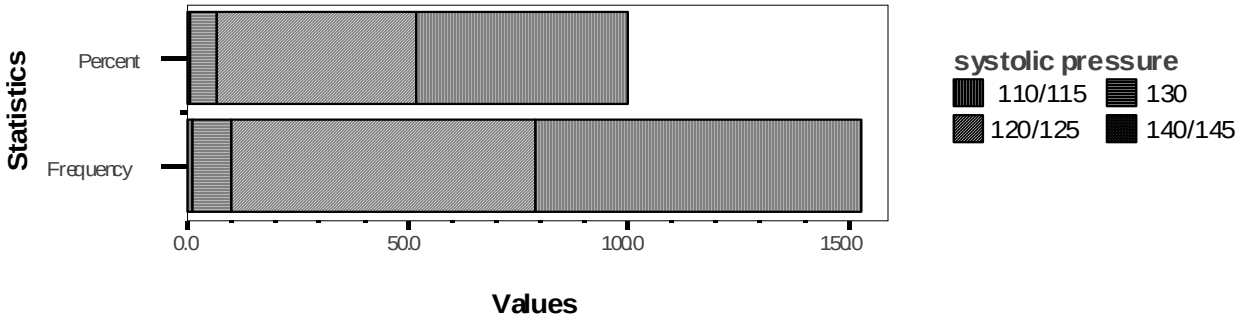


Fig 9: Diastolic Pressure

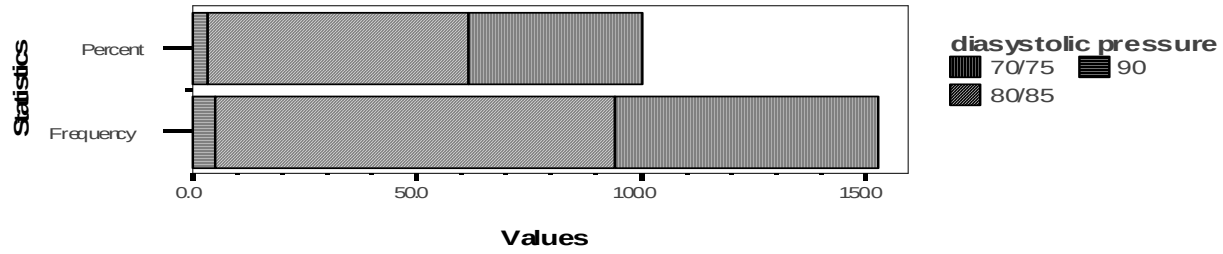


Fig 10: Pulse Rate

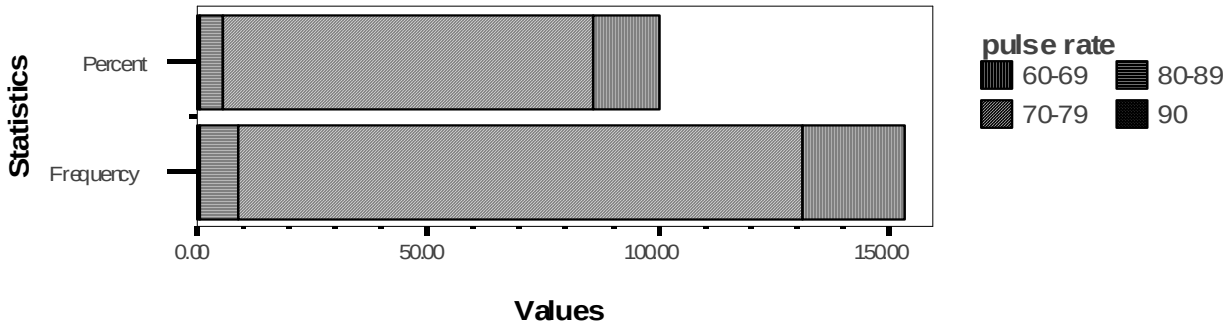
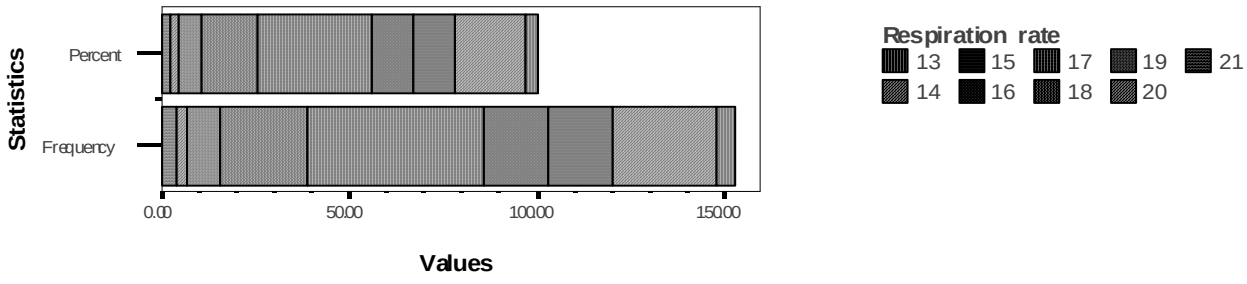


Fig 11: Respiration Rate



2.2 Health Characteristics as per Respondents' Characteristics

Following figures, 12 and 13 shows the health characteristics of the respondents' as per age, sex, weight and height. However, the results were not statistically significant, the result was normal.

Fig 12: Health Characteristics as per the sex

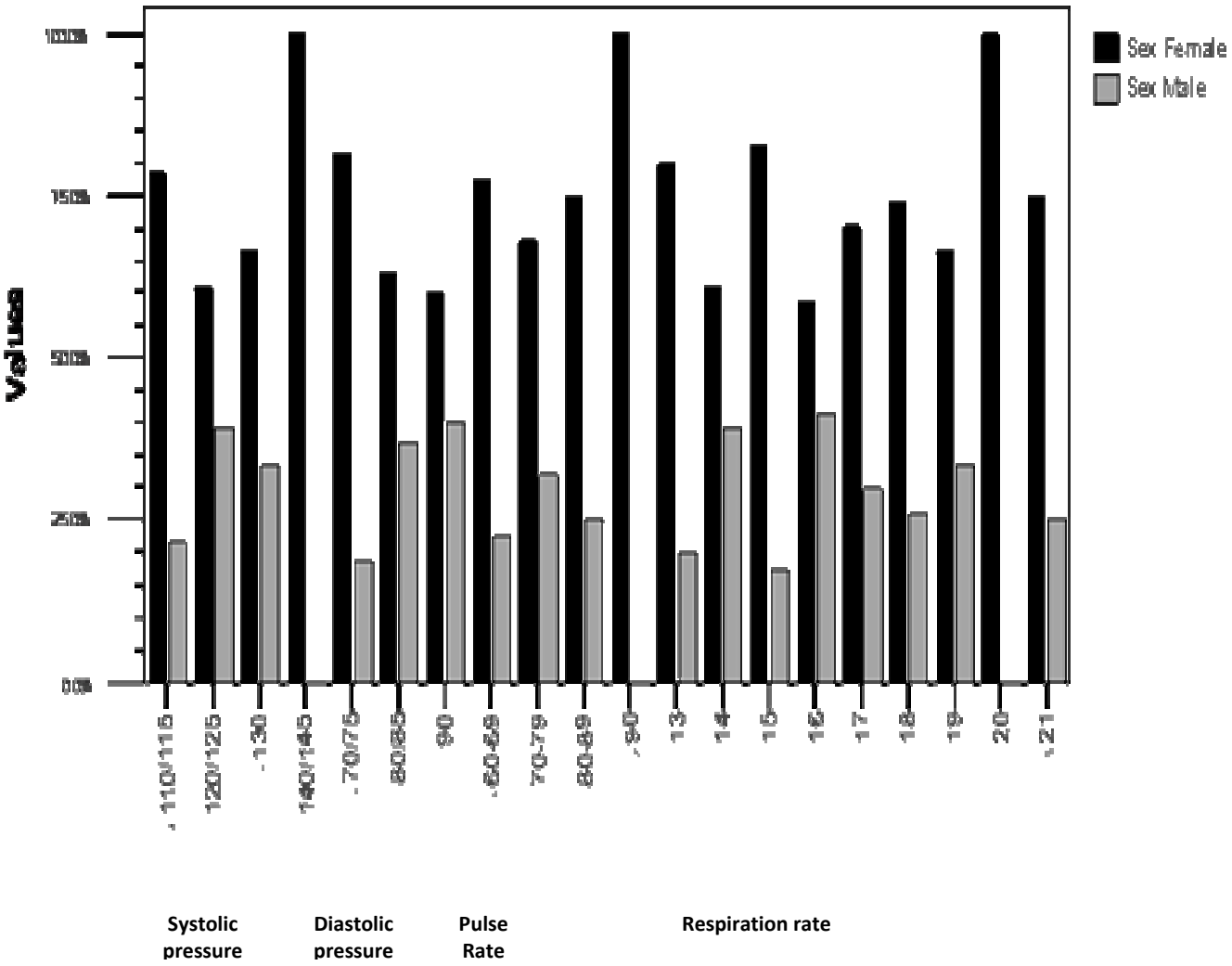


Fig 13: Health Characteristics as per the age, weight and height

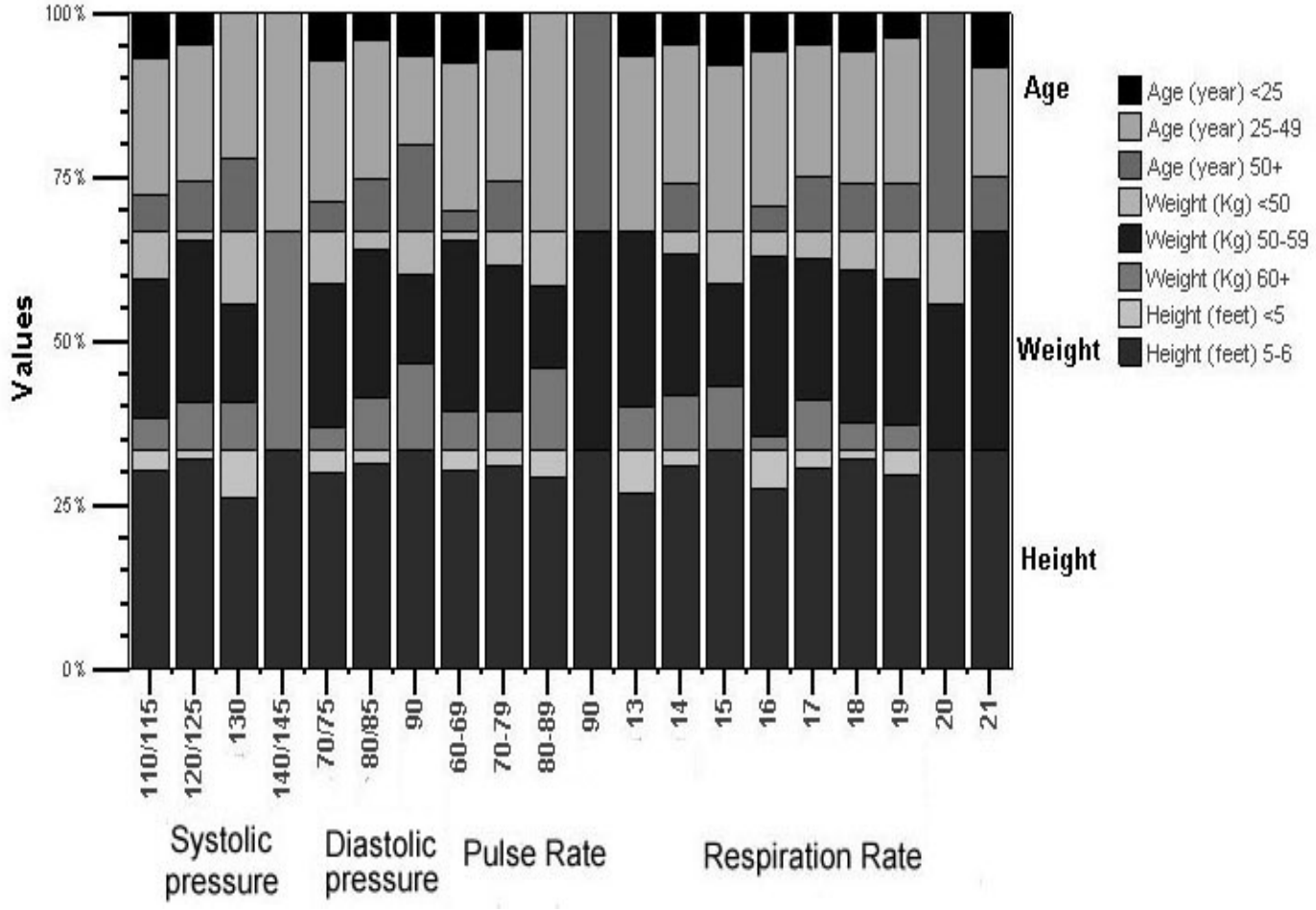


Table 6: Test of ANOVA (F-Statistics) for Age Group

Parameters	F	Significance
systolic pressure	1.698	.186
diastolic pressure	2.099	.126
pulse rate	1.302	.275
Respiration rate	2.461	.089

2.3 Health Characteristics as per the household and Kitchen Characteristics

The result obtained by analyzing the household and Kitchen characteristics with Health condition (Fig: 14 and 15) showed that the Kitchen and Household Environment don't play any significant role to increase or decrease the systolic pressure, diastolic pressure, pulse rate and respiration rate of the respondents.

