Impact of Fuel Scarcity and Pollution on Rural Poor: A Comparative Analysis of Vulnerable Groups in Himachal Pradesh

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PREAMBLE

Poverty, environment and health linkages in the literature are done generally with small sample and are not convincing. Several statistical approaches will confirm the linkages from our large random representative sample. This is the first ever study in India that uses large sample and gives qualitative and quantitative understanding of vulnerable groups, socio economic factors and role of policies by using various valuation methods and attributable risk factors that affect millions of lives in India. In particular it will provide new knowledge about:

- Defining characteristics of vulnerable groups, that can help in identifying them.
- The extent and opportunity cost of time spent to deal with resource scarcity.
- The burden of disease due to resource scarcity and its valuation
- Willingness to pay of vulnerable groups for clean fuels.

The overall objective of the research project is to assess the impact of scarcity of clean fuels as well as of traditional fuels and assess in economic terms the impact of pollution from the use of traditional bio fuels on vulnerable groups of rural poor in Himachal Pradesh in the context of their socio-economic circumstances, access to fuel, needs and willingness to pay for cleaner fuels.

These understandings will be relevant for other countries as well. The developing countries in Asia, Africa and South America can also benefit from this study. In order to achieve the overall objective the following specific objectives have been set to

- Estimate economic cost of lack of access to clean fuels and reliance on often scarce bio fuels, such as loss of time in gathering fuels, its opportunity costs and health impact associated with carrying heavy dirty fuels and its use.

- Characterise and profile various vulnerable groups in Himachal Pradesh.

- Analyse the impact of use of clean fuel vs. traditional dirty fuel on the basis of health indicators.

- Estimate their willingness to pay for clean fuels so that measures can be designed considering people's preferences and their willingness to pay so that one can design measures in which they have a stake.

- Present the information collected and analyse the impact of Government policy of additional quota of clean fuels, so that it can be used for energy policy and health policy at the State level.

- Discuss results and disseminate with policy makers and NGOs to improve the lives of the vulnerable poor.

Important features of the ongoing research project entitled "Impact of Fuel Scarcity and Pollution on Rural Poor: A Comparative Analysis of Vulnerable Groups in Himachal Pradesh" are give below.

a) The economic burden of dirty fuels on the rural poor is large in terms of sickness, work days lost and the opportunity cost of time spent in gathering fuel.
   - What is the time cost of gathering fuels ?
   - What are the health impacts of dirty fuels?
   - What is the economic burden of sickness and time?

b) The health and economic burden varies from group to group and particularly falls on vulnerable groups such as women and girls.
   - What are the vulnerable groups?
   - What is the extent of variation among the sub samples of vulnerable groups? Can we differentiate them according to age, fuel use, etc.
   - What are the gender issues?
   - To what extent these problems are not solved because of inequality of women within the family?

c) Use of dirty fuels adversely affects people's health in a quantifiable manner.
   - How to establish cause and effect relationship?
   - How do we quantify the impact?
   - How to control for the confounding variables?
   - What would be the impact of a policy of additional quota of cleaner fuel ?

d) Market distortions aggravate the problem as the willingness to pay for clean fuels is much more than
   - What is currently for subsidised fuels with quota restrictions?
   - To what extent people are willing to pay for clean fuels?

- What other improved distribution systems can be made feasible on sustainable basis?

Appropriate statistical method will be used to test the hypotheses. The main deliverables of the project are described below:

- The main deliverables are technical reports that describe the new knowledge gained and executive summaries for policy makers and for creating stakeholder awareness.
- Dissemination to policy makers and stakeholders could lead to attention to the problem.
- Stakeholder seminars at various stages will be held to reflect stakeholder concerns and create stakeholder awareness. The reports of these can be illuminating and will be prepared.
- Findings and recommendations of the study will be disseminated through executive summaries and policy briefs to local decision makers and NGOs.

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ABBREVIATIONS

AHI	:	Annual Household Income
ARI	:	Acute Respiratory Infectious
BPL	:	Below Poverty Line
CPR	:	Common Property Resource
HC	:	Health Centres
HH	:	Households
HP	:	Himachal Pradesh
LRI	:	Lower Respiratory Infectious
MRC	:	Medical Research Council
PDS	:	Public Distribution System
PHC	:	Public Health Centres

1 INTRODUCTION

Rural population obtains 90% of cooking energy from biofuels such as fuel wood, crop residues and animal dung. These biofuels result in very high levels of indoor air pollutants. This issue has been neglected in energy, environment, health and economic policy for decades and is now poised for major policy and programme initiatives. Such comprehensive analysis could direct energy and environment policy and health initiatives in proper direction. This requires an understanding not only of the socio-economic aspects, but of many other factors also. For example,

- What is the extent and magnitude of biofuels in the rural areas and how difficult it is to get them?
- Why do clean fuels have limited presence in the consumption basket despite the fact that many other consumer durables as well as consumables have already entered? Is there a willingness to pay for cleaner fuels?
- What interventions are acceptable to the rural people among cleaner fuels, improved stoves or ventilation?
- Which groups suffer most from the health risks?
- What are the levels of pollution exposures due to biofuels to chief cooks and others who are present. What are the determinants of exposure such as fuel, stoves, house type, kitchen type, ventilation and so on?
- What is the linkage between exposure and health? Do they produce symptoms that medical doctor can verify? Do they affect lung capacity over time?
- What is the role played by health centres? Do they find more cases of air and water pollution related diseases?
- What are the environmental priorities of people themselves? Do they give higher weight to water pollution and sanitation due to their immediate effect on their health in the short term?

Himachal Pradesh represents a mountain ecosystem and is a small state and therefore it was selected for a comprehensive survey to address issues of energy, water, sanitation, health issues covering 712 households in rural areas. Because of hilly terrain, settlement is unique in the state, where villages are scattered, with mere 10 households per village in many cases. To achieve the required sample size it was therefore necessary to cover most of the districts in the State. We have covered 54 villages from these 9 districts. Health survey was conducted for 4100 individuals. The analyses helped up to draw some state level inferences. As we have a random representative sample of households, we used this data to draw macro level conclusions.

The layered survey involved surveys within the survey to get to the bottom of this issue. Along with socio-economic variables, views on intervention that can lead to success, people's perception about these issues we also included measurement of body mass index and lung capacity, experts to measure pollution and medical doctors to check health status.

Interventions are now being planned by several agencies such as World Bank, United Nations Development Programme, World Health Organisation and many other aid agencies who are now interested in action. At this juncture it is essential to get a comprehensive picture that channelises these interventions in the right direction.

In this study, the fuel supply, the fuel consumption patterns, and people's desire to change the fuel consumption pattern has been analysed. Second, the exposure to pollution from these fuels (with attributes such as kitchen locations, cooking practices, type of housing etc.) has been examined. Third, the health impact due to these exposures and the way women perceive them and the way medical professionals see them have also been analysed.

2 SURVEY DESIGN

2.1. INTRODUCTION

Surveys conducted earlier have been limited to some specific objective. Thus, in some surveys we have pollution measurements but not enough information about socio-economic characteristics or in some cases disease prevalence but no measurements of level of pollution. Moreover, most of them were small surveys, rarely covering more than 400 households (Smith, 1996; Saxena and Dayal, 1997). This makes it difficult to understand a lot of uncertainties in linking pollution with symptoms and physical conditions of human beings. Our aim was to carry out a comprehensive survey with a large sample so that many doubts and uncertainties can be removed. Thus, the survey team was accompanied by doctors to check the health profile of all individuals present. Socio-economic and other household details, as well as individuals' self reported information was collected through appropriately designed questionnaire.

According to the Census 2001 there were 1.10 million rural households in Himachal Pradesh spreading around 17,000 inhabited villages. Thus, village sizes were very small, many villages were even with less than 10 households. Moreover, road accessibility being a problem due to heavy terrain or snowfall, selection of villages from Himachal Pradesh State was made flexible. We therefore covered the State by selecting many districts, 9 districts out of total 12 districts, and within a district household quota was fixed to achieve the proposed sample size in proportion to universe population distribution. The selected nine districts, namely, Bilaspur, Chamba, Hamirpur, Kangra, Mandi, Shimla, Sirmaur, Solan and Una, covered 54% of the geographical area and 92% of the State's population. Selection of households within a village was performed using systematic random sampling. The number of households from each district is given in Table 2.1.

Table 2.1: Distribution of sample households in different districts

District	Rural Population 2001 ('000)	Estimated Rural HHs ('000)*	Proportionate Sample Size	Actual Sample Size	Percent
Bilaspur	319	64	46	58	8
Solan	408	82	58	50	7
Hamirpur	382	76	54	66	9
Sirmaur	411	82	58	51	7
Una	409	82	58	62	9

Chamba	426	85	60	59	8
Shimla	555	111	79	79	11
Mandi	840	168	119	112	16
Kangra	1,266	254	180	175	25
Total	**5,016**	**1,004**	**712**	**712**	**100**

* Number of households estimated based on average family size of 5.0 in HP rural as per Census 2001

The survey was conducted at three levels, viz. household level survey including individual responses for health status, village level survey and survey of near by health care facility (health centre) which villagers are availing (for example primary health centres, public health centres, Govt. hospital, etc.). Village level and Health Centre (HC) survey were performed for the purpose of validation of data acquired at household and individual level, and also to get an overall picture of the area. This also helped in economising the number of questions. For example, in a village level survey one ascertains fuel sources, schools, health facilities and doctors' availability along with distance from the road, any air polluting industry, etc. HC survey indicates what types of diseases are reported in the area, what type of facilities are available, what are the high and low seasons for respiratory diseases, etc. At the household level a multi-pronged approach was used to collect different types of information. The methods used were following.

- Face to face interview with chief cook.
- Symptom inquiry and health assessment with measurement of weight, height and lung capacity with peak flow meter.
- Diagnostic with medical professionals.