Fig 14: Health Characteristics as per Indoor Environment

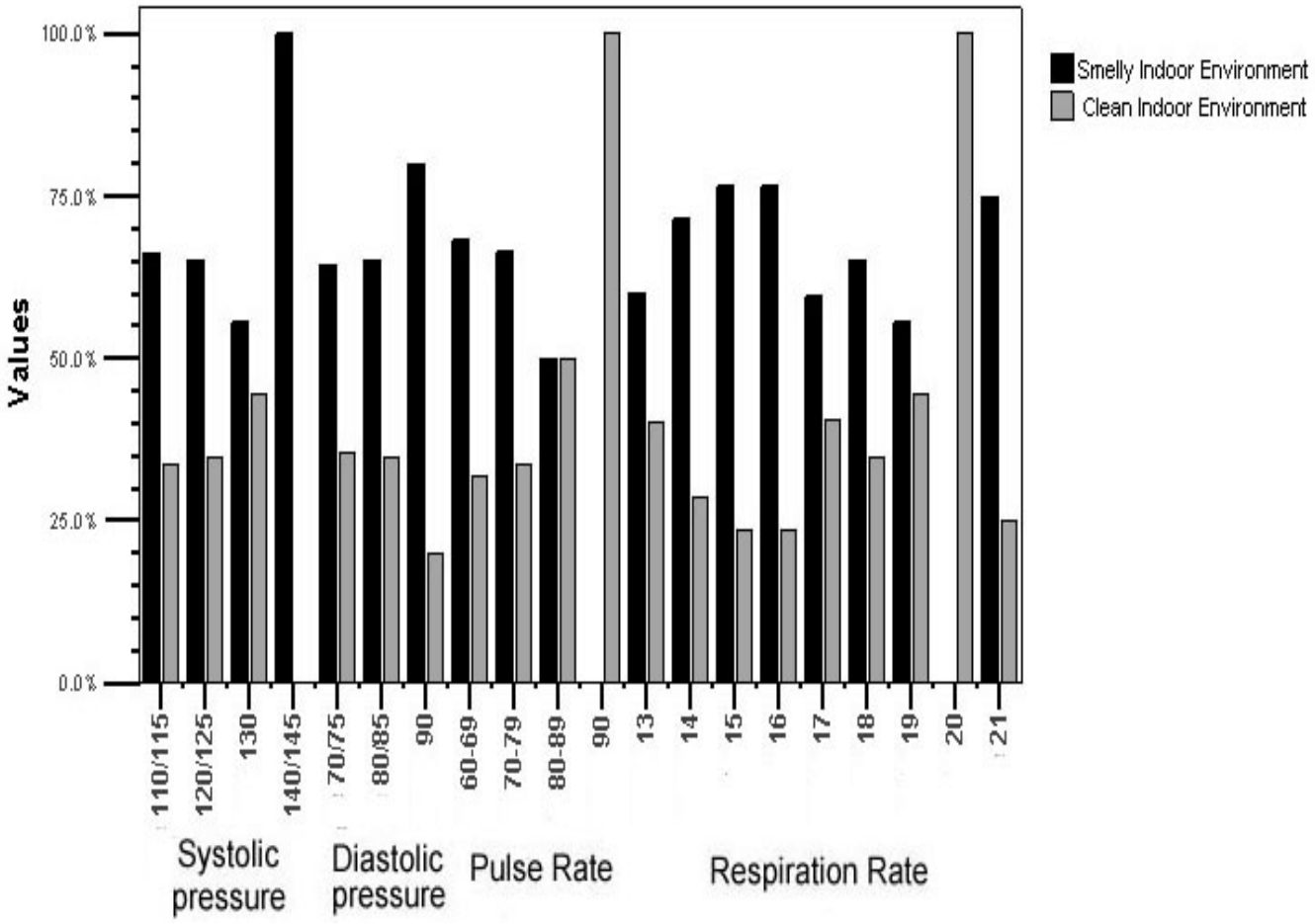


Fig 15: Health Characteristics as per the Exposure Duration

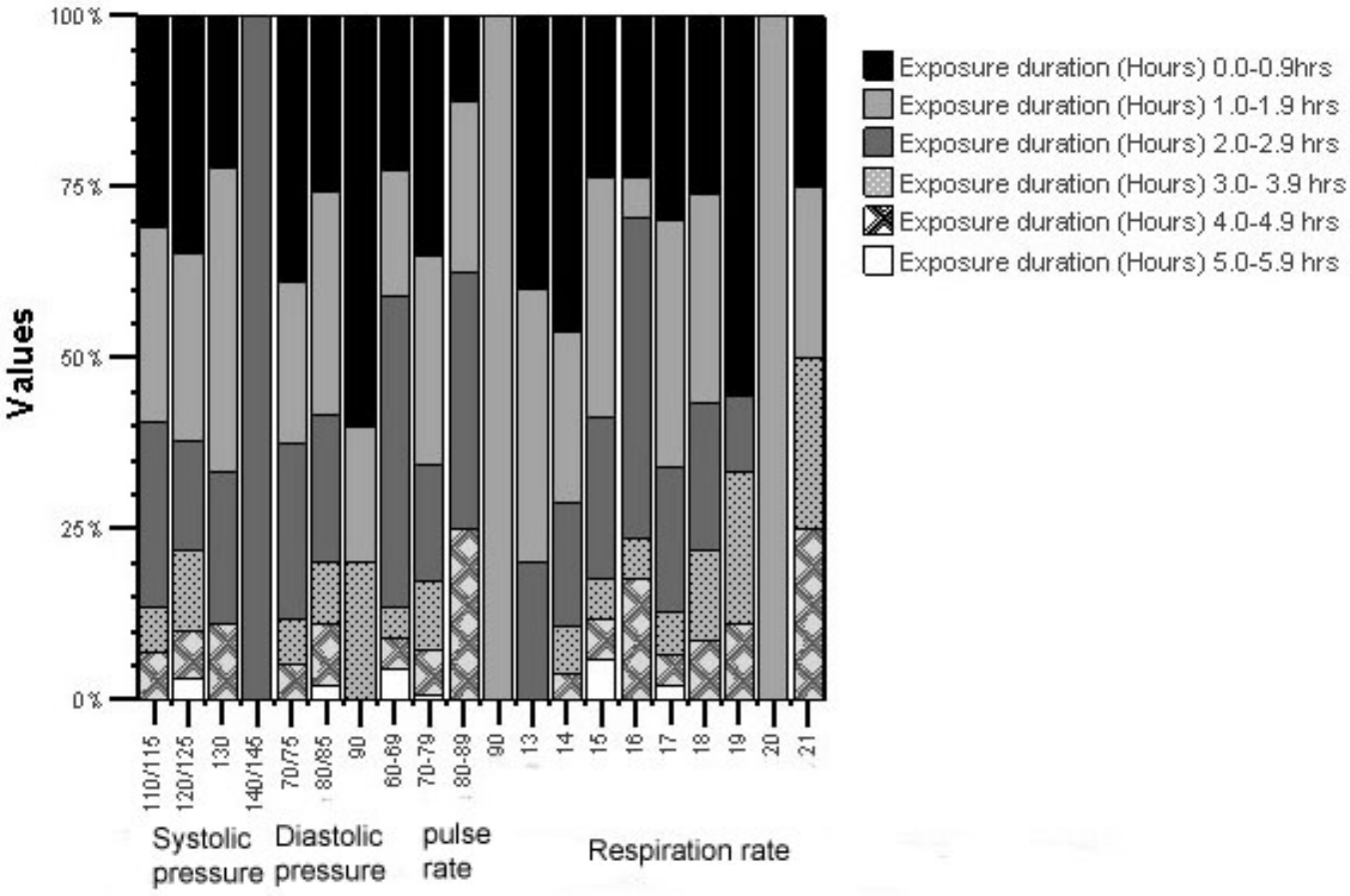


Table 7: Test of ANOVA (F-Statistics) for Exposure Level

Parameters	F	Level of Significance.
systolic pressure	0.259	0.934
diastolic pressure	0.719	0.610
pulse rate	1.392	0.231
Respiration rate	0.920	0.470

Fig 16: Health Characteristics as per Smoking Habit

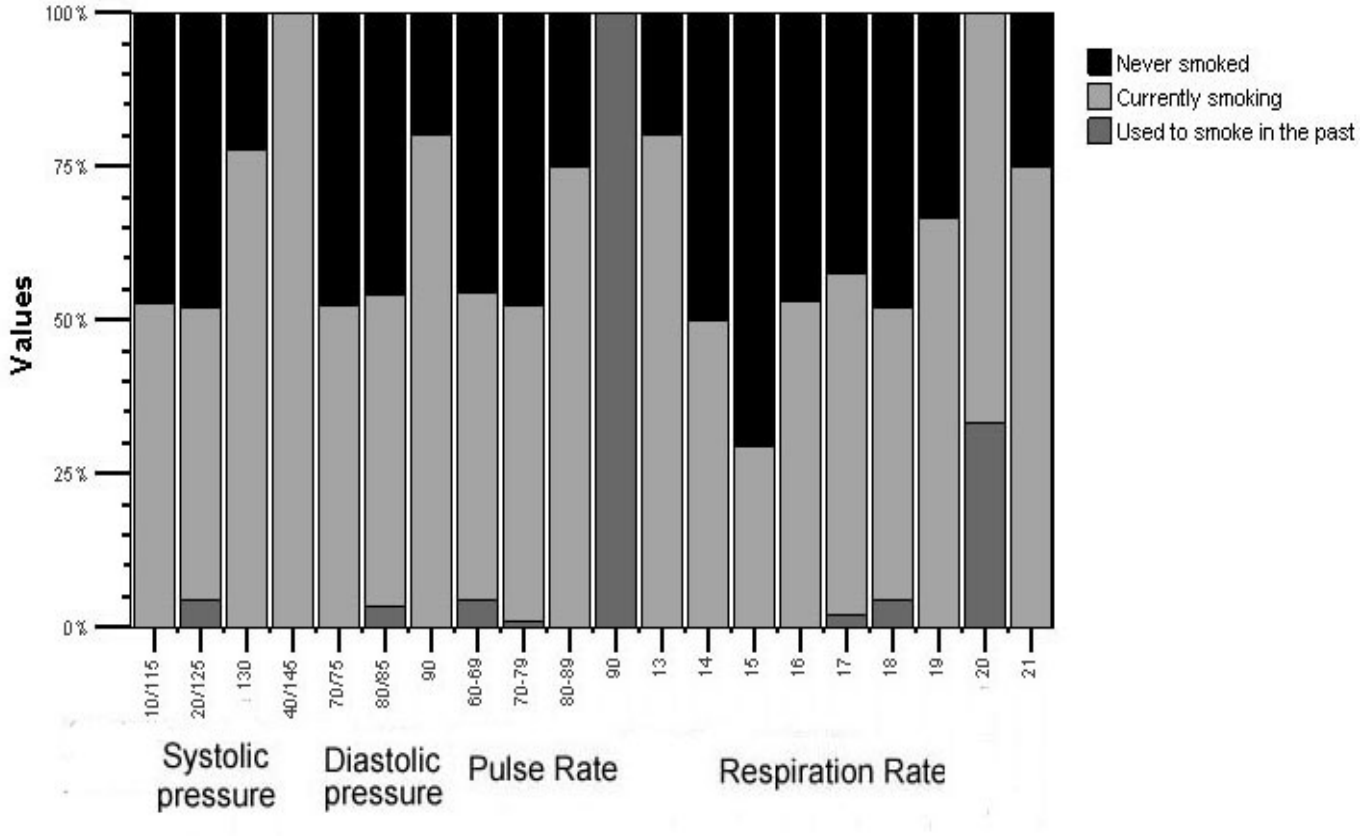


Table 8: Test of ANOVA (F-Statistics) for Smoking Habit

Parameters	F	Sig.
systolic pressure	1.079	0.343
diastolic pressure	0.789	0.456
pulse rate	1.431	0.242
Respiration rate	2.431	0.091

2.4 Disease Prevalence

The disease prevalence of sample people (153), most of whom were women (69.9%), showed that total 11 kinds of diseases and disease related symptoms prevailed in the 42 of 62 sampled households (67.74%). Cough problem was prevalent in 30.1% of the respondents, while 22.9% were suffering from ENT problem. Bronchial Asthma was also prevalent among 10 (6.5%) of respondents, while 1 was suffering from Bronchial TB.

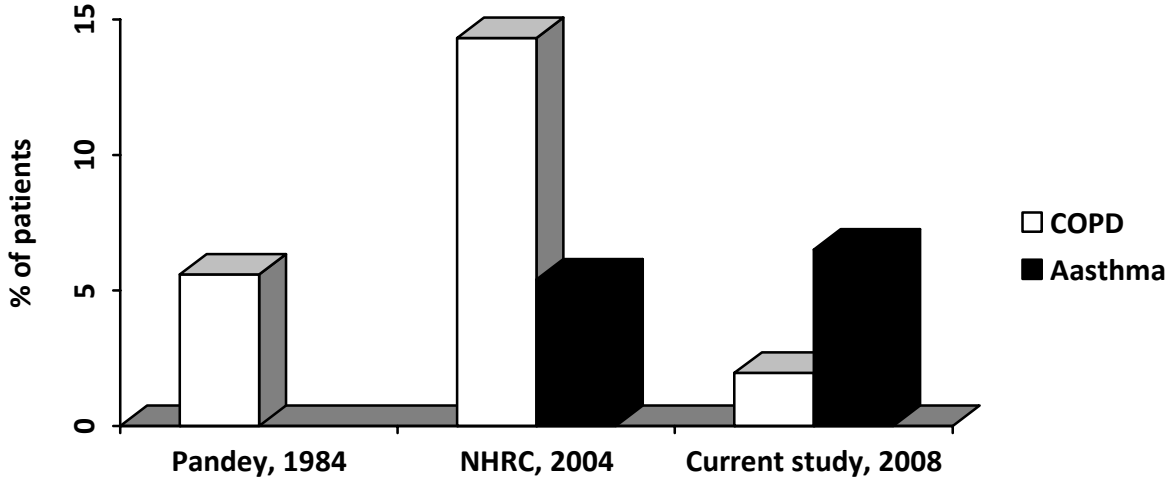
Table 9: Overall Frequency of Diseases*

S.N.	Disease/Problem	Yes		No	
		Frequency	%	Frequency	%
1	Eye Problem	10	4.95	143	12.17
2	ENT	35	17.33	118	10.04
3	Cough	46	22.77	107	9.11
4	Phlegm	27	13.37	126	10.72
5	Breathlessness	27	13.37	126	10.72
6	Wheezing	21	10.40	132	11.23
7	Abnormal Inspiration/Expiration	23	11.39	130	11.06
8	COPD	3	1.49	150	12.77
9	Bronchial Asthma	10	4.95	143	12.17
Total		202	100.00	1175	100.00

*: The results obtained are not from the clinical examination but are from questionnaire survey and their hospital records

Pandey (1984) found that 5.6% of people in Jumla had COPD problems. Further, in the study carried out by NHRC (2004), in Kathmandu valley, Chitwan and Nawalparasi districts, the frequency of COPD patients were found to be 14.3%, while 5.4% of the people were Asthma patients (Fig 17).

Fig17 : Comparison of disease prevalence with past studies



Prevalence of Disease as per Characteristics of Respondents

Following Tables 10, 11 and 12 reveal the different types of diseases as per the different categories. It is revealed that Phlegm and Breathlessness is significant with the increasing age. This may have happened because of elder people spending more time in fire than children do as the majority of children were found to be going schools. This is verified by Table 11 as uneducated people were found to be more suffered from the different kinds of diseases. As the people who were less educated

were less aware about the malignance of smoke, they may have suffered more in comparison to the educated one. Further, It was found that overall prevalence of disease in case of male was higher that that of the female. In average, it was found that 13.03% of male suffered from different diseases in contrary to the 12.06% of female. Further the occurrence of diseases were found to be increased with the increasing age as only 3.63% of average people less than 25 yrs were found to be suffered from diseases while 11.88% of those between 25-49 yrs were suffering from the diseases. The maximum no. of disease holders were of the 50+ age group people (20.63%). In addition, the smoking habit is significant in causing diseases (cough, phlegm, breathlessness and wheezing and COPD). Also the respondents who used to smoke in the past had occurrence of the disease, showing that the effect of smoke remains longer.

Table 10: Frequency of Diseases as per the sex and age

Disease/Problem	Sex		Age (year)		
	Female	Male	<25	25-49	50+
	%	%	%	%	%
Abnormal Inspiration/Expiration	14.0	17.4	4.0	14.4	25.8
EYE	5.6	8.7	4.0	4.1	16.1
ENT	22.4	23.9	16.0	21.6	32.3
Cough	29.9	30.4	16.0	29.9	41.9
Phlegm[a]	15.9	21.7	0.0	17.5	32.3
Breathlessness[a]	15.9	21.7	0.0	16.5	35.5
Wheezing	15.0	10.9	0.0	14.4	22.6
COPD	2.8	0.0	0.0	1.0	6.5
Bronchial Asthma	7.5	6.5	0.0	8.2	9.7
Pulmonary TB	0.9	0.0	0.0	0.0	1.0
Susceptible Respiratory Ill health	2.8	2.2	0.0	3.1	3.2

[a]: $p<0.05$ for the age group (yr) [F-Statistic]

Table 11: Frequency of Disease as per Education and Smoking Habit

Disease/Problem	Education						smoking habit					
	Uneducated		General		Up to SLC		Never smoked		Currently smoking		Used to smoke in the past	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Abnormal Inspiration/Expiration[b]	21	11.29	1	8.33	1	25	5	9.62	15	11.03	3	21.43
EYE[b]	10	5.38	0	0.00	0	0	0	0.00	10	7.35	0	0.00
ENT	32	17.20	2	16.67	1	25	17	32.69	18	13.24	0	0.00
Cough[a, b]	41	22.04	3	25.00	2	50	12	23.08	32	23.53	2	14.29
Phlegm[a, b]	25	13.44	2	16.67	0	0	5	9.62	20	14.71	2	14.29
Breathlessness[a, b]	25	13.44	2	16.67	0	0	5	9.62	19	13.97	3	21.43
Wheezing[a, b]	19	10.22	2	16.67	0	0	5	9.62	14	10.29	2	14.29
COPD[b]	3	1.61	0	0.00	0	0	0	0.00	2	1.47	1	7.14
Bronchial Asthma	10	5.38	0	0.00	0	0	3	5.77	6	4.41	1	7.14
Total	186	100	12	100	4	100	52	100	136	100	14	100

[a]: p<0.05 for Education (F-Statistic)
[b]: p<0.01 for smoking habit (F-Statistic)

Furthermore, indoor environment and exposure duration of the households were found to be playing significant role in determining the disease condition of the respondents. The prevalence of the diseases including Bronchial Asthma and Pulmonary TB increases were found to be high in the exposure duration of 4-4.9 hrs.

Table 12: Frequency of Disease as per Indoor Environment and Exposure Duration

Disease/Problem	Indoor Environment		Exposure Duration (hr)					
	Smelly	Clean	0-0.9	1-1.9	2-2.9	3-3.9	4-4.9	5-5.9
	%	%	%	%	%	%	%	%
Abnormal Inspiration/Expiration[a,b]	13.5	18.4	10.2	13.6	17.6	23.1	27.3	0.0
EYE	6.7	6.1	6.1	6.8	8.8	0.0	9.1	0.0
ENT	24.0	20.4	16.3	25.0	29.4	27.3	27.3	50.0
Cough[a,b]	26.9	36.7	14.3	38.6	35.3	30.8	54.4	0.0

Phlegm[a,b]	15.4	22.4	12.2	18.2	20.6	30.8	18.2	0.0
Breathlessness[a,b]	17.3	18.4	10.2	20.5	20.6	23.1	27.3	0.0
Wheezing[a,b]	10.6	20.4	8.2	13.6	17.6	23.1	18.2	0.0
COPD[a,b]	1.0	4.1	0.0	0.0	0.0	9.5	9.1	0.0
Bronchial Aasthma[a,b]	6.7	8.2	0.0	0.0	14.7	4.8	27.3	50.0
Pulmonary TB[b]	2.9	2.0	0.0	0.0	0.0	0.0	9.1	0.0
Susceptible Respiratory Ill health[b]	2.0	3.8	0.0	0.0	0.0	4.8	27.3	0.0

[a]: $p<0.05$ for Indoor Environment
[b]: $p<0.05$ for Exposure Duration

2.7 Prevalence of Disease as per the Household and Kitchen Characteristics

Table 13 to table 19 represents the mean no. of households having disease problem because of different kitchen characteristics. The result was not significant ($p>0.05$) in telling that house characteristics play important roles in causing the disease, except in case of COPD and cough, which was found to be significantly occurred in the households having its kitchen without partition ($p<0.05$). Further it was found that the household having solar as their lighting source had higher average of patients (Table 17) than those having other sources. This may have happened as the households have moved into solar technology after they have caught the diseases.