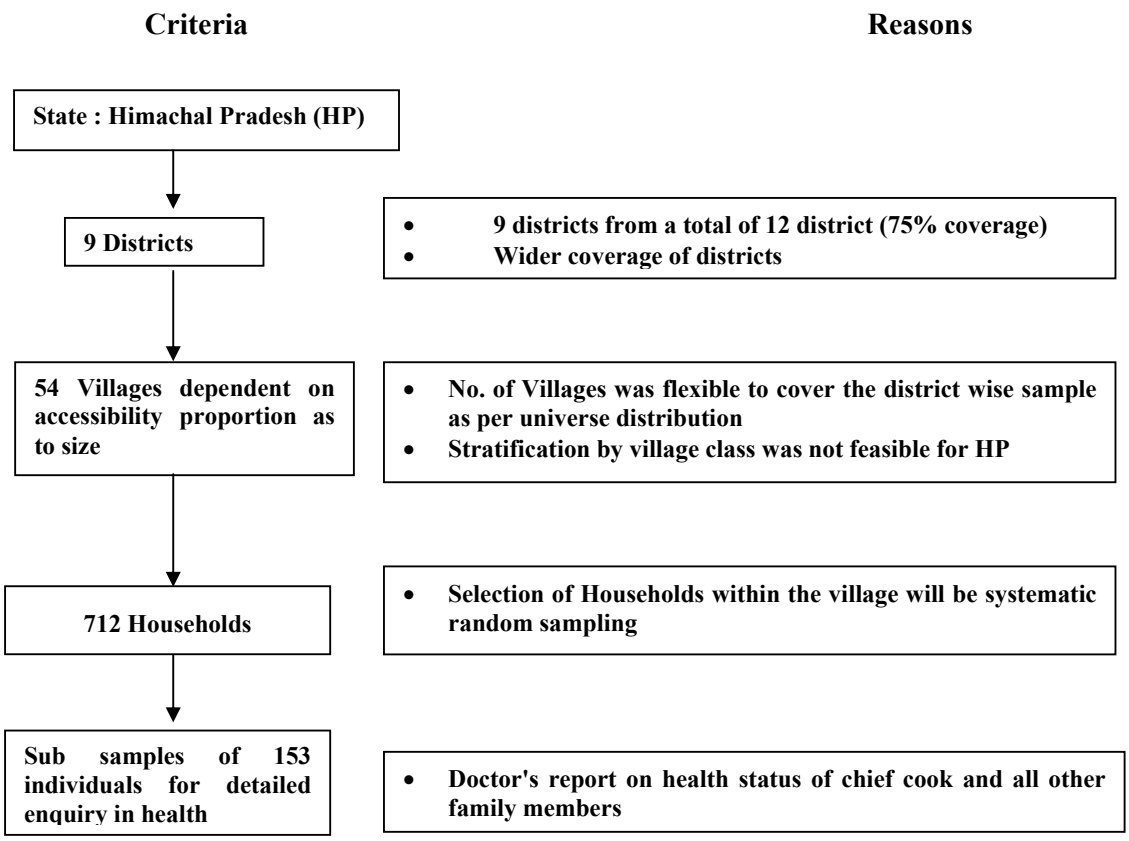
The data at household level were collected to have a complete picture of socio-economic conditions, fuel consumption pattern, cooking behaviour, villagers' exposures to selected indoor air pollutants generated during the combustion of bio-fuels, and health profile of the individuals, so as to link pollution with health and other confounding variables. Village level information was collected from the head of the village panchayat, whereas HC level information was collected from administrative officer or chief resident doctor. (See the Fig. 2.1 for over all picture of the survey). The total sample size information is as follows.

Total no. of village level interview	11 interviews (Based on availability of head of Panchayat and the head is representing for 2/3 villages)
Total no. of HC level interviews	2 interviews
Total no. of households covered	712 household interviews

Total no. of individual health record	4,100 household members
Total no. of lung function records	1,580 individuals

The methodology for collecting the information from household is explained below for each of these components.

Fig 2.1(a): Case of Himachal Pradesh : Sampling Procedure



2.2 SOCIO-ECONOMIC CONDITIONS

Data were collected through face-to-face interview of the chief cook of the house. The information collected was age, literacy and income status, asset structure, willingness to pay for different improvements to reduce kitchen smoke, time activity pattern of the members of the household, environmental concerns of the respondent.

2.3 FUEL CONSUMPTION PATTERN

The information collected was regarding different type of fuels and its quantity used for cooking, source and distance from where fuel is being collected (in case it is being collected),

price paid (if any) for purchasing of different type of fuels. The information regarding availability of kerosene and willingness to switch to clean fuels were also collected.

2.4 COOKING BEHAVIOR

The information in this category too was collected from the chief cook of the house. The queries were regarding, type of house and kitchen, location of kitchen, meals cooked in a day, quantity of fuel used, type of stove, availability of clean fuel etc.

2.5 HEALTH PROFILE

To understand the health profile of the individuals the task was divided between the three groups,

- Trained surveyors to handle the questionnaire based on MRC (Medical Research Council) questionnaire on respiratory symptoms, 1986
- Physicians to confirm the disease
- Trained surveyors to measure peak expiratory flow readings

The surveyors were trained by a physician to collect health data through MRC questionnaire on respiratory diseases. Therefore, for 1,580 adult individuals direct responses were available, whereas, for absent members and children proxy data were collected from the respondent. Thus a proxy response on health status were collected for 2,520 individuals.

The senior physician, who was responsible for reviewing the individual case sheets before making a final assessment, supervised a group of junior doctors. These doctors performed physical examination of all the symptomatic cases found through questionnaire for identifying the disease.

2.6 ORGANIZATION OF SURVEY RESULTS

Results of the survey are presented in the following manner. In chapter 3 district characteristics including infrastructure facilities, health care facilities and human development indicators are presented. Chapter 4 deals with the preliminary analysis of the survey results. Different characteristics of fuel use including fuel use pattern, time and effort involved in fuel wood collection, access to use of clean fuel, price willing to pay for clean fuel and reasons for not using the clean fuel are discussed. Housing conditions and cooking

practices are also discussed in this section. Over all health status is presented in Chapter 5. Linkages between bio-fuels use, different cooking practices and type of house with health are established. Chapter 6 deals with main environmental concerns of the rural women. The last chapter (i. e. chapter 7) deals with summary.

3 DISTRICT PROFILES

3.1. GEOGRAPHIC AND DEMOGRAPHIC PROFILE

Himachal Pradesh (HP) is divided into 12 administrative districts. These districts have some distinct features in terms of its altitude, climate, geology, soil, flora, fauna, and topography. More than 90 percent of the state's population of 6.08 million (as per Census 2001) lives in rural areas in these districts. Table 3.1 presents the geophysical profile of the districts of Himachal Pradesh. The district wise area and population is given in Table 3.2.

Table 3.1: Geophysical Profile of the Districts

S. No.	State/District	Altitude (height from MSL in metres)	Climate
1	Bilaspur	300 to 600 and 1200 to 2100	Warm temperate and Sub-tropical
2	Chamba	1000 to 5000	Alpine, Cold temperate and Warm temperate
3	Hamirpur	300 to 600 and 1200 to 2100	Warm temperate and Sub-tropical
4	Kangra	500 to 1000 and 3000 to 6000	Cold temperate and Warm temperate
5	Kinnaur	1800 to 4800	Sub-arctic, Alpine and Cold temperate
6	Kullu	1500 to 4800	Alpine, Cold temperate and Warm temperate
7	Lahul & Spiti	3000 to 4500	Sub-arctic and Alpine
8	Mandi	1200 to 3000	Warm temperate
9	Shimla	1500 to 3200	Cold temperate and Warm temperate
10	Sirmaur	300 to 450 and 3000 to 3300	Warm temperate and Sub-tropical
11	Solan	300 to 2100 and 150 to 1500	Warm temperate and Sub-tropical
12	Una	300 to 600 and 1200 to 2100	Warm temperate and Sub-tropical

Source : Himachal Pradesh Human Development Report 2002
Districts 5, 6 and 7 were not covered in our survey

Table 3.2: Geographic Area and Population of the Districts

S. No.	State/District	Area (Sq. km.)	Total Population 2001 ('000)			Rural population 2001 ('000)			Rural Population (%)	Estimated Rural H'holds@ ('000)
			Persons	Males	Females	Persons	Male	Female		
	Himachal Pradesh	**55,673**	**6,077**	**3,085**	**2,992**	**5,482**	**2,754**	**2,728**	**90%**	**1,098**
1	Bilaspur	1,167	341	171	170	319	159	160	94%	64
2	Chamba	6,528	461	235	226	426	216	210	93%	85
3	Hamirpur	1,118	412	196	216	382	180	202	93%	76
4	Kangra	5,739	1,338	660	678	1,266	622	644	95%	254
5	Kinnaur*	6,401	84	45	39	84	45	39	100%	17
6	Kullu	5,503	380	197	183	350	180	170	92%	70
7	Lahul & Spiti	13,835	33	18	15	33	18	15	100%	7
8	Mandi	3,950	901	447	454	840	415	425	93%	168
9	Shimla	5,131	722	380	342	555	285	270	77%	111
10	Sirmaur	2,825	458	241	217	411	216	195	90%	82
11	Solan	1,936	499	269	230	408	213	195	82%	82
12	Una	1,540	448	224	224	409	204	205	91%	82

* Includes estimated population of Kinnaur where population enumeration could not held due to natural calamity.
@ Number of households is estimated based on the average state household size of 5 persons.
Source : Census 2001
Districts 5, 6 and 7 were not covered in our survey

The lowest proportion of rural population is in Shimla district which encompassed the state capital Shimla. The districts like Kinnaur, Lahul and Spiti being a hilly terrain has no urban component at all. These districts have a population density below 70. Whereas Hamirpur is a district with high population density. The district wise population growth rate, density and sex ratio are presented in Table 3.3.

Table 3.3: Population growth, Density and Sex ratio of the Districts

Sr. No.	State/District	Decadal growth rate		Density		Sex ratio	
		1981-1991	1991-2001	1991	2001	1991	2001
	Himachal Pradesh	**20.79**	**17.53**	**93**	**109**	**976**	**970**
1	Bilaspur	19.41	15.35	253	292	1,002	992
2	Chamba	26.40	17.09	60	71	949	961
3	Hamirpur	16.17	11.62	330	369	1,105	1,102
4	Kangra	18.50	14.01	205	233	1,024	1,027
5	Kinnaur	19.69	17.79	11	13	856	851
6	Kullu	26.68	25.60	55	69	920	928
7	Lahul & Spiti	-2.51	6.17	2	2	817	804
8	Mandi	20.40	16.05	197	228	1,013	1,014
9	Shimla	20.84	16.90	120	141	894	898
10	Sirmaur	23.72	20.72	134	162	897	901
11	Solan	26.02	30.64	197	258	909	853
12	Una	19.17	18.43	246	291	1,017	997

Source : Census 2001
Districts 5, 6 and 7 were not covered in our survey

3.1.1 Population Growth

With the current decadal growth rate at 17.53 percent, it is estimated that the population would double in about 50 years i.e. by 2050 the population would be approximately 12 million. With such a high population increase, the State would require additional resources to meet health care needs of the people. As for Family Planning, unmet needs which were assessed at 15 percent in 1992 shall have to be met, with a particular emphasis on spacing methods, especially among low parity couples.