Table 13: Prevalence of Diseases as per the Wall and Roof Material

Disease/Problem	Wall material		Roof material	
	Stone/Mud (N=59)	Stone/Cemented (N=3)	Stone/slate (N=61)	Lenter (N=1)
	Mean	Mean	Mean	Mean
Eye Problem	0.1724	0.0000	0.1667	0.0000
ENT	0.5690	0.6667	0.5667	1.0000
Cough	0.7414	1.0000	0.7500	1.0000
Phlegm	0.4655	0.0000	0.4500	0.0000
Breathlessness	0.4655	0.0000	0.4500	0.0000
Wheezing	0.3621	0.0000	0.3500	0.0000
COPD	0.0517	0.0000	0.0500	0.0000
Bronchial Asthma	0.1897	0.0000	0.1833	0.0000
Pulmonary TB	0.0172	0.0000	0.0167	0.0000
Susceptible Respiratory Ill health	0.0690	0.0000	0.0667	0.0000

Table 14: Prevalence of Disease as per the Kitchen Location

Disease/Problem	Kitchen Location		
	Upstairs (N=39)	Downstairs outside (N=3)	Downstairs inside (N=20)
	Mean	Mean	Mean
Eye Problem	0.1579	0.0000	0.2000
ENT Problem	0.6316	0.3333	0.5000
Cough	0.6842	1.6667	0.7500
Phlegm	0.4474	0.3333	0.4500
Breathlessness	0.4737	0.6667	0.3500
Wheezing	0.3158	0.3333	0.4000
COPD	0.0263	0.0000	0.1000
Bronchial Asthma	0.1842	0.3333	0.1500
Pulmonary TB	0.0000	0.0000	0.0500
Susceptible Respiratory Ill health	0.1053	0.0000	0.0000

Table 15: Prevalence of Disease as per the Stove Type

Disease/Problem	Stove Type	
	Traditional stoves (N=61)	Three Stone (N=1)
	Mean	Mean
Eye Problem	0.1667	0.0000
ENT Problem	0.5667	1.0000
Cough	0.7500	1.0000
Phlegm	0.4333	1.0000
Breathlessness	0.4333	1.0000
Wheezing	0.3333	1.0000
COPD	0.0500	0.0000
Bronchial Asthma	0.1667	1.0000
Pulmonary TB	0.0167	0.0000
Susceptible Respiratory Ill-health	0.0667	0.0000

Table 16: Prevalence of Disease as per the Cooking Fuel

Disease/Problem	Fuel for Cooking
	Fuel wood (N=62)
	Mean
Eye Problem	0.1639
ENT Problem	0.5738
Cough	0.7541
Phlegm	0.4426
Breathlessness	0.4426
Wheezing	0.3443
COPD	0.0492
Bronchial Asthma	0.1803
Pulmonary TB	0.0164
Susceptible Respiratory Ill-health	0.0656

Table 17: Prevalence of Disease as per the Fuel for Lighting

Disease/Problem	Fuel for Lighting					
	Kerosene (N=8)	Pine (N=5)	Solar (N=15)	Kerosene+Pine (N=1)	Kerosene +Solar (N=31)	Pine+Solar (N=1)
	Mean	Mean	Mean	Mean	Mean	Mean
Eye Problem	0.0000	0.2000	0.2000	0.0000	0.1935	0.0000
ENT Problem	0.5000	1.2000	0.4000	0.0000	0.5484	2.0000
Cough	0.1250	0.6000	0.8000	0.0000	0.6452	1.0000
Phlegm	0.6250	0.2000	0.5333	0.0000	0.3871	1.0000
Breathlessness	0.5000	0.2000	0.5333	1.0000	0.3871	1.0000
Wheezing	0.5000	0.2000	0.5333	0.0000	0.2581	0.0000
COPD	0.1250	0.0000	0.0000	0.0000	0.0645	0.0000
Bronchial Asthma	0.1250	0.2000	0.3333	0.0000	0.1290	0.0000
Pulmonary TB	0.0000	0.0000	0.0667	0.0000	0.0000	0.0000
Susceptible Respiratory Ill-health	0.0000	0.0000	0.0667	0.0000	0.0968	0.0000

Table 18: Prevalence of Disease by kitchen characteristics

Disease/Problem	Kitchen Characteristics			
	Separate (N=40)	Partition(N=12)	Without Partition(N=6)	Open Air Kitchen (N=3)
	Mean	Mean	Mean	Mean
Eye Problem	0.2000	0.0833	0.1667	0.0000
ENT Problem	0.6500	0.2500	0.8333	0.3333
Cough[a]	0.6000	0.7500	1.3333	1.6667
Phlegm	0.4000	0.4167	0.8333	0.3333
Breathlessness	0.3750	0.4167	0.8333	0.6667
Wheezing	0.3000	0.2500	0.8333	0.3333
COPD[a]	0.0000	0.0833	0.3333	0.0000
Bronchial Asthma	0.2000	0.0833	0.1667	0.3333
Pulmonary TB	0.0250	0.0000	0.0000	0.0000
Susceptible Respiratory Ill-health	0.0750	0.0833	0.0000	0.0000

[a]: $p<0.05$

Table 19: Prevalence of Disease by Type of Ventilation

Disease/Problem	Type of Ventilation			
	No Ventilation(N=47)	Wall Roof Gap(N=5)	Hole in Roof(N=5)	Ventilation window (N=4)
	Mean	Mean	Mean	Mean
Eye Problem	0.1489	.0000	.6000	.0000
ENT Problem	0.4894	.6000	1.0000	1.0000
Cough	0.7447	.6000	.4000	1.5000
Phlegm	0.4255	.4000	.2000	1.0000
Breathlessness	0.4043	.6000	.2000	1.0000
Wheezing	0.3404	.2000	.2000	.7500
COPD	0.0426	0.0000	0.0000	0.2500
Bronchial Asthma	0.1915	0.2000	0.0000	0.2500
Pulmonary TB	0.0213	0.0000	0.0000	0.0000
Susceptible Respiratory Ill-health	0.0638	0.0000	0.2000	0.0000

Correlation between different parameters and occurrence of disease

Following table shows that the no. of cases of disease occurring households increases with the increase in no. of smokers in the house and also with the household size. Though the no. of case was also increasing with the increasing no. of stories, Fuel wood amount and decrease of kitchen area and its height, the result were not significant ($p>0.05$)

Table 20: Correlation of household and kitchen environment with no. of cases of diseases

Variables			**Pearson's correlation coefficient (r)**
Household Size	vs.	no. of cases of disease	0,.452**
No. of Stories	vs.	no. of cases of disease	0.102
Fuel wood amount	vs.	no. of cases of disease	0.037
Kitchen Area	vs.	no. of cases of disease	-0.108
Kitchen Height	vs.	no. of cases of disease	-0.028
Door Size	vs.	no. of cases of disease	-0.131
No. of Smokers	vs.	no. of cases of disease	0.464**

**: $p<0.01$

Kitchen Dimension

The sample households had kitchen dimension as shown in following figures 18 and 19. The average door size was found to be 0.7407m^2, while the average window size was found to be 0.2554m^2. The size of the door is less than suggested by NHRC (2004) (1.4 m^2). Similarly, the size of the kitchen was found to be 9.48m^2 while the average kitchen height was 1.61 m. As NHRC (2004) suggest the kitchen height not to be less than 2.4m, the observed kitchen height is not desirable.

Fig 18: Box-plots showing door size and window size in different households

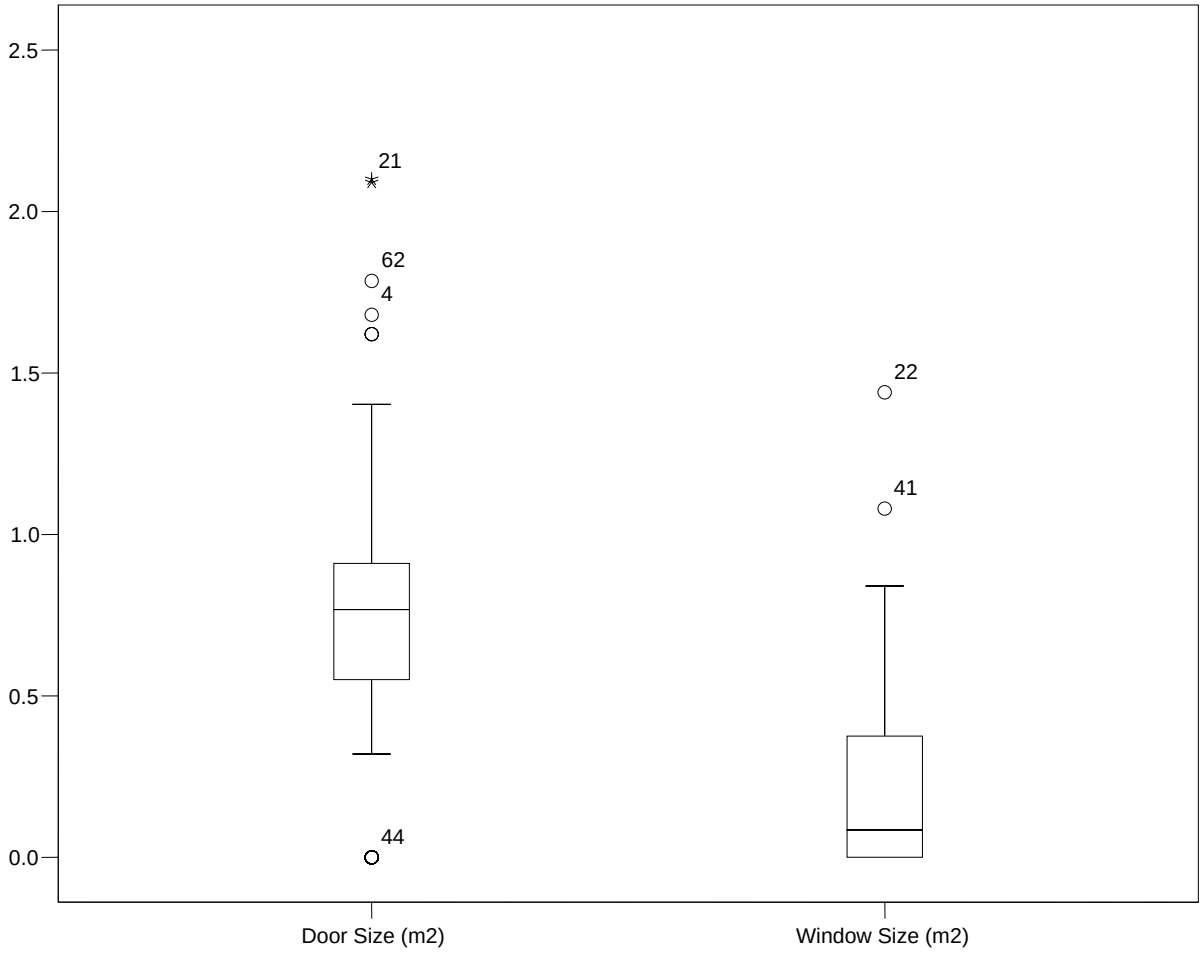
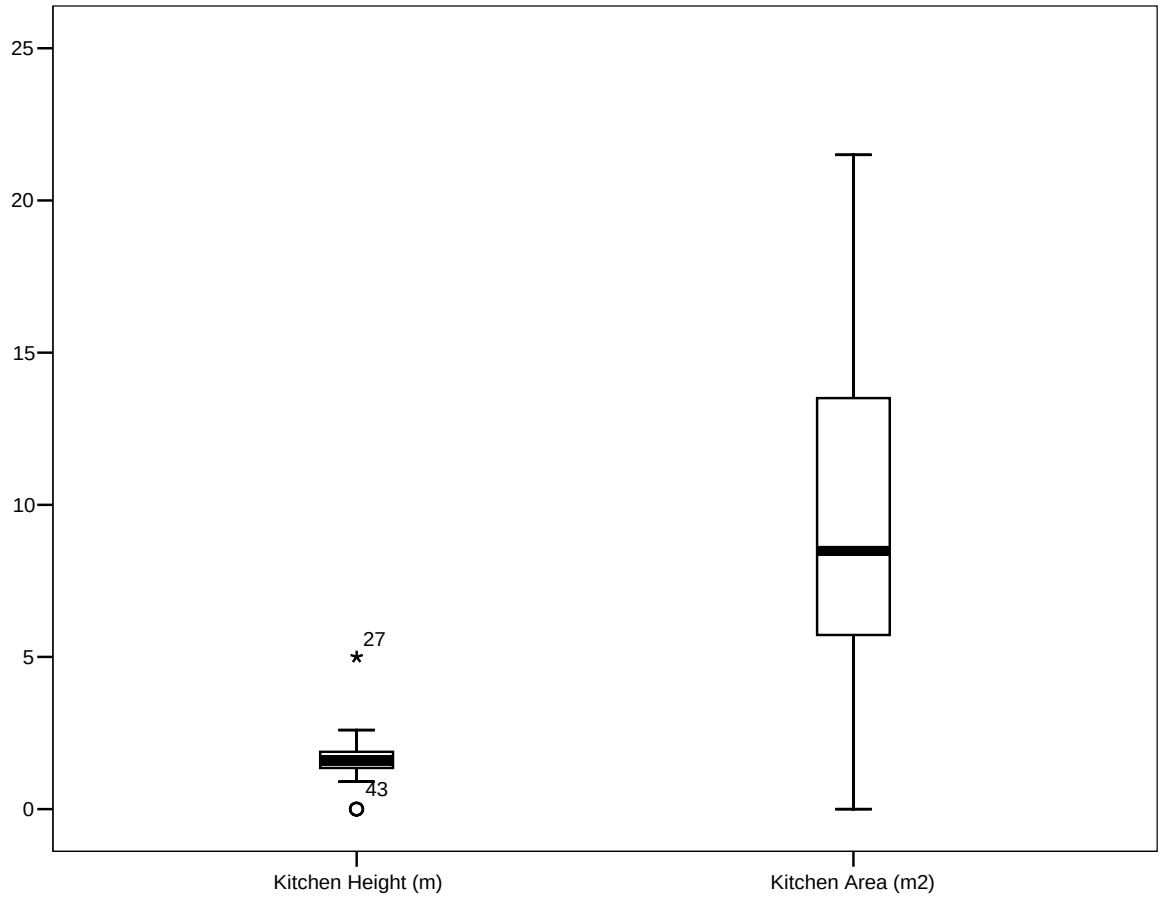