3.1.2 Sex Ratio

The state is much better placed in sex ratio as compared to many states in the country.

3.2 EDUCATION AND LITERACY PROFILE

Advances in the field of education comprise one of Himachal Pradesh's greatest success stories. In the 1950's the literacy ratio of 4.8 percent in the State was almost the lowest in the country. Two decades later, it had increased to 63.9 percent. Female literacy levels increased

from 2 percent in 1951 to 52.1 percent in 1991. By 1991 the State had emerged as the fifth most literate State of India. As a result of "schooling revolution", despite a hilly terrain making access to schools extremely difficult, had overtaken the people. The growth of literacy levels were boosted in the 1980's with the rising enrolment ratios at the primary level, of both, boys and girls. Similar gains, though less striking, were recorded at the middle levels. During the 1990's, these gains were further consolidated with enrolment ratios in the middle level approaching 100 percent, with more significant increases in the enrolment of girls.

As a result of these efforts, even rural literacy has reached 74.4 percent. But still there is a gap between male literacy and female literacy to the extent of 18 percent which needs to be narrowed down further. The widest gap still exists in Chamba (28.9 percent) and the gap is narrowest in Hamirpur, Kangra and Una (around 15 percent) as shown in Table 3.4.

Table 3.4: District wise rural literacy and the literacy gap between males and females

S. No.	State/District	Rural Literacy Rate (%) – Census 2001			
		Persons	Males	Females	Literacy gap between males and females
	Himachal Pradesh	**74.4**	**83.6**	**65.2**	**18.4**
1	Bilaspur	78.0	86.7	69.4	17.3
2	Chamba	61.5	75.7	46.8	28.9
3	Hamirpur	82.6	90.7	75.7	15.0
4	Kangra	80.3	88.0	73.0	15.0
5	Kinnaur	NA	NA	NA	NA
6	Kullu	72.0	83.8	59.4	24.4
7	Lahul & Spiti	73.2	82.8	60.9	21.9
8	Mandi	74.7	86.1	63.8	22.3
9	Shimla	75.8	85.5	65.5	20.0
10	Sirmaur	68.7	78.2	58.1	20.1
11	Solan	74.5	83.7	64.5	19.2
12	Una	80.9	88.6	73.5	15.1

Source : Census 2001
Districts 5, 6 and 7 were not covered in our survey

The role of the public sector in general, of an expanding private sector, supported by growing governmental budgetary allocations in promoting education in the State is well recognized. The expansion of the school network, at the same time, has managed to maintain the student-teacher ratio. Nevertheless, to keep this healthy trend training institutes for teachers need to be continually increased, and the overall intra-district imbalances in all spheres of education need to be bridged. Incentives like mid-day meals, scholarships and free textbooks have improved access to elementary education among the poorer sections of the State, though

concerns in these areas remain. While the State may have "miles to go" in the field of education, the current status of this critical sector of human development constitutes a remarkable achievement.

3.3. SOCIO-ECONOMIC CONDITION

Available data shows that poverty levels have not improved much over the years. The decade since 1993-94 has seen a little less than one-third of the population living under the poverty line. As per the instructions of the government of India, the state government has conducted a fresh household survey for the 9th Five Year Plan which has been made applicable with effect from 1st April, 1999. The families having monthly per capita consumption expenditure up to Rs. 289.31 have been identified below the poverty line. The district wise number of families below poverty line identified for 9th five year plan is given in Table 3.5.

Table 3.5: District Wise Families Below Poverty Line (BPL)

S. No.	District/State	No. of Rural Households	No. of Rural Families Below Poverty Line				Percentage families BPL
			Total	SC	ST	Women	
	Himachal Pradesh	**1,036,996**	**286,112**	**107,057**	**19,105**	**41,850**	**27.59**
1	Bilaspur	65,532	17,448	6,649	505	2,222	26.62
2	Chamba	76,418	47,165	9,863	13,650	6,328	61.72
3	Hamirpur	83,505	20,179	7,826	-	3,902	24.16
4	Kangra	265,740	63,972	21,432	37	10,421	24.07
5	Kinnaur	10,899	2,896	1,326	1,570	334	26.57
6	Kullu	59,227	11,432	5,335	197	1,630	19.30
7	Lahul & Spiti	6,446	2,445	197	2,248	542	37.93
8	Mandi	169,863	42,012	18,469	422	5,254	24.73
9	Shimla	94,316	21,755	14,839	152	4,686	33.67
10	Sirmour	58,618	13,418	6,416	272	1,569	22.89
11	Solan	65,418	17,951	9,155	52	2,461	27.44
12	Una	81,014	15,439	5,550	-	2,401	19.02

Source : Government of Himachal Pradesh
Districts 5, 6 and 7 were not covered in our survey

Development programmes need to address this situation that will require careful monitoring and critical assessment in the years ahead.

3.4. HEALTH INSTITUTIONS

Coverage norms for opening Primary Health Care institutions fixed by Govt. of India, have by and large, been achieved as shown in Table 3.6.

Table 3.6: Average rural population covered by health institutions as on June 30, 2000

Institutions	Govt. of India norms for plain areas	Govt. of India norms for hill state	Rural population covered
Sub-centre	5000	3000	2698
PHC	30000	20000	18485
CHC	1.20 lakhs	80,000	85883

Source: Health and Family Welfare Department of Himachal Pradesh

The difficult hilly terrain and limited resources has not deterred the State in attempting to solve the problem of accessibility by establishing and locating health institutions as close to the people as possible. A dedicated team of health providers has tried its best to ameliorate the sufferings of the human being. Himachal Pradesh has made a definite niche in the health framework. The State has a fairly extensive network of health institutions. The district wise health institutions as on 31st March 2000 are presented in Table 3.7.

Table 3.7: Existing Health Institutions, District wise

S. No.	District/State	CHs	CHCs	PHCs	CDs	ISM Inst	S/Cs
	Himachal Pradesh	**48**	**65**	**302**	**167**	**1,153**	**2,069**
1	Bilaspur	2	5	17	11	67	110
2	Chamba	4	7	28	11	102	161
3	Hamirpur	2	5	17	6	72	150
4	Kangra	8	12	50	34	223	447
5	Kinnaur	2	3	17	0	44	34
6	Kullu	1	3	14	5	65	99
7	Lahul & Spiti	1	3	9	5	24	32
8	Mandi	6	9	44	13	165	300
9	Shimla	9	6	47	30	149	241
10	Sirmaur	5	3	24	14	82	143
11	Solan	5	3	20	17	78	172
12	Una	2	3	12	9	73	125

Source : H & FW Department of HP

Districts 5, 6 and 7 were not covered in our survey

3.5. HUMAN DEVELOPMENT INDICES FOR THE DISTRICTS

Having limitations of HDI as the selected variables may not be appropriate for different reasons having different geo-climatic, socio-cultural, economic and environmental

conditions, it provides a broad idea about the level of human development. The human development indices of the districts of Himachal Pradesh State are presented in Table 3.8.

Table 3.8: Human Development Indices for the Districts

S. No.	District /State	Income Index	Rank	Educational Attainment Index	Rank	Health /Life Index	Rank	Human Development Index	Rank
	Himachal Pradesh	**0.184**		**0.697**		**0.417**		**0.433**	
1	Bilaspur	0.183	7	0.747	4	0.340	7	0.423	7
2	Chamba	0.191	6	0.510	12	0.569	2	0.423	7
3	Hamirpur	0.103	11	0.810	1	0.299	9	0.404	9
4	Kangra	0.163	8	0.752	3	0.382	10	0.432	6
5	Kinnaur	0.349	2	0.626	10	0.556	3	0.510	3
6	Kullu	0.238	5	0.663	9	0.701	1	0.534	1
7	L & Spiti	0.471	1	0.678	7	0.257	11	0.469	4
8	Mandi	0.132	10	0.711	5	0.326	8	0.390	11
9	Shimla	0.304	3	0.681	6	0.569	2	0.518	2
10	Sirmaur	0.155	9	0.571	11	0.500	4	0.409	8
11	Solan	0.255	4	0.676	8	0.431	6	0.454	5
12	Una	0.090	12	0.759	2	0.347	5	0.399	10

Source: Computed by the Department of Planning, Govt. of HP
Districts 5, 6 and 7 were not covered in our survey

4 PRELIMINARY ANALYSIS OF THE SURVEY RESULTS

We discuss below the survey results and preliminary analysis. This exercise familiarises us with the households, individuals and other characteristics.

4.1 DEMOGRAPHIC DETAILS

The nine districts, namely Bilaspur, Solan, Hamirpur, Sirmaur, Una, Chamba, Shimla, Mandi and Kangra were selected to have the maximum spread within the State (See Table 4.1). These nine districts together comprise 92 percent of the State's rural population. General characteristics of the districts are as follow:

Table 4.1: Sample coverage in Himachal Pradesh

Characteristics	Total	Study covered
Rural Population (million)	4.670	0.004 (0.09)
Number of villages	16,997	54 (0.3)
Estimated number of households (000)	848	0.7 (0.08)
Average number of households per village	50	13

Village characteristics including demographic details, infrastructure facilities, heath care facilities are shown here. The survey reveals that in the area, female population is slightly higher than male population. Population distribution is such that there are 1036 females per 1000 males. Sex wise age distribution is indicated in Table 4.2. Male literacy is higher than the female, as 80 percent of males are literate whereas, in case of females this percentage is just 69 percent.