Fig 19: Box-plots showing Kitchen height and Kitchen area in different households



Peak Flow Meter

Peak flow meter analysis for the expiration of 81 respondents' (Table 21-26) revealed that 35.8% of the respondents had peak flow rate of 300-399 l/m. In addition, 28 respondents (34.57%) had the peak flow rate of 200-299 l/m. The average peak flow rate of the respondents was found to be 284.48 l/m. Comparison of peak flow rate with household characteristics revealed that sex, indoor environment, smoking habit and exposure duration are playing significant role in determining the peak flow rate of the respondents.

Table 21: Peak flow rate of respondents as per the age structure

Age (year)	peak flow rate (l/m)						Total
	<100	100-199	200-299	300-399	400-499	500+	
<25	0	0	1	6	2	0	9
25-49	3	8	22	19	4	2	58
50+	3	2	5	4	0	0	14
Total	6	10	28	29	6	2	81

Table 22: Peak flow rate of respondents as per the sex

Sex	peak flow rate (l/m)[a]						Total
	<100	100-199	200-299	300-399	400-499	500+	
Female	5	8	24	23	2	0	62
Male	1	2	4	6	4	2	19
Total	6	10	28	29	6	2	81

[a]: p<0.05

Table 23: Peak flow rate of respondents as per the Ethnic Group

Ethnic Group	peak flow rate (l/m)						Total
	<100	100-199	200-299	300-399	400-499	500+	
Chettris	5	8	25	25	5	2	70
Dalits	1	2	3	4	1	0	11
Total	6	10	28	29	6	2	81

Table 24: Peak flow rate of respondents as per the Indoor Environment

Indoor Environment	peak flow rate (l/m)[a]						Total
	<100	100-199	200-299	300-399	400-499	500+	
Smelly	3	8	13	20	4	1	49
Clean	3	2	15	9	2	0	32
Total	6	10	28	29	6	2	81

[a]: p<0.05

Table 25: Peak flow rate of respondents as per the smoking habit

smoking habit	peak flow rate (l/m)[b]						Total
	<100	100-199	200-299	300-399	400-499	500+	
Never smoked	1	3	4	20	5	2	35
Currently smoking	3	7	24	8	1	0	43
Used to smoke in the past	2	0	0	1	0	0	3
Total	6	10	28	29	6	2	81

[b]: p<0.01

Table 26: Peak flow rate of respondents as per the exposure duration

Exposure duration (Hours)	peak flow rate (l/m)[b]						Total
	<100	100-199	200-299	300-399	400-499	500+	
0.0-0.9hrs	0	0	3	7	1	2	13
1.0-1.9 hrs	0	0	12	13	4	0	29
2.0-2.9 hrs	2	3	9	6	1	0	21
3.0- 3.9 hrs	2	1	2	3	0	0	8
4.0-4.9 hrs	1	6	2	0	0	0	9
5.0-5.9 hrs	1	0	0	0	0	0	1
Total	6	10	28	29	6	2	81

[b]: p<0.01

Acute Respiratory Infection

Among infants and children between 1 and 2 yrs, the episodes of ARI per child increased with the increased level of smoke exposure. The increase is more pronounced in grade I, in both cases, rather than other two higher levels (grade II and grade III) This may have happened because grade I patients didn't think they had to go hospital, while those with II and III were found to go hospital for check up as shown by hospital records (Annex 3) The prevalence of ARI on the households shows high smoke exposure of the people in their households. This shows the direct relationship between ARI and smoke exposure

Table 27: ARI episodes according to the time spent in fireplace per day

Exposure time (hrs/day)	No. of Infants	0-1 yrs			No. of Children	1-2 yrs		
		ARI Episode by grade				ARI Episode by grade		
		I	II	III		I	II	III
0-0.9	3	3 (1.00)	1 (0.33)	0 (0.0)	2	1 (0.50)	0 (0.0)	0 (0.0)
1-1.9	11	14 (1.27)	1 (0.09)	0 (0.0)	10	6 (0.60)	0 (0.0)	0 (0.0)
2-2.9	5	7 (1.40)	0 (0.00)	0 (0.0)	6	5 (0.83)	1 (0.17)	0 (0.0)
3-3.9	7	11 (1.57)	2 (0.29)	0 (0.0)	10	11 (1.10)	1 (0.10)	1 (0.10)
4+	10	19 (1.90)	3 (0.30)	0 (0.0)	7	13 (1.86)	2 (0.29)	1 (0.14)
Total	36	54 (1.50)	7 (0.19)	0 (0.0)	35	38 (1.08)	4 (0.29)	2 (0.06)

p<0.01 for the ARI in grade I (both age group combined)

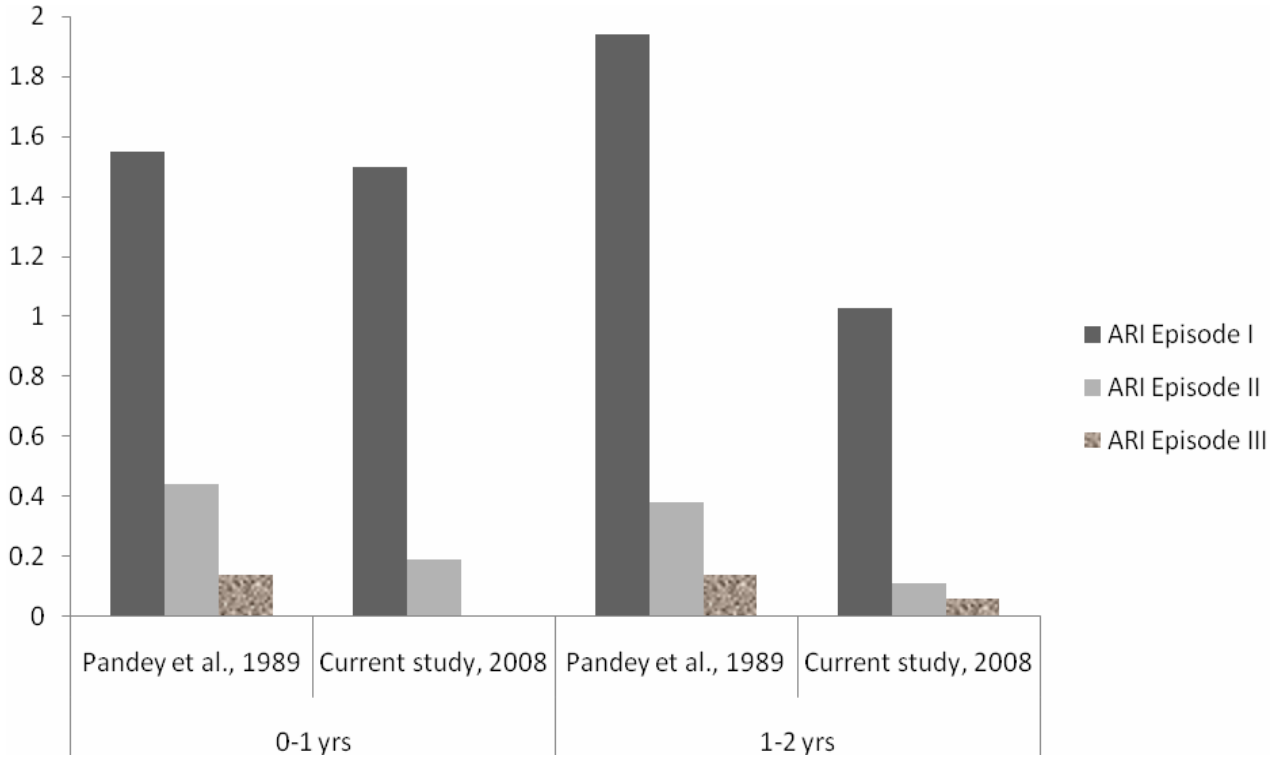
Table 28: ARI episodes according to the smoking habits of parents

Smoking Habit	No. of Infants	0-1 yrs			No. of Children	1-2 yrs		
		ARI Episode by grade				ARI Episode by grade		
		I	II	III		I	II	III
Smoker	23	37 (1.61)	6 (0.26)	0 (0.0)	19	29 (1.58)	4 (0.21)	2 (0.11)
Never smoked	13	17 (1.31)	1 (0.08)	0 (0.0)	16	7 0.50)	0 (0.0)	0 (0.0)
Total	36	54 (1.50)	7 (0.19)	0 (0.0)	35	36 (1.03)	4 (0.11)	2 (0.06)

Note: Average episode per child in parentheses
p<0.01 for the ARI in grade I (both age group combined)
p<0.05 for the ARI in grade II (both age group combined)

Past study by Pandey (1989) in the VDCs of Kathmandu valley revealed that the average ARI episode of grade I was found to be 1.55 for 0-1 yrs child, while it was 1.94 for 1-2 yrs child (Fig. 20). The result reveals that in the period of the cases of ARI have decreased.

Fig 20: Comparison of average ARI with past studies



CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

Conclusion

This study carried out by observing the household characteristics and health conditions of the local people of Malikarjun VDC of Darchula District, Far western Nepal, was highly relevant in concluding the following aspects:

1. Kitchen area, height and its door are below the standards provided by NHRC (2004), increasing indoor air pollution in households.

2. Kitchen characteristics play significant roles in determining the general health characteristics of the family members. Therefore, indoor air pollution is virulent for the health of the people.

3. Exposure to the smoke and smoking habit of the family members affect the health of the people negatively, especially of the women and children.

4. Though the use of alternative energy was found, they were used in very minimum quantity and were only used when they suffered from the diseases.

5. Blood pressure and pulse rate of the people is independent of the exposure level and smoking habit.

6. Expiration capacity of the people was highly dependent on their exposure level and smoking habit.

7. Acute Respiratory Infection (ARI) in case of infants and children of 1-2 yrs may have due to smoking habit of their parents and their exposure duration plays important role.