Table 4.2: Age composition by sex

	Male	Female
Base: All individuals	2,013	2,087
	percent	percent
< 5 years	11	10
6 – 10 years	10	9
11 – 15 years	11	11
16 – 20 years	12	12
21 – 40 years	32	36
41 – 50 years	12	10
> 50 years	13	12

4.2 INFRASTRUCTURE FACILITIES

The survey shows that most of the villages have some road network and mode of transportation. In the selected villages 64 percent of the villages have pucca road within half a kilometre distance and another 18 percent villages have pucca road within two kilometres. The remaining 18 percent villages have pucca road within a distance of 4 kilometre. Only 18 percent of the sample villages have the railway station within a distance of 2 kilometre. Being a hilly State a large majority of villages (82 percent) however have the railway stations beyond 5-kilometre distance. About a half (45 percent) of the sample villages have a town at a distance beyond 5 kilometre. Since the majority of the sample village is close to pucca roads, the main mode of transport is bus. In addition, there are other modes of transport like auto rickshaw and train.

4.3 EDUCATIONAL FACILITIES

Seventy three percent of sample villages have primary schools, and 18 percent of villages have both primary and secondary schools. Only one village (9%) do not have any school. Only one village has a vocational training centre.

4.4 AVAILABILITY OF HEALTHCARE FACILITIES

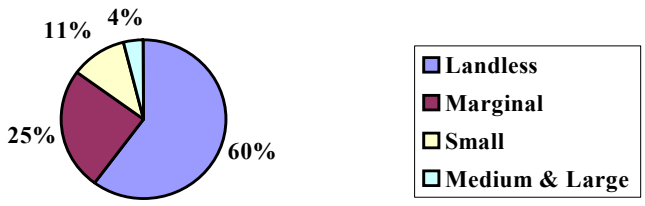
Almost all sample villages have healthcare facilities. Moreover, most of the villages are also serviced through primary health centres/government hospitals/private hospitals. Average distance to the nearest hospital ranges between 2 to 5.5 km. Pathological laboratory facilities are also available to 27 percent of the villages within an average distance of 1.4 km. Presence of any polluting industry also affects the health of the local people. Village level survey shows that 27 percent of the sample villages have industry nearby. Most of these industries are located within a radius of 2 km from the village. All these industries are non-polluting type (neither air nor water).

4.5 SOCIO-ECONOMIC CONDITIONS

Majority of villagers (60 percent) are landless and about 36 percent of the villagers are either small or marginal farmers (see Fig 4.1) having land area less then or equal to 5 acres. The income structure shows that 11 percent of the households have income less than Rs. 10,000 per annum. 34 percent of the households have income between Rs. 10,000 to Rs. 30,000 per annum, and 54 percent of the households have income greater than Rs. 30,000. As against the estimated proportion of low-income households of 0 percent by Panchayat office, sample proportion of

households derived from our household survey is 11 percent. Thus, around 11 percent of households belong to low-income category with annual income less than Rs. 10,000 (less than Rs. 850 per month).

Fig 4.1 : Land Holdings



4.6 COMMON PROPERTY RESOURCE (CPR) BASE

The survey shows that approximately in 55 percent of the villages (See Table 4.3), people share open water sources, which are not used for drinking. In 55 percent of the villages, grazing and pasturelands are available as CPRs.

Table 4.3: Sharing of CPRs* (Base : No. of villages 11)

Resources Shared	Total (percent)
Open water sources - not used for drinking	55
Open water sources - used for drinking	18
Grazing land	55
Forest, of which	
- Village forest	18
- Government forest	18
- Forest department's forest	55

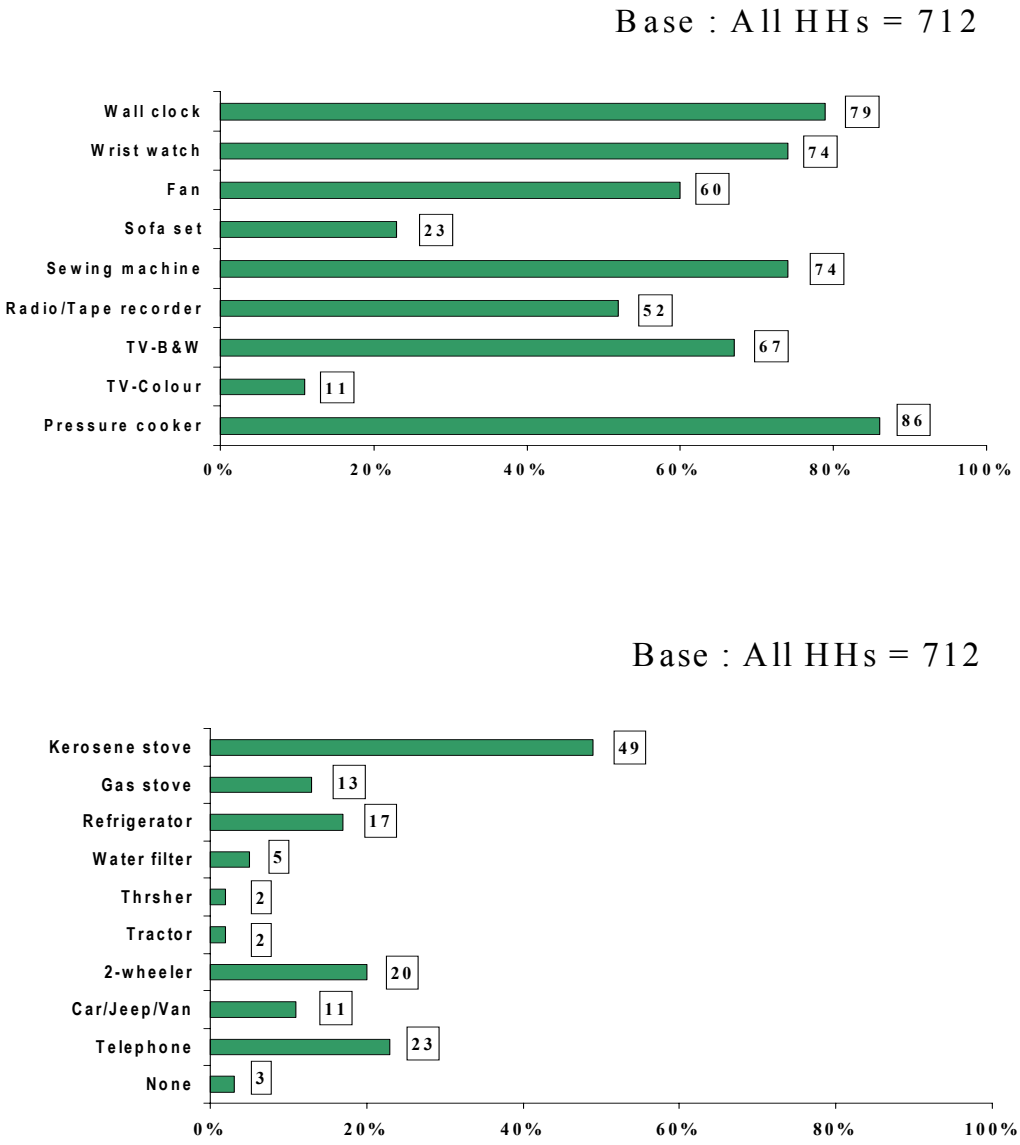
*As enquired from head of each village

4.7 HOUSEHOLD DURABLES

The different types of durables owned by the household reflect the purchasing power of a household. Statements about income are often found to be unreliable in surveys. A more reliable indicator of income would be ownership of consumer durables. The survey reveals that most of the households (79 percent) own wall clock and 74 percent own a wristwatch (See Fig 4.2). Fan and radio/tape recorder, is owned by 60 percent and 52 percent households respectively. 54 percent households have gas stove and 49 percent households have kerosene stove. At least these 49 percent households who already have kerosene stove

can be expected to switch to next cleaner fuel on energy ladder i.e. kerosene if made available in sufficient quantity.

Fig 4.2: Durables Owned (% households)



4.8. DIFFERENT CHARACTERISTICS OF FUEL USE

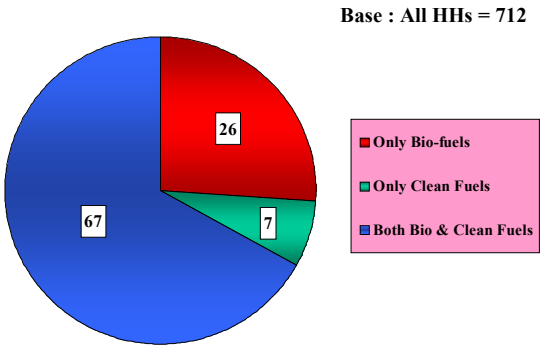
Characteristics of fuel use include issues such as what is the major fuel used for cooking, time and effort involved in getting that particular fuel and availability of other type of fuels in the area. In this section we will discuss each one of this.

4.8.1 Fuel Consumption Pattern

In rural Himachal Pradesh use of clean fuel is quite significant. Distribution systems for LPG and Kerosene are quite good. However, bio-fuels are still the main source of cooking fuel for about 93 percent households are using fuel wood. 67 percent household use both clean and bio-fuels. Whereas only 7 percent use clean fuels exclusively. Use of dung cake for cooking is not very common in the area (19 percent). Kerosene is used for cooking to the extent of 31 percent of households.

The results of the study show that fuelwood is the main source of cooking fuel. Average consumption of fuel wood is 7.4 kg per household per day in the area. Only 7 percent of the households were using clean fuels exclusively, like kerosene or liquid petroleum gas for cooking purposes. Whereas 67 percent were using fuel combination i.e. biomass and clean fuel (Fig 4.3). Where combination of clean fuels and bio-fuels are used, kerosene is mainly used for lighting and cooking snacks or very small meals. Main meals in these households too are cooked using fuelwood. This is obvious from the very small amount of kerosene consumed per household i.e., on an average 7.8 litres per household per month.

Fig 4.3 : Fuel Consumption Pattern



When the lighting fuel is subtracted say 3 to 5 litres per household than only 24 percent households remain that are using kerosene for cooking. See the Table 4.4.

Table 4.4: Kerosene consumption

Litres of Kerosene per month	Households	Percent households using kerosene
Less than or equal to 5 litres	145	40
Greater than 6 to 10 litres	59	16
Greater than 10 and less then 40 litres	23	8

4.8.2 Fuel Wood Collection

The households (94 percent) generally gather fuel wood from village and government forests and very few households purchase fuel-wood. These fuel wood collecting households mostly send one person. In some cases, however, 2 persons are also engaged for collection of fuel wood. On the average 15 trips per household (taking into account whoever collected) are made in a month to collect wood. In most of the villages the distance travelled to collect wood is less than 2 km (Table 4.5). Average distance to collect the fuel wood is about 2 km. Thus, in a month 30 km. distance is being travelled for gathering the required quantity of fuel wood.