All in all, from the study carried out, what we can conclude is, the indoor air pollution in, Darchula District, do play significant role to determine the health condition of the local people.

Recommendations

The foremost approach on, to fight with the diseases, should be started with the reduction of severity of indoor environmental pollution. From the present study, following recommendations are suggested:

1. People should be made aware about the effects of smoke on them, the sources of smoke they receive in their households and also the better alternative technologies for reducing the indoor air pollution in their house.

2. The locals should be motivated to build the houses and their kitchen with proper ventilation. They can be motivated to use the natural ventilations in their houses, reducing the cost of building the ventilation system. These houses should meet the standards suggested by NHRC (2004).

3. Extensive use of alternative energies should be promoted. By removing the traditional stoves, people should be provided Improved Cooking Stoves (ICS), which, by previous studies, has been proved to be reducing the smokes and indoor health significantly.

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Annex 1
Sampling

1. Sample Size Determination

The sample size (n) of the household to represent the study area was determined by using formula (Atkins and Colton, 1963) at 95 % confidence level.

$$n = \frac{NZ^2 P(1-P)}{Nd^2 + Z^2 P(1-P)}$$

Where, n = sample size

N = total number of households

Z = confidence level (at 95 % level Z = 1.96)

P = estimated population proportion (0.05, this maximize the sample size)

d = error limit of 5 % (0.05)

Using standard formula given above, the total number of sample size (household no.) to be surveyed was founded to be 62.23, which was rounded off as 62 (14.70% of total household) Similarly, for Systematic examination for detection of health effect linked to indoor air pollution, the Respondent size was optimized to 10 % of the total population of VDC. Thus, sample size for responded is 224.9 which was rounded off as 225.

2. Sampling Frame and Sampling Process including Criteria for Sample Selection

The number of sampling household and respondent with respect to respective wards was selected in the proportion basis and is tabulated herewith:

Ward Number	Name of Village	Total Household no.	Sample Household no.	Sample Respondent for systematic Health Survey (PPS)
1	Bashedi	33	5	18
2	Palang	29	4	14
3	Ghodegaun	39	6	29
4	Madamallagaun	54	8	22
5	Bhadrigada	43	6	22
6	Malbab	51	8	29
7	Khalidada	61	9	33
8	Bhaitada	59	8	29
9	Phokhara	55	8	29
Total		**422**	**62**	**225**

Selection of Respondent for Systematic Health survey:

S. N.	Respondent	Sample no.	Inference
1	Women	107	20% of the total population of woman between 15-60 years age (535)
2	children	71	50% of the total population of children below 2 years of age (151)
3	Men	47	30% of total adult sample size
Total		225	

Source for population data: Sub-health post, Malikarjun, Darchula

Annex 2
GPS points of Sample Households

Household No.	Latitude (N)	Longitude (E)	Elevation
1	29.72279	80.48263	1806
2	29.72262	80.48164	1768
3	29.71927	80.48109	1641
4	29.71907	80.48102	1572
5	29.72109	80.47411	1429
6	29.74091	80.47795	1498
7	29.74134	80.47712	1504
8	29.74121	80.47592	1474
9	29.73146	80.47573	1404
10	29.73295	80.46986	1346
11	29.7245	80.47052	1463
12	29.73124	80.47783	1436
13	29.72649	80.47083	1538
14	29.74298	80.47552	1555
15	29.74347	80.47586	1571
16	29.73469	80.47389	1470
17	29.73592	80.47045	1312
18	29.73700	80.47028	1334
19	29.73743	80.46949	1303
20	29.73417	80.47224	1353
21	29.73638	80.48089	1692
22	29.73597	80.48088	1667
23	29.73582	80.47957	1622
24	29.73590	80.48113	1655
25	29.73588	80.47863	1603
26	29.70596	80.47327	1605
27	29.73085	80.49185	1912
28	29.73073	80.49107	1907
29	29.73141	80.49009	1881
30	29.73380	80.49113	1750
31	29.70492	80.48392	1687
32	29.73571	80.47821	1595
33	29.73445	80.49515	1719
34	29.73544	80.49545	1735
35	29.73445	80.49515	1719

36	29.73585	80.49261	1700
37	29.73899	80.49114	1770
38	29.73896	80.49018	1718
39	29.73376	80.48954	1673
40	29.73820	80.48853	1648
41	29.73875	80.48863	1667
42	29.73710	80.49014	1662
43	29.70714	80.48997	1690
44	29.72450	80.47052	1463
45	29.73653	80.48419	1788
46	29.73858	80.48157	1581
47	29.74106	80.48172	1635
48	29.74128	80.48152	1663
49	29.74139	80.48149	1668
50	29.74174	80.48125	1641
51	29.74094	80.48352	1624
52	29.74290	80.48372	1553
53	29.74364	80.48065	1578
54	29.74529	80.47859	1562
55	29.74549	80.47458	1536
56	29.74439	80.47415	1544
57	29.74091	80.47795	1498
58	29.74134	80.47712	1504
59	29.74121	80.47592	1474
60	39.74298	80.47552	1555
61	29.74347	80.47586	1577
62	29.74354	80.47694	1587

Annex 3

Hospital Data

Table: Prevalence of ARI in Malikarjun 2064/65

ARI Episodes	Shrawan	Bhadra	Aswin	Kartik	Marg	Paush	Magh	Falgun
1. Category One ARI I	0	0	5	0	7	6	8	5
2. Category two ARI II	6	6	38	11	10	6	17	30
3. Category Three ARI III	0		0	0	0	0	0	0

Source: Sub-health post Malikarjun, Malikarjun VDC

Table: Top Ten Disease in Darchula district, 2063/64

1	ARI
2	Diarrhoea
3	Pyrexia
4	Skin disease
5	Gastrotitis
6	Worm
7	Bronchitis
8	Air infection
9	Sore eye and eye complication
10	Toothache

Source: Yojana anugaman tatha tathyanka sakha, Darchula jilla aspatal, District Profile

Table: Total number of Cases of Diseases in Malikarjun VDC, 2007/2008 (Associated with Indoor Air Pollution)

Parameters	Bhadra	Aswin	Kartik	Marg	Paush	Magh	Falgun	Chaitra	Baishak	Jestha
	F/M	F/M	F/M	F/M	F/M	F/M	F/M	F/M	F/M	F/M
A. Respiratory										
Bronchitis	3//2	5//4	6//5	6//7	8//6	11//8	13//14			
Asthma	0/0	**1//3**	4//0	**3//0**	0/0	0/0	0/0			
COPD	0/0	**0/0**	0/0	**1//0**	0/0	0/0	**1//0**			
ARI Lower	0/0	**0/0**	0/0	0/0	0/0	0/0	0/0			
ARI Upper	0/0	**0/0**	0/0	0/0	0/0	0/0	0/0			
Pneumonia	0/0	**0/0**	0/0	0/0	5//2	0/0	0/0			
Severe Pneumonia	0/0	**0/0**	0/0	0/0	0/0	0/0	0/0			
B. ENT										
Sinusitis	0/0	0/0	1//1	0/0	0//1	2//2	2//2			
Tonsillitis	0/0	0//1	0/0	2//0	2//1	0/0	0//2			
Pharangititis/sore throat	0/0	0/0	0/0	1//0	0/0	0/0	0//1			
Foreign body in respiratory tract	0/0	0/0	0/0	0/0	0/0	1//0	0/0			
Acute or chronic supporative ottis media	0/0	0//1	1//0	3//2	1//1	0/0	0/0			
C. EYE										
Oral ulcer mucosa and related disease	0/0	0//1	3//0	0/0	1//0	0//2	0/0			
Conjunctivitis	1//0	0/0	1//0	1//0	1//0	1//0	2//2			
Trachoma	0/0	0/0	0/0	0/0	0/0	0/0	0/0			
Cataract	0/0	0/0	0/0	0/0	0/0	0/0	0/0			
Blindness and low vision	0/0	0/0	0/0	0/0	0/0	0/0	0/0			

F/M: Female/Male **source: sub-health post Malikarjun, Malikarjun, Darchula**

Table: Total Infection of diseases in Darchula Districts (2006/2007)

Months	A. ARI		B. Pneumonia		C. Bronchitis		D. Sore Eye	
	Darchula district	Pasti Health	Darchula district	Pasti Health	Darchula district	Pasti Health	Darchula district	Pasti Health
Shrawan	310	48	172	39	651	208	328	N/A
Bhadra	390	52	215	30	693	251	219	N/A
Aswin	266	34	115	21	424	206	132	N/A
Kartik	335	29	186	15	469	172	153	N/A
Marg	299	35	133	18	315	140	148	N/A
Paush	295	47	171	33	428	150	142	N/A
Magh	347	37	183	30	314	120	85	N/A
Falgun	427	47	215	33	613	273	182	N/A
Chaitra	338	40	198	28	452	168	95	N/A
Baishak	278	31	149	23	287	115	97	N/A
Jestha	306	40	169	29	396	169	178	N/A
Ashad	281	49	127	26	480	260	142	N/A
Total	3872	489	2033	325	5522	2232	1901	N/A

N/A: Not Available **Source: Darchula District Hospital, Darchula**

Annex 4

Ethno-Biological Use of Flora and Fauna

Tabulation of Flora and Fauna used in traditional medicine in Respiratory Disorder by the locals of Malikarjun VDC, Darchula

FLORA

S.N	Botanical name	Family Name	Local name	Parts used	Disease
1	*Achyranthus bidentata Blume*	Amaranthacaeae	Bipya kuro	Root	Common cold, fever
2	*Costus speciosus(J.Konig) Sm.*	Zingiberaceace	kauchho	Rhizome	Eye infection
3	*Curcuma aromatica Salisb.*	Zingiberaceace	banhaldi	Rhizome	Common cold,fever
4	*Phyllunthus embilica L.*	Euphorbiaceae	Aula	Fruit	Asthama, hair tonic and burns
5.	*Punica grantum L.*	Punicaceae	Dadim	Fruit	Common cold, cough
6	*Ranunculus laetus Wall.ex D.Don*	Ranunculaceae	Aado	Rhizome	Common cold, cough
7	*Terminalia chebula Retz.*	Combreatceae	Harado	Fruit, Bark	Cough, Asthma
8.	*Terminalia bellirica (Gaertn.) Roxb.*	Combreatceae	Barado	Fruit	Tonic for Asthma
9.	*Zanthoxylum armantum DC.*	Rutaceae	Timur	Fruit	Cough and Cold
10.	*Azadirachta indica*		Neem	Leaf, Bark, Fruit	Cough, Pneumonia
11	*Cladonia sps.*	Gramineae	Siru	Root	Cough, ARI
12.	*Swertia chirayita (Roxb. ex Fleming)*	Gentianaceae	Lektite	Whole plant	Cough
13.	*Cinnamomum zeylanicum*	Lauraceae	Dalchini	Bark, Leaf	Pneumonia, Pulmonary Tuberclusis

FAUNA

S.N.	Zoological Name	Order	Lacal Name	Organ Used	Medicinal uses
1.	*Moschus chrysogaster*	Moshchideae	Khu khu Kasturi	Musk	Asthma, Tuberclusis
2.	*Gallusgallus domesticus*	Gallifroms	Kalij	Meat	Cold and Cough
3.	*Hystrix brachyura*	Rodentia	Sauda	Meat	Asthma

Annex 5
Questionnaire for Household Survey

Consent for interview
We are conducting a survey about household energy, indoor air pollution and its health impact in Malikarjun VDC. We would very much appreciate your participation in this survey. I would like to ask you some questions about your household. This information will help people plan programs to decrease indoor air pollution in homes. It will take about 20 minutes. Participation in this survey is voluntary. You can choose not to answer any question. If you decide to participate, you may stop answering questions at anytime. All information will be kept strictly confidential and will not be shown to other persons. Do you want to ask me anything about this survey at this time?
Response: Respondent agrees/declines for interview
Date_____ M M / D D Start time ____:____ am/pm

Household Serial No. ..... Household Identification No.....