Table 4.5: Time and Efforts for Collection of Fuel wood

Districts	Total	Bilaspur	Solan	Hamirpur	Sirmaur
Base : HHs always/mostly gather wood	417 %	45 %	50 %	51 %	46 %
HHs collecting from up to 1 km	42	27	28	65	26
HHs collecting between 1 - 2 km	31	35	26	22	24
HHs collecting from 2 - 3 km	12	16	20	6	20
HHs collecting from more than 3 km	14	20	26	6	30
Average time spent per trip (hours)	2.7	2.6	2.9	2.5	2.8
Average time spent per month per household	40.8	25.5	45.0	34.3	50.7

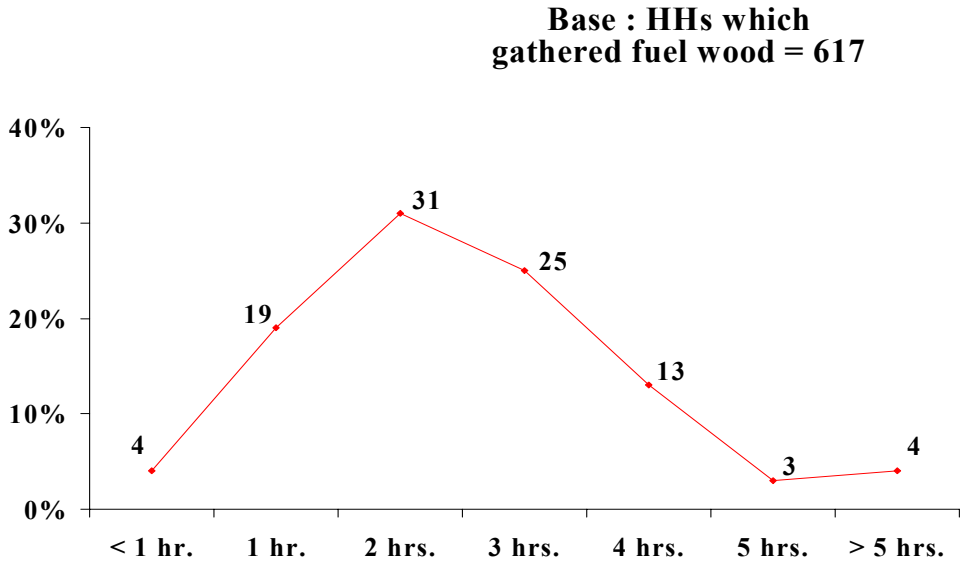
Districts	Una	Chamba	Shimla	Mandi	Kangra
Base : HHs always/mostly gather wood	53 %	58 %	65 %	94 %	155 %
HHs collecting from up to 1 km	21	36	23	65	52
HHs collecting between 1 - 2 km	51	40	40	26	28
HHs collecting from 2 - 3 km	17	14	18	1	8
HHs collecting from more than 3 km	11	10	18	4	12
Average time spent per trip (hours)	2.8	2.8	3.2	2.4	2.5
Average time spent per month per household	29.7	53.2	57.3	32.9	37.8

4.8.3 Time Spent for Fuel-Wood Collection

Average time spent on collection of wood is around 2.7 hours per trip per person (see Fig 4.4). Therefore, approximately 40 hours per month per household are spent on fuel wood

collection. Except for person hour involved in collection of fuel wood there is no other expense involved towards fuel wood collection.

Fig 4.4: Average Time Spent in Collection of Fuel-wood (person hours/household/trip)



4.8.4 Access to and Extent of Use of Clean Fuel

Availability of clean fuel is good in the study area. The kerosene supplied through public distribution system (PDS) is quite good and receives a quota of 5-6 litres per households. Whereas, one out of 11 sample villages do not receive kerosene regularly through PDS. In the survey area 91 percent of villages have infrastructure for kerosene. At least 49 percent of households have *facilities* to use but only 31 percent of households are actually using Kerosene for cooking.

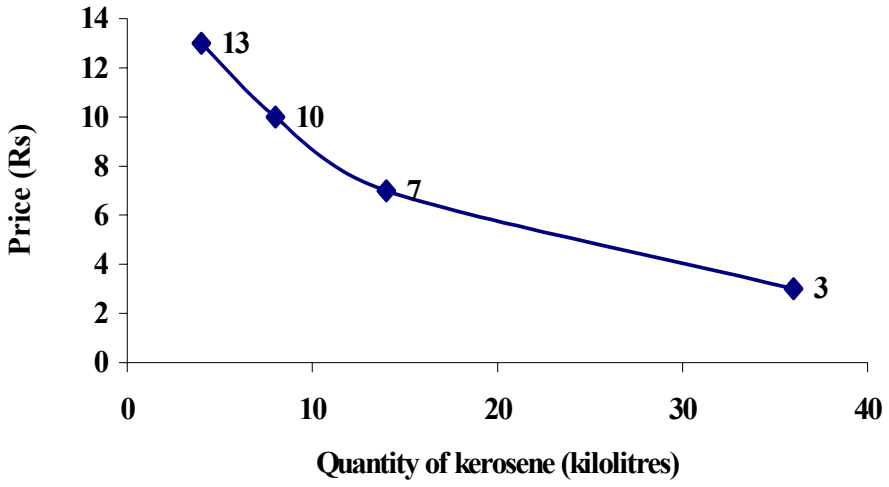
Extent of use of clean fuel is higher among higher income groups. As against 8 percent of households with Annual Household Income (AHI) up to Rs. 6,000, 55 percent of households with AHI Rs. 30,000 and above are using clean fuels.

66 percent of clean fuel users as well as bio-fuel users were drawing Kerosene from ration. Only 4 percent of households were buying an average quantity of 0.7 litres per month of kerosene from open market for cooking.

4.8.5 Price Willing to Pay for Clean Fuel

Across all the villages covered, respondent households have expressed their willingness to switch to kerosene if available abundantly at a price of Rs. 1.70 (rounded to Rs. 2) per litre. The additional demand of kerosene in all the sampled households is 0.71 *kilolitres per month* at ration price over and above the present consumption of 5.1 kilolitres. Therefore, total demand of kerosene at Rs 3 is 5.8 kilolitres per month. At the time of the survey in February 2000 the ration price was Rs 3 per litre, which was subsequently increased to Rs 5 per litres in March 2000. Therefore, willingness to pay for price above Rs. 6 was examined.

Fig 4.5: Demand of kerosene (kilolitres per month)



At the price of Rs 5/litre the demand of kerosene in the sampled households work out to be 2.7 kilolitres per month. Whereas, demand at parallel market rate (Rs 6/) of kerosene works out to be 0.25 kilolitres per month (See Fig 4.5 for demand of kerosene). Even there is demand of 0.57 kilolitres at Rs 13 per litre, this shows that some people are willing to pay higher than the market rate. In such a situation it is necessary to find out the reasons why people who are willing to pay are not getting it. These demand refer to only sample households in the sample villages. For all the households and all the villages, the demand could be quite large.

4.8.6 Reasons for not Using Clean Fuels

In the survey area 27 percent households (i.e. 191 HH) are not using clean fuels. Only 22 percent of the households are not willing to switch from the current fuel. Multiple reasons were given for not using the clean fuel. These are summarised in Table 4.6. Approximately

64 percent households are of the view that it is very expensive where as 12 percent told that it is not always available.

Table 4.6: Reasons for Not Using the Clean Fuels

Reasons	No. of households	Percent of households
Not always available	22	12
It is very expensive	123	64
Scared or hesitant of using	43	22
Taste of food changes	2	1
Wood works as repellent for insects	4	2

Availability of clean fuel in the rural areas of HP is not a problem. Out of many options, only two reasons viz., lack of affordability and hesitant of using stand out. All the rest of the conjectures often made in the literature, such as cooking with kerosene will cause change in the taste of the food or wood smoke works as repellent for insects, are not supported by the survey in HP State.

4.8.7 Willingness for Other Interventions to Avoid Smoke

The results of the survey reveal that only 18 percent households are willing to spend some money to improve the air quality in the kitchen. Those who have shown willingness would like to spend on the items shown in Table 4.7. Some households were willing to have more than one improvement.

Table 4.7: Improvements for reducing kitchen smoke

Improvements	Number of households	Percent of households
Fitting a window/ventilator	94	13
Installation of improved chulha	34	5
Fitting a chimney	73	10
Fitting a door	3	-

Improvement cost estimated by them to reduce smoke in the kitchen is more associated with the present living condition i.e. kitchen type (kachcha, Pucca or Semi-pucca). There is a higher willingness to pay for ventilation in houses rather than for improved stoves. The average estimated cost varies from Rs. 1,333 to Rs. 2,514. As against this, they are willing to spend between Rs. 1,250 to Rs. 1,505 respectively for kachcha and Pucca type of kitchen.

4.9. HOUSING CONDITIONS

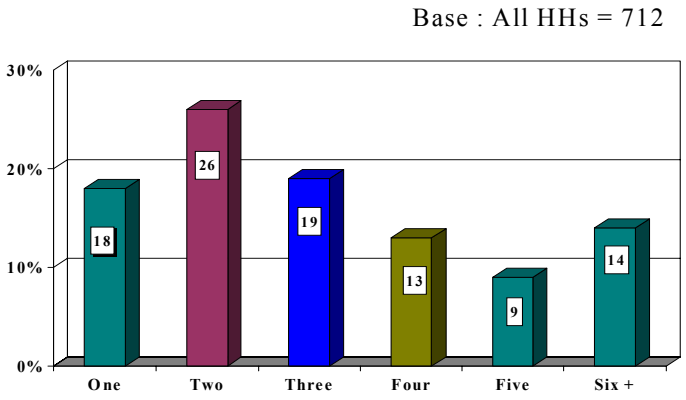
Housing conditions have a direct bearing on health; especially air pollution and sanitation related diseases. The relevant parameters are

a. Number of rooms
b. Location of the kitchen
c. Type of kitchen (kachcha, pucca or semi-pucca type)
d. Type of ventilation

4.9.1 Number of Rooms

About 18 percent of the houses have only one room (Fig 4.6). The number of rooms in the house is a very important information as for as the indoor air pollution is concerned. It is being observed that if there are less number of rooms in the houses chances of respiratory diseases increase because of less dispersion of the smoke. In our study also a negative correlation is observed between reporting symptoms of respiratory diseases and number of rooms.