Ward number..... Cluster Number ..... Name of the village / tole.....

1. Demographic Information
Now I would like to ask some information about the people who usually live in your household or are staying with you. Please give me the names of the persons who usually live in your household, starting with the head of the household.

Name	Relationship to Head of Household Head	Sex Male/ Female	Age (<1 year; give age in month)	Involved in cooking?	Usually present in kitchen during cooking?	Smokes more than 1 cigarette/*bidi* everyday at home?
1	Head of the household			Yes No	Yes No	Yes No
2				Yes No	Yes No	Yes No
3				Yes No	Yes No	Yes No
4				Yes No	Yes No	Yes No
5				Yes No	Yes No	Yes No
6				Yes No	Yes No	Yes No
7				Yes No	Yes No	Yes No
8				Yes No	Yes No	Yes No
9				Yes No	Yes No	Yes No
10				Yes No	Yes No	Yes No

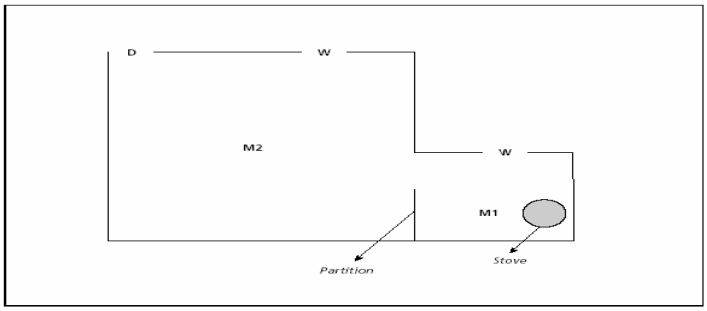
2. Household characteristics
(Eligibility criteria)

Roof Materials:	Grassleaves,Reeds,Thatch,wood,mud,Bamboo……1 Stone…….....2 Concrete RBC/RCC……..……..……...3 Tiles, Slate, Shingle……...……..4 Brick Stone and Lime……...5 Corrugated Iron, Zinc or other Metal Sheets……6 All other materials not stated……7
Wall Materials:	Grass, Leaves,Reeds,Bamboos or Thatch……1 Mud/Dirt……2 Unburned Bricks……..……..3 Wood……..……4 Burnt Bricks ……..……5 Stone……6 Cement concrete……7 Other Material Not Stated……8
Floor:	Mud/Dirt……1 Wood/Planks……2 Bamboo or Logs……..……3 Cement……..……4 Brick, Stone and Lime……5 Other materials not Stated……..……6
Do you have a separate room that is used as a kitchen? Yes…….. No…….	
Characteristics of the kitchen:	Indoor kitchen with Partition……..……1 Indoor Kitchen without Partition……..…..2 Separate Indoor kitchen Outside the House…….....3 Open Air kitchen Outside the House……..……4
What type of fuel does your house hold mainly use for cooking? (check only one)	Woods (logs)……..……..1 Crop Residues……2 Dung Cakes……..……..……3 Kerosene……..……..……4 Bio-gas……...……5 Other (specify)……..6

Total number of rooms ……

Number of storey ……..

Household Sketch (sample)



3. About Kitchen and Ventilation (*Kitchen characteristics*)

Kitchen Area	Length X Breadth ……..
Kitchen Height	……...
Measurement of size of door in meter (height X Breath) Kitchen door open to	1 …… 2 …… Outside / Inside / Both
Number of windows/Openings/ventilation in Kitchen	……..
Measurement of size of open windows in meters (height X Breath)	1 …… 2 ……
Measurement of size of ventilation in meter (height X Breath)	1 …… 2 ……
For household with kitchen partition: Does partition extend to the ceiling?	Yes No
If No, record the height of partition in cm.	Cm ……
For household with open-air kitchen outside the house: Is stove located under any shed roof or canopy?	Yes No
If Yes, record height of shed roof/canopy meter	……
How many sides of the outdoor kitchen are enclosed (i.e. by walls, make shift partitions, etc)	

4. A) Biomass Stove characteristics: A stove is defined by presence of fire/combustion chamber. Count two fires as two stoves even if they look alike and are side by side.

Traditional Biomass Stoves (No chimney)

Stove	**Traditional stove # 1**	**Traditional stove # 2**
	Fixed …….. Portable …….	Fixed …….. Portable …….
Type of stove	Three stone or Brick …….1 Simple Chula ……..2 Modified Chula ……..3 (Ridge at the pot hole)	Three stone or Brick …….1 Simple Chula ……..2 Modified Chula ……..3 (Ridge at the pot hole)
If Stove is, modified Chula (# 3 above) was this stove constructed as an improved Chula.	Yes No	Yes No
Number of pot holes	……	……
Height of stove in centimeters (From inner side)	……	……
Stove materials	Mud ……..1 Brick/Stone ……2 Other (specify) ……..3	Mud ……..1 Brick/Stone ……2 Other (specify) ……..3
Does the stove have hood?	Yes No	Yes No
If yes, describe the hood: ……		
Is the stove ever used for space heating indoors?	Yes No	Yes No
Is the stove ever used for cattle feed?	Yes No	Yes No
The stove is located at	ground floor top floor	ground floor top floor

B) Improved Biomass stoves

Improved biomass stoves are characterized by the presence of a chimney or fuel	Improved stove # 1	Improved stove # 2
	Fixed ……..1 Portable ……..2	Fixed ……..1 Portable ……..2
Does the stove have chimney (flue)?	Yes No	Yes No
If no, this is not an improved stove please record stove details in traditional section		
If improved, what type?	…….	…….
If improved, for how long have you had this stove?	Months/years	Months/years
Number of pot holes	…….	…….
Described the chimney materials		
Height of chimney in centimeters:	…….	…….
Please rate the overall condition of the chimney:	Poorly Maintained/Inefficient……..1 Moderately well maintained ……2 Well maintained/efficient ……..3	Poorly Maintained/Inefficient..1 Moderately well maintained…2 Well maintained/efficient.....3
Describe the maintenance of the chimney	…….	…….
Does the stove have a controllable damper?	Yes No	Yes No
Height of the stove in centimeters	…….	…….
Does the stove have a hood?	Yes No	Yes No
The stove is located at	ground floor top floor	ground floor top floor

Black soot/tar deposit in Ceiling:

Low Moderate High

Soot/tar deposit and visibility of wall:

Low Moderate High

C) Lighting

What is the main source of the lighting for your household?	fuel	Consumed per month
	Kerosene .....1 Pine wood fuel…….2 Solar ……....3 Other ……..4	…… …… …….. ……

5. Exposure vulnerability by Indoor Air Pollution

	Cook # 1 **Name**	**Cook # 2** **Name**
When do you usually cook? Fill in the following all mentioned	……	……
MORNING before noon If yes, how long do you cook for in the morning?	Yes No Hr/Minutes ……..	Yes No Hr/Minutes ……..
ATERNOON noon to 5 pm If yes, how long do cook in the afternoon?	Yes No Hr/Minutes ……..	Yes No Hr/Minutes ……..
EVENING after 5 pm If yes long do you cook for in the evening?	Yes No minutes	Yes No minutes
OTHER TIMES Specify other times Activities (making tea etc.)	Yes No Hr/Minutes ……..	Yes No Hr/Minutes ……..
What kind of work do you (cook) do most of the time?	Yes No minutes	Yes No minutes

6. For mothers / housewives: Do children up to the age of 5 years (if any) accompany you during cooking time?

Always Most often Sometimes Never

7. Which cooking oils do you use most often? Raw oil or refined oil such as Soya bean oil, Mustard oil, Mustard oil, Rape Seed oil, other (name): .....

8. How much cooking oil is required (liters) per month / week? .....

9. During cooking time, smoke in the kitchen is often

Not noticeable / Feebly smoky / Visibly smoky / Unbearably smoky

Questioners (Individual) for survey and measurement of Indoor Air Quality and its Health Effects.

PART-A

(General)

1. Household Identification Number .....

2. Name of the respondent: Last Name .....First Name .....

Gender ..... Age .....

3. Date of the Interview.....

4. Literacy (Aged 6 or Over)

No Schooling ……..... Under SLC ……..... SLC ……..... Above SLC …….....

6. Marital Status

Single/ Married /Divorced/ Separated /Others

7. How long have you been living in this house? ..... (Years)

8. Give the time you usually spend at home / outdoors daily (in hours):

Description	Duration	Description	Duration
At the kitchen during cooking		Inside home when kitchen is not functioning, including sleeping at night	
At other rooms during cooking hours		Total time your spend outside home	

9. Occupation

Agriculture / Labor / Factory worker / Business / Office Staff

Other (Specify).....

10 Describe the general environment of your workplace.....

(Open outdoor; clean / dusty / smelly/; Indoor; clean / dusty / smelly; teaching / business / government building; shop; restaurant etc.)

12. How long you have been in the present job? ..... (Years)

13. Describe your previous jobs (accounting for 10 yrs of occupation).....

14. About Smoking habit (if any) Smoker Previous Smoker Never Smoked
If Current Smoking Age (smoking started).....

Type of smoking Cigarettes / Bidis / Hukka / Other Specify …….....

If others..... Type of Smoking plain / filter

Number of Cigarettes / Bidis per day..... Duration of Hukka Smoking per day.....

If Previous Smoker

Age at which Smoking started..... Type of Cigarette: plain / filter

Number of years of Smoking.....

Reason for stopping smoking.....Years of smoking ……

PART B

Systemic Examination for the detection of Health effects linked to indoor air pollution

Household Identification Number…… ..... Name…….....

1. GENERAL

Weight..... (Kg) Height..... (cm) Pulse ….....per min BP.....

Temperature.....Respiration Rate..... per min Pallor [ ] Icters [ ] Cyanosis [ ]

Lymph nodes: Enlarge [ ] Not Enlarged [ ] Appetite: Normal [ ] Poor [ ]

2. Chest

Inspiration Normal [ ] Abnormal [ ]

Expiration Normal [ ] Abnormal [ ]

3. EYE

Conjunctiva [ ] Glistering Moist [ ] Dry and wrinkled [ ]

Bitol's Spot [ ] Eyelid [ ] Visual Acuity RE [ ] LE [ ]

4. ENT

- Ear - Pina [ ] wax [ ]
- Nose – Normal / Problem [PNS /Polyp/Discharge]
- Throat - Tonsil Left [ ] Right [ ]

5. Peak flow rate

I. [ ] II. [ ] III. [ ]

Best One [ ]

6. Impression / comment:

Part C

Questions for detection of Respiratory Symptoms (for adults) When in doubt record as No.

1. Have your ever had periods of cough, phlegm, breathlessness, and wheezing in the past?

COUGH → Yes / No If Yes, When _____ Duration / Frequency_____

PHLEGM → Yes / No If Yes, When _____ Duration / Frequency _____

BREATHLESNESS → Yes / No If Yes, When _____ Duration / Frequency_____

WHEEZING → Yes / No If Yes, When _____ Duration / Frequency_____

2. COUGH

a. Do you usually cough first thing in the morning in winter? (Exclude clearing of throat)

[ ] Yes [ ] No

b. Do you usually cough during the day or at night-in the winter? (Ignore an occasional cough)

[ ] Yes [ ] No

c. If Yes to a or b Do you cough like this on most days for as much as three months each year?)

[ ] Yes [ ] No

3. PHLEMG

d. Do you usually bring up phlegm from your chest first thing in the morning in the winter?

[ ] Yes [ ] No

e. Do you usually bring up any phlegm from your chest during the day-or at night in winter?