Fig 4.6 : Number of Rooms in the House

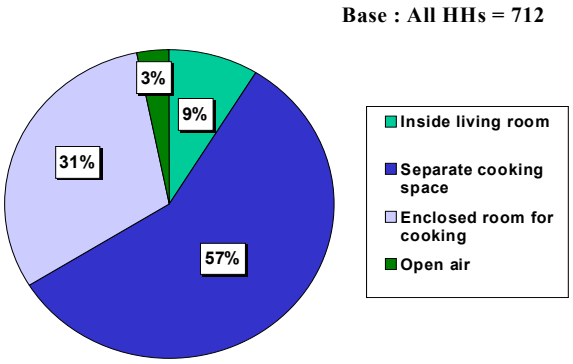


4.9.2 Location of Kitchen and Ventilation

In HP a large majority (88 percent) of households have separate kitchen. Only 3 percent did not have any kitchen or any cooking space. These households cook their food outside in the open air. In such type of kitchen exposure is minimal for both cook and other family members, as the pollutant generated dissipate quickly in the air. The heath impact is discussed in the subsequent section of health impacts.

Nine percent households had cooking space inside the living room itself, due to which all other family members who are present during the cooking also get exposed to air pollution. 88 percent have separate kitchen outside the house (Fig 4.7).

Fig 4.7: Location of kitchen



Among the separate kitchen type, 20 percent households have tiled roofing, 33 percent have slate or shingle roofing, 13 percent have brick or stone. Only 9 percent have kitchen with concrete roofing. 5 percent of these separate kitchens have open entrance without any door. 21 percent of kitchens are very badly ventilated, as there is no window or ventilator.

4.9.3 Type of Kitchen

The households those have separate kitchen, these kitchens are mostly (66 percent) of semi-pucca or kachcha type. Very few kitchens (35 percent) are pucca type having brick wall and concrete roofing.

4.10 COOKING PRACTICES

Such information is very crucial for determining the exposure to air pollution due to use of bio-fuels of the cook and also of other family members who stay inside the house while cooking. The number of meals cooked determines total exposure a cook might get in 24 hours. Each time when the fire is being started using biofuels, it produces lot of smoke and pollutants. In the same manner if cooking is performed in an enclosed area with bad ventilation condition and traditional stoves, exposure is much higher than cooking the same meal in open air. The health impacts are discussed in the subsequent section of health.

Most households cooked two meals a day (58 percent) and 37 percent of the households cooked thrice. 4 percent cooked four times a day. The total time required to cook all the meals on an average was about 3 hours 25 minutes in a day. Therefore, cooks are exposed to smoky atmosphere for this long everyday.

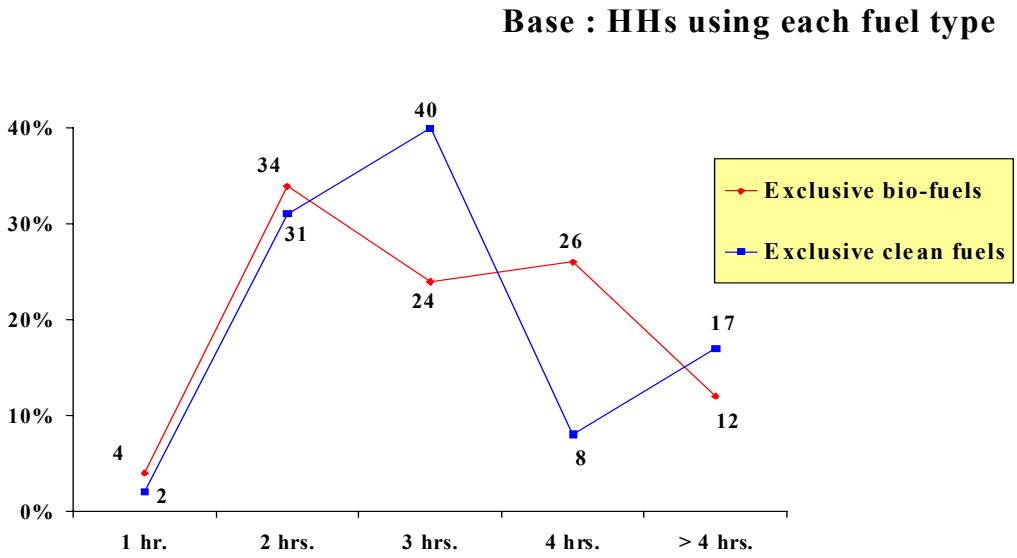


Fig 4.8: Time Spent by Housewives (involved in cooking) in the Kitchen (Hrs per day)

Mostly female adults of age above 15 years are the chief cooks. Those who are chief cooks have a greater risk of respiratory symptoms. (see health section). On the whole males were not involved in cooking at all (Table 4.8 : Cooking involvement).

Table 4.8: Cooking involvement of females at different age group

Base : 1509

Age group	Unit	Involvement in cooking (percent of female)			
		Chief cook	Always assist	Sometimes assist	Not involved*
10 - 15 yrs.	%	2	7	69	22
16 - 20 yrs.	%	13	50	20	17
21 - 30 yrs.	%	51	14	5	30
31 - 40 yrs.	%	68	8	5	19
41 + yrs	%	28	11	8	53

* Note: female of age > 15 those who are not at all involved in cooking represent those women also who had cooked in past as chief cook but currently not involved due to old age or some other reasons

4.11 HEALTH IMPACTS

The health impacts of indoor air pollution due to use of bio-fuels can be attributed to exposure to domestic smoke. Since a large number of variables are involved in linking air pollution with human health, it is very difficult to prove that air pollution has a clearly demonstrable effect on human health. Many studies in the past have tried to link air pollution with respiratory diseases (Ostro, 1995; Smith, 1987, 1996; NFHS, 1995). In this study we have tried to link health impacts with exposure to indoor air pollution and also other confounding socio-economic variables.

As discussed earlier, data related to health status was collected through personal interview, peak flow meter for lung function and checkup by doctors of symptomatic cases. To obtain overall view of the area, data was collected from health centers (HCs) records and interview of employees. We will first have overview of health profile from selected HCs.

4.11.1 Overall Health Profile

This information is based on the survey conducted at 2 HCs servicing the villages covered in the study. Working hours for 2 HCs were 6 1/2 hours. One HC is running with one doctor whereas the other one is running with two doctors. The instruments and facilities available in these 2 HCs are listed below in Table 4.9.

Table 4.9: Facilities available at HCs

Instrument/facility	No. of HC have it	No. of HCs where it is working
Blood pressure measuring equipment	2	2
Cardiograph	-	-
X-ray machine	1	1
Refrigerator	2	2
Anaesthesia equipment	-	-
Emergency light	-	-
Incubator	-	-
Pathological lab.	1	1

Source: Data collected from records of HCs

None of the HCs contacted felt that the medicine made available at health center is adequate and both the HCs do not charge any fee from the patients.

4.11.2 Prevalence of diseases

The records from two HCs reveal that they received less than 150 patients in a day, thus average works out to about 75 patients per HC per day. None of the HCs could mention about the seasonality in number of patients coming to HCs for treatment. None of the HCs have stated about prevalence of any particular disease in nearby villages. Total number of patients treated in a month by these HCs for respiratory or water related problems and average number of patients per PHCs are given in Table 4.10.

Table 4.10: Number of patients per month in two health centers of Himachal Pradesh (March 2000)

Disease type	Total patients	Avg. No. of patients per HC	Percentage to total patients
Air borne diseases			
- Bronchitis	15	8	0.4
- Asthma	445	223	13.1
- TB	4	2	0.1
- Other respiratory diseases	65	33	1.9
Water borne diseases			
- Diarrhoea	220	110	6.5
- Total worm infection	650	325	19.1
- Round worm	215	108	6.3
- Hook worm	150	150	4.4
- Guinea worm	150	150	4.4
- Other water borne diseases	15	8	0.4
Eye diseases			
- Eye disease	125	63	3.7
Other diseases			
- Skin infection	124	62	3.6
- Pneumonia	5	3	0.1

Source: Data collected from records of HCs.

The patients suffering from respiratory diseases and water related diseases appear to be quite high. The patients suffering from respiratory diseases are 16 percent and from water related diseases are 41 percent, of total patient treated at these HCs. The prevalence of air and water pollution related diseases are shown to give a picture of the area covered by these HCs. These HCs cover many villages along with the sample village.

4.11.3 Self Reported Assessment of Health

The survey data show that smoking is not prevalent in the women, whereas 21 percent men smoke in the sample. The results of personal direct interview using MRC questionnaire on

health status reveal that 21 percent of the total population have one or the other symptoms of respiratory diseases (see Table 4.11).

Table 4.11: Self reported respiratory disease symptoms

Respiratory Disease Symptoms	No. of persons per 1000 persons
Cough most days for 3 months each year	40
Bring up Phlegm for 3 months each year	30
Stop for breath when walking at own pace	60
Woken at night by attack of shortness of breath	20
Blood in sputum	10
Any respiratory disease symptom	210

Among past disease cases Bronchial Asthma was reported by 8 persons per 1000 persons whereas, 4 per 1000 persons reported bronchitis (see Table 4.12). The reporting of symptoms and diseases were recorded on the basis of respondent's memory and diagnosis made the doctor.

Table 4.12: Disease prevalence on the basis of self reporting

Disease	Number of persons per 1000 persons
Bronchial Asthma	8
Bronchitis	4
Pneumonia	6
Tuberculosis	3
Heart trouble	4
Other chest trouble	18

4.11.4 Physicians Report

Physicians examined all those who reported disease symptoms and who were present during the survey. The summary of physicians' check-up is given in Table 4.13. The report reveals that approximately 28 percent of population are suffering from chronic obstructive airway diseases. This result is biased because the sub-sample, which was examined by the

physicians, included mostly symptomatic cases. The physician report also reveals that prevalence of respiratory illness in men is found to be higher than that in women in this state.