[ ] Yes [ ] No

f. If yes to d or e, do you bring up phlegm like this on most days for as much as three months each year? [ ] Yes [ ] No

4. Periods of cough and phlegm

g. In the past three years have you had a period of (increased) cough and phlegm lasting for three weeks or more? [ ] Yes [ ] No

h. If Yes to g, have you had more than one such period? [ ] Yes [ ] No

5. Breathlessness

If subject is disabled from walking by any condition other than heat or lung disease, omit the questions in this section.

i. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?

[ ] Yes [ ] No

j. If Yes to i, Do you get short of breath walking with other people of your own age on level ground?

[ ] Yes [ ] No

k. If Yes to j, Do you have to stop for breath when walking at your own pace on level ground?

[ ] Yes [ ] No

6. WHEEZING

I. Have you had attacks of wheezing or whistling in your chest at any time in the last 12 months?

[ ] Yes [ ] No

m. Have you ever had attacks of shortness of breath with wheezing?

[ ] Yes [ ] No

n. If Yes to m, Is / was your breathing absolutely normal between attacks?

[ ] Yes [ ] No

o. Have you at any time in the last 12 months been woken at night by an attack of shortness of breath? [ ] Yes [ ] No

7. PAST ILLNESS

Have you ever had, or been told that you have had:

p. An injury or operation affecting your chest Yes / No

q. Heart trouble Yes / No

r. Blood Pressure Yes / No

s. Bronchitis Yes / No

Bronchial Asthma Yes / No

t. Pneumonia Yes / No

u. Pleurisy Yes / No

v. Pulmonary Tuberculosis Yes / No

Part D

Questions on Respiratory Symptoms for the diagnosis of Acute Respiratory Infections (ARI) in children up to2 years of age (to be asked to the mother of the child)

1. Has (NAME) had an illness with cough an illness with cough and cold at any time in the last two weeks?

[ ] Yes [ ] No

2. What signs and symptoms did you notice when the child was sick?

- is coughing
- has a blocked/running nose
- has fever
- is breathing
- has difficulty in breathing
- has chest in- drawing
- has problem eating / drinking
- other,specify _____

3. Did you seek advice or treatment for the sickness?

- No where and no treatment
- No where but home treatment
- Sub - health post / health post
- PHCC / hospital
- Aurvedic center/hospital
- Private clinic / Nursing home
- Medical shop / pharmacy
- Others, specify _____

4. How many times had this child suffered from ARI during the last year? …….

ARI Data Sheet

S. N.	Mother's Name	Mother's Smoking Habit	Child's Name	Child Age	ARI Episode			Average Exposure Hours
					I	II	III/IV	

Note
I: No Pneumonia
II: Pneumonia
III/IV: Severe Pneumonia

Annex 6
Plates

Plate 1: Health check up

Plate 2: Health check up

Plate 3: Health check up

Plate 4: Health check up of child

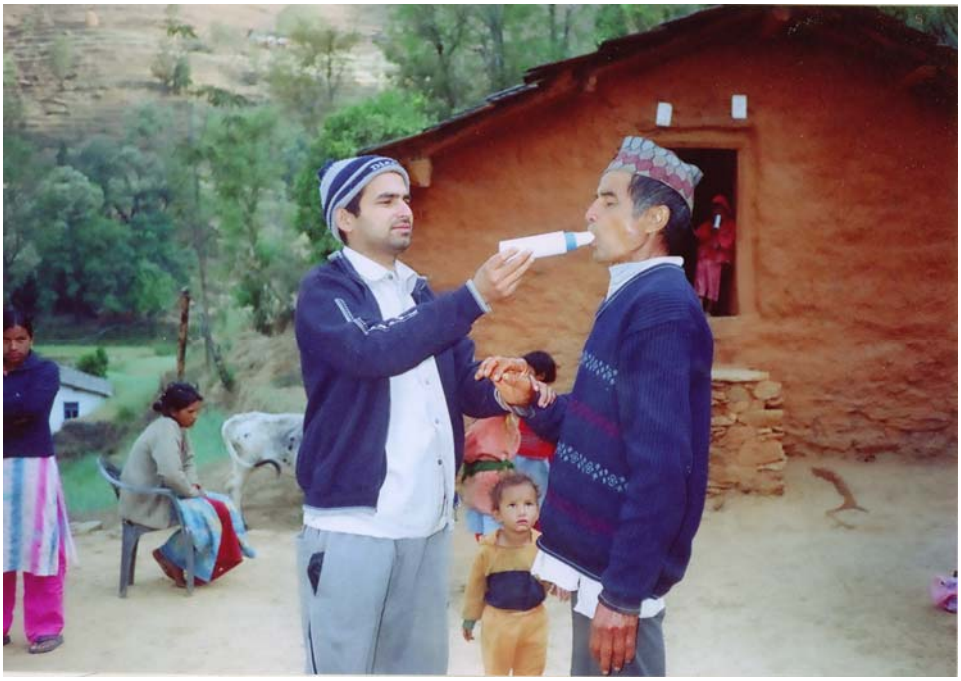


Plate 5: Peak Flow Meter Reading

Plate 6: Peak Flow Meter Reading

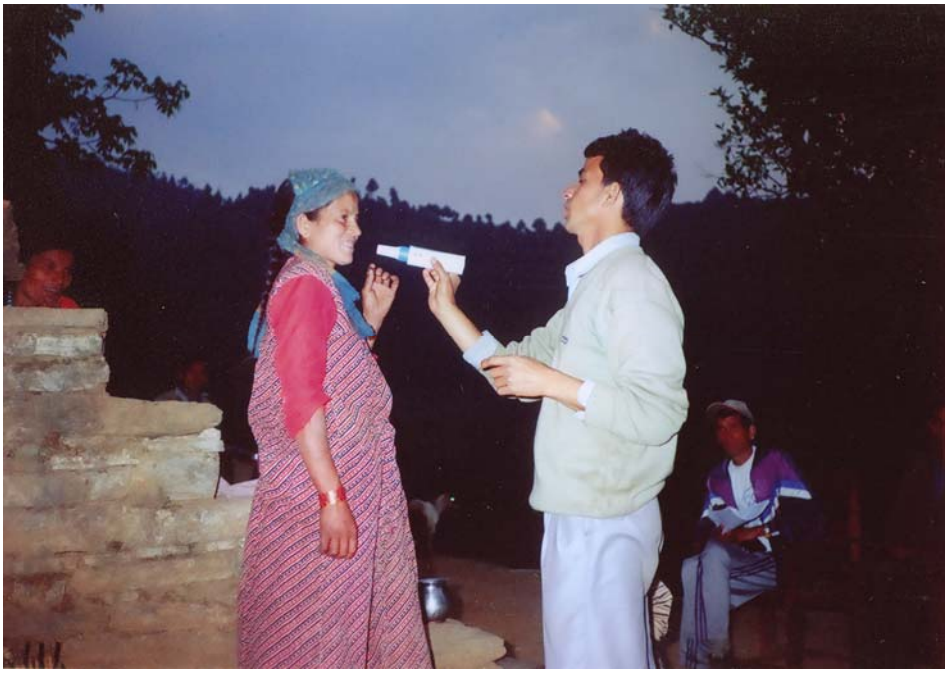


Plate 7: Peak Flow Meter Reading

Plate 8: Questionnaire Survey

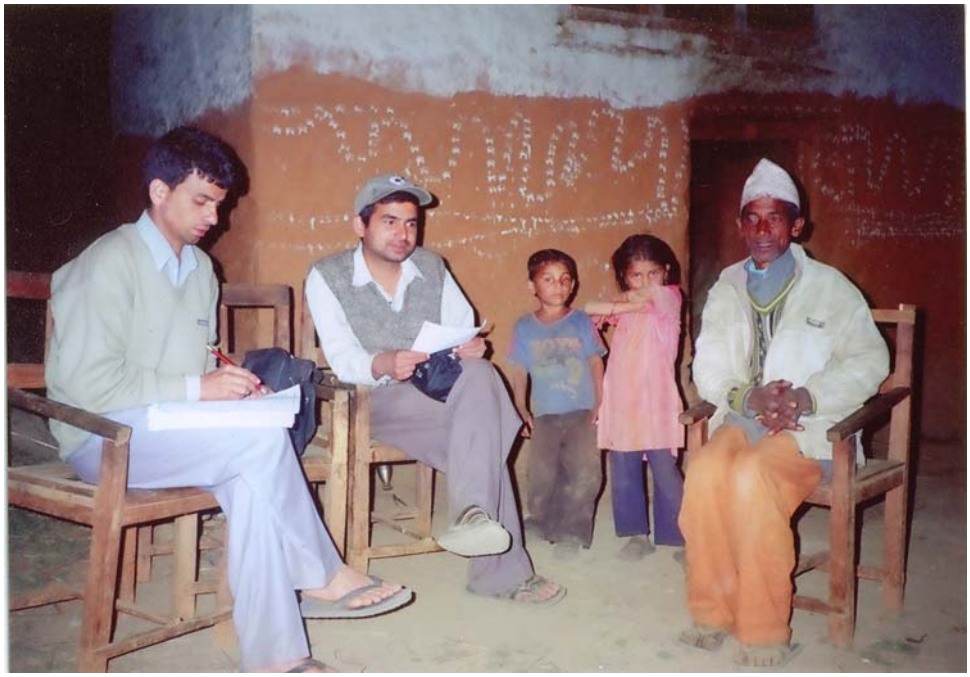


Plate 9: Questionnaire Survey

Plate 10: Kitchen View

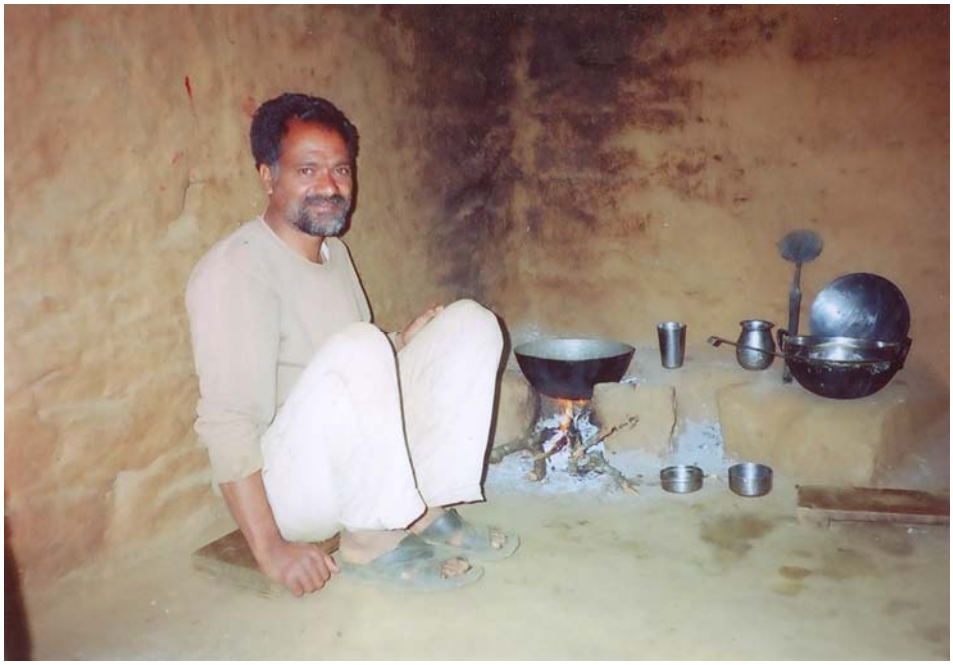


Plate 11: Men at Cooking

Plate 12: Women cooking in smoky kitchen

Plate 13: Hole in Roof (A type of Ventilation)

Plate 14: Locals growing Tobacco on their field