Table 4.13: Analysis of physicians' checkup reports

Diseases	**Total**	**Male**	**Female**
Base	153(100)	63(100)	90(100)
Chronic Obstructive Airway	42(27.5)	28(44.4)	14(15.6)
Bronchial Asthma	16(10.5)	10(15.9)	6(6.7)
Tuberculosis	12(7.8)	6(9.5)	6(6.7)
Bronchiectasis	1 (0.7)	-	1(1.1)
Other chronic lung disease	14(9.2)	6(9.5)	8(8.9)
Common cold	1(0.7)	1(1.6)	-

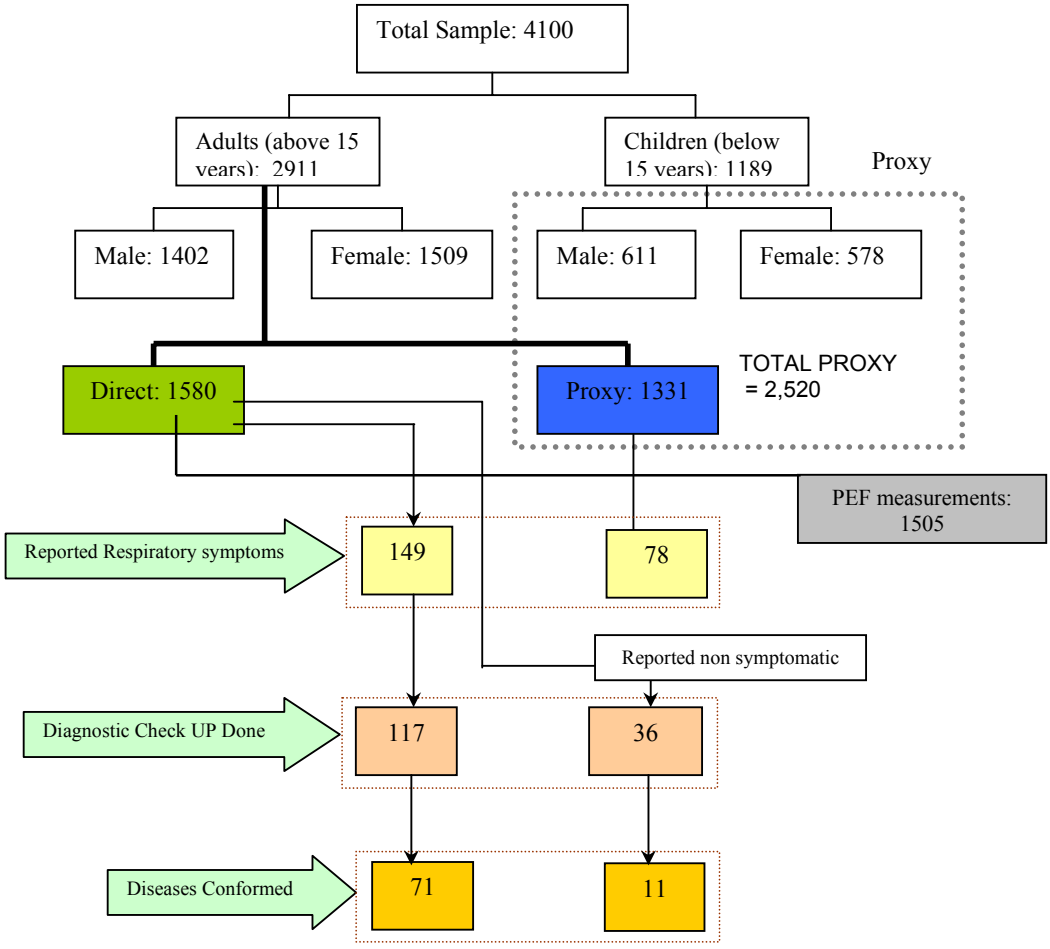
5 STATISTICAL ANALYSIS

5.1 HEALTH IMPACTS OF INDOOR AIR POLLUTION

To confirm a linkage between exposure to indoor air pollution and impact on human health several exercises were carried out. These are described in the following section.

In HP, symptoms of any respiratory disease, intestinal disease, eye irritation or skin problem, etc. were collected directly from the adult members present at the time of interview, and through proxy interviews (of main respondents) in other cases. Thirty nine percent of the individuals were thus checked through direct interviews. It is observed that symptomatic cases are significantly higher among those reported directly as compared to those reported through proxy interviews. The flow of events that was undertaken to confirm the occurrence of diseases and the results are shown in the Fig. 5.1.

Figure 5.1: Sample structure for health analysis



5.2 PREVALENCE OF REPORTED RESPIRATORY DISEASE SYMPTOMS

The linkages of health with biofuels use were examined on the basis of self-reported symptoms of respiratory diseases. Prevalence of some respiratory symptoms was as high as 17 percent in Himachal Pradesh. See Table 5.1.

Table 5.1: Prevalence of respiratory symptoms as reported (% of individuals)

Disease symptoms	All	Females	Males	
			Smokers	Non-smokers
Cough				
Cough first thing in the morning in winter	6	4	23	4
Cough during the day or at night in winter	6	4	22	4
Cough most days for 3 months each year	4	3	15	3
Phlegm				
Bring up phlegm in the morning in winter	5	3	20	4
Bring up phlegm during day or night in winter	5	3	17	4
Bring up phlegm for 3 months each year	3	2	14	2
Breathlessness				
Troubled by shortness of breath when hurrying	17	19	30	7
Get short of breath walking with other people	7	7	18	3
Stop for breath when walking at own pace	6	6	16	2
Wheezing				
Had attack of wheezing in last 12 months	3	3	9	1
Had attack of shortness of breath with whizzing.	3	3	11	1
Was breathing absolutely normal between attacks	2	2	6	1
Woken at night by attack of shortness of breath	2	1	6	1
Chest illness				
Had chest illness in past 3 years	2	2	9	1
Brought up more phlegm in these illness	2	1	8	1
Had more than one illness in past 3 years	1	1	7	1
Blood in sputum				
Coughed blood in the past	1	1	1	-
Base: Total individuals (direct interviews)	**1,580**	**1,084**	**162**	**334**

As the results suggest, male smokers are highly vulnerable to most of the disease symptoms compared to male non-smokers and females. It is worth noting that the difference is small between male non-smokers and females for all symptoms in spite of female's exposure to indoor air pollution due to cooking. Impact of indoor air pollution appears to be less because of separate kitchen, good ventilation and use of clean fuels. In some cases the prevalence rates of symptoms are higher among males.

5.3 LINKAGES BETWEEN SOCIO-ECONOMIC VARIABLES AND RESPIRATORY DISEASE SYMPTOMS

Table 5.2a and 5.2b show the proportion of female adults who suffer from various disease symptoms and their relationships with individual and household characteristics. Statistical significance is validated through normal z-statistic tests (which should be above 1.96 for significance at 95 percent confidence level) and odds ratio[1] are calculated to know the likely chance of occurrence of the diseases.

Individual characteristics

Individual characteristics based on physiological and behavioural characteristics show the following (see Table 5.2a):

- Age, smoking habit have significant influence on almost all the respiratory symptoms as observed through higher odds ratios and higher z value.
- Female adults with higher fuel index (an indicator of exposure to biofuels) have shown significantly higher incidence of cough, phlegm, breathlessness, wheezing, and blood in sputum and eye irritation.
- Cough, phlegm, breathlessness, wheezing, chest illness and eye irritation are significantly higher among illiterates.
- Symptomatic are significantly higher among illiterates, more than 30 years of age and smokers.
- Occupation as dusty jobs as done in HP has no significant impact on respiratory symptoms among female adults.

[1] Commonly used in epidemiological studies to describe the likely harm, an exposure might cause. It is calculated by dividing the odds in the more susceptible group by the odds in the less susceptible group. The higher the odds ratio, the higher the chance of the chance of a symptom

Table 5.2a: Linkage between different individual characteristics and self-reported respiratory disease symptoms

	Disease symptoms per thousand based on direct response from female adults present during the survey								
	Base	Cough	Phlegm	Breath lessness	Wheez ing	Chest illness	Blood in sputum	Any respiratory symp.	Any eye irritation
Age									
Up to 30 yrs	535	7	4	13	2	2	2	22	28
More than 30 yrs.	549	49	38	107	27	15	9	146	104
Total	1084	29	21	61	15	8	6	85	66
Z value		*-4.12*	*-3.94*	*-6.50*	*-3.47*	*-2.30*	-1.61	*-7.28*	*-5.01*
Odds ratio (above 30 yrs. vs. up to 30 yrs.)		**6.87**	**10.60**	**9.08**	**15.00**	**7.90**	4.91	**7.43**	**4.02**
Smoking Habits									
Smokers	29	207	172	207	103	34	34	276	138
Non-smoker	1055	24	17	57	12	8	5	80	64
Combine (p)	1084	29	21	61	15	8	6	85	66
Z value		*5.84*	*5.73*	*3.33*	*4.01*	1.57	*2.13*	*3.74*	1.57
Odds ratio (smokers vs. non-smokers)		**10.75**	**12.00**	**4.33**	**9.25**	4.67	**7.50**	**4.40**	2.32
Job type									
Dusty jobs (like farming, cement fac. Etc.)	21	48	1	1	1	1	1	48	48
Non dusty jobs	1063	28	22	62	15	8	6	86	67
Total	1084	29	21	61	15	8	6	85	66
Z value		0.53	-0.68	-1.18	-0.57	-0.42	-0.35	-0.62	-0.35
Odds ratio (Dusty jobs vs. non-dusty jobs)		1.72	0.05	0.02	0.07	0.12	0.18	0.53	0.70
Fuel Index (females over 15 yrs – direct)									
Up to 20	708	11	6	35	4	4	1	45	45
More than 20	263	53	46	106	30	15	15	160	114
Total	971	23	16	55	11	7	5	76	64
Z value		*-3.90*	*-4.35*	*-4.34*	*-3.43*	-1.80	*-2.67*	*-5.98*	*-3.90*
Odds ratio (FI above 20 vs. up to 20)		**4.92**	**8.41**	**3.26**	**7.37**	3.63	**10.92**	**4.01**	**2.72**
Literacy									
Illiterate	330	79	61	139	36	21	12	191	106
Literate	754	7	4	27	5	3	3	38	49
Total	1084	29	21	61	15	8	6	85	66
Z value		*6.56*	*5.95*	*7.15*	*3.90*	*3.10*	1.93	*8.29*	*3.47*
Odds ratio (Illiterate vs. literate)		**12.81**	**16.15**	**5.94**	**7.08**	**8.15**	4.61	**5.90**	**2.30**

Figures in italics/bold are statistically significant at 95%. Negative Z value means the symptom decreases with increase in that variable over the other variable with which it is compared

Table 5.2b shows the relationship between self reported respiratory disease symptoms and household characteristics.

Household characteristics

- High odds ratios indicate that females using bio fuels are more susceptible to cough, phlegm, wheezing, chest illness and blood in sputum as compared to females using clean fuels.
- Number of hours of cooking shows high odds ratio for wheezing.
- Number of rooms has significant impacts on breathlessness symptoms.
- Land holdings and household income have no significant impact on respiratory symptoms. However, females from lower income households (less than Rs. 30,000 p.a.) are more susceptible to blood in sputum as observed through high odds ratio. Similarly females from low (or no) land holdings are more susceptible to phlegm, chest illness and blood in sputum.
- Reported respiratory symptoms did not show significant difference among members from households with kachcha type of kitchens as compared to those with pucca type of kitchens. This could be due to the ventilation provided by kachcha type of kitchen.

Table 5.2b: Linkage between different household characteristics and self-reported respiratory disease symptoms

	Disease symptoms per thousand based on direct response from female adults present during the survey								
	Base	**Cough**	**Phlegm**	**Breathlessness**	**Wheezing**	**Chest illness**	**Blood in sputum**	**Any respiratory symp.**	**Any eye irritation**
Type of Fuel Used									
Exclusive Bio-fuels	264	64	49	95	23	15	8	136	80
Exclusive Clean Fuels	55	1	1	55	1	1	1	55	91
Total	319	53	41	88	19	13	6	122	82
Z value		1.93	1.68	0.96	1.13	0.92	0.65	1.69	-0.28
Odds ratio (biofuels vs. clean fuels)		***68.76***	***51.74***	***1.81***	***23.23***	***15.37***	***7.63***	***2.74***	***0.86***
No. of meals cooked in a day									
Cooked 2 or fewer meals	578	29	22	55	14	9	9	88	71
Cooked more than 2 meals	506	28	20	67	16	8	2	81	61
Total	1084	29	21	61	15	8	6	85	66
Z value		0.17	0.31	-0.81	-0.27	0.13	1.48	0.42	0.64
Odds ratio (>2 meals vs. 2 meals)		***0.94***	***0.88***	***1.23***	***1.14***	***0.91***	***0.23***	***0.91***	***0.85***
Hours of cooking									
Cooked for 2 hrs or less in a day	273	22	15	84	7	7	7	99	73
Cooked for more than 2 hrs in a day	796	31	24	53	18	9	5	80	60
Total	1069	29	22	61	15	8	6	85	64
Z value		-0.80	-0.91	1.88	-1.20	-0.23	0.44	0.95	0.76
Odds ratio (> 2 hrs. vs. ≤2 hrs.)		***1.44***	***1.64***	***0.61***	***2.43***	***1.20***	***0.68***	***0.80***	***0.81***
Kitchen location									

Cooked indoor	1049	28	21	62	14	9	6	86	68
Cooked outdoor (open air)	24	42	42	42	42	1	1	42	42
Total	1073	28	21	62	15	8	6	85	67
Z value		-0.41	-0.69	0.41	-1.09	0.46	0.37	0.77	0.50
Odds ratio (indoor vs. open air cooking)		0.65	0.49	1.52	0.33	8.65	5.75	2.16	1.67
Type of Kitchen									
Kachcha type kitchen	870	30	20	60	10	8	6	85	66
Pucca type kitchen	77	26	26	39	26	13	1	39	52
Total	947	30	20	58	12	8	5	81	64
Z value		0.19	-0.39	0.75	-1.23	-0.45	0.67	1.42	0.46
Odds ratio (kachcha vs. pucca kitchen)		***1.16***	***0.75***	***1.57***	***0.39***	***0.62***	***5.77***	***2.29***	***1.28***
No. of rooms in the house									
Less than 2 rooms	159	50	31	126	25	19	6	145	88
2 or more rooms	910	24	20	51	13	7	5	75	64
Total	1069	28	22	62	15	8	6	85	67
Z value		1.84	0.94	*3.64*	1.15	1.56	0.12	*2.92*	1.13
Odds ratio (≥ 2 rooms vs. < 2 rooms)		***2.14***	***1.61***	***2.70***	***1.93***	***2.90***	***1.15***	***2.09***	***1.42***
Land Holdings									
Landless & Marginal (up to 3 acres)	961	30	24	62	15	9	6	87	68
Small, Medium & Large (more than 3 acres)	123	16	1	49	16	1	1	65	57
Total	1084	29	21	61	15	8	6	85	66
Z value		0.87	1.73	0.60	-0.15	1.08	0.88	0.84	0.45
Odds ratio (< 3 acres vs. ≥ 3 acres)		***1.88***	***24.50***	***1.30***	***0.89***	***9.44***	***6.28***	***1.38***	***1.20***
Annual Household Income									
Annual Income up to Rs. 30,000	430	30	21	63	14	9	9	93	74
Annual Income > Rs. 30,000	644	28	22	61	16	8	3	81	62
Total	1074	29	21	61	15	8	6	86	67
Z value		0.22	-0.09	0.15	-0.21	0.27	1.33	0.70	0.79
Odds ratio (Up to Rs. 30,000 vs. > Rs. 30,000)		***1.08***	***0.96***	***1.04***	***0.90***	***1.20***	***3.01***	***1.17***	***1.21***
Figures in italics/bold are statistically significant at 95%. Negative Z value means the symptom decreases with increase in that variable over the other variable with which it is compared.									

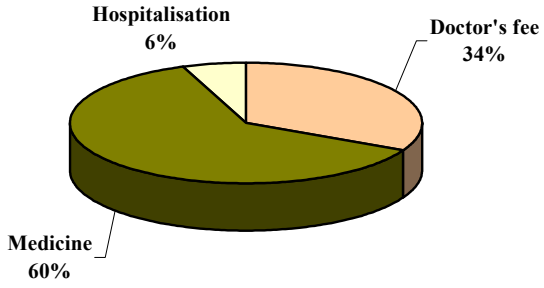
5.4 HEALTH STATUS OF CHILDREN BELOW FIVE YEARS OF AGE

In case of children below 5 years health status particularly about Lower Respiratory Infectious / Acute Respiratory Infectious (LRI/ARI) has been collected from the mother of the child. Out of total 386 children below 5 years in the sample, the reported cases LRI/ARI was 6 percent (23 cases). About 96 percent of cases (22 cases) were required medical attention. About one half of the cases were referred to private doctors and the other half were referred to hospitals. Eighty six percent of cases (19 cases) got cured and the remaining 14 percent cases continue to have cough symptom. Analysis of this vulnerable group is discussed in the statistical analysis section.

5.5 ECONOMIC BURDEN OF INDOOR AIR POLLUTION

The survey also collected data on costs incurred on doctors' fees, hospitalization, medicine, additional cost for special diet and days lost due to respiratory diseases. Out of 1,580 self reported cases 21 percent (335 adults) reported 'any' respiratory disease symptoms, leading to 56 disease cases, of which 27 percent (15 cases) took treatment, mainly allopathic, for discomforts. Average frequency of visit to the doctor in past one month was 2.2 times. Average amount spent on respiratory disease was Rs.100 per sick person for one month (or Rs. 1200 per year). Large proportion of this amount is spent on medicine (60 percent), followed by doctor's fee (34 percent) and hospitalisation (6 percent) as given in the Fig. 5.2. On an average 6 days are lost per month by the sick individuals and 2 days by other members of the family due to respiratory illness. It is important to note that most of the rural people rely on the health centres (HCs) for their treatment and the HCs render services free of cost. These patients on an average lost about 2 working days (including other family members who took care of the patient) in the past month due to illness.

Fig. 5.2: Percentage break up of expenditure on health due to respiratory diseases

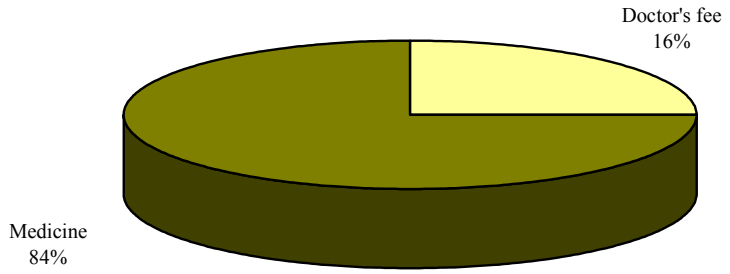


5.6 EXPENDITURE ON EYE IRRITATION AND RELATED DISEASES

In addition to respiratory diseases, it is found that about 7 percent of adults reported (107 adults) some eye related problem in the past one month. About three percent (or 48 adults) had eye problems with redness of eyes and six percent (or 93 adults) had eye problems with watery discharge. However, 2.2 percent had both redness and watery discharge problems. Only 38 percent of the sufferers (41 adults) referred to doctors for check up.

Average amount spent in the previous month on treatment of eye disease was Rs. 54 per sick person. Eighty four percent of this was spent for medicines and the balance was spent as doctor's fee as given in the Fig. 5.3.

Fig. 5.3: Percentage break up of expenditure on eye related disease



5.7 WILLINGNESS TO PAY TO REDUCE KITCHEN SMOKE

About 18 percent of households were willing to spend some money to improve air quality inside the kitchen. This is because large proportion of households already uses clean fuel. Those who have shown willingness expressed their desires to spend on multiple facilities such as fitting windows, fitting chimney, installing improved cook stoves, etc. as shown in Table 5.3. Seventy two percent households (who have shown willingness to spend) are willing to spend on ventilation, 56 percent of the households are willing to spend on fitting chimney, 26 percent of the households are willing to install improved cook stoves and small proportion of households are willing to spend by switching to clean fuels, fitting more doors, etc. These percentages are a lot higher than other States.

Table 5.3: Willingness to pay for better indoor air quality

Facility	% of households
Fitting a window/ventilator	71.75
Fitting a chimney	55.73
Installation of improved cook stove	25.95
Switch to clean fuel	4.58
More doors	2.29
Others	6.87
Base: Households willing to spend money: 131	

Further, the analysis, as given in the Table 5.4 shows that about 29 percent of the households who showed willingness to pay to improve kitchen smoke are ready to contribute Rs. 501 to Rs. 1000, about 30 percent of the households are willing to contribute more than Rs. 1000 and so on. According to respondents' estimates, the average improvement cost for reducing smoke in the kitchen works out to about Rs. 2,067 as against their willingness to spend Rs. 1,340.

Table 5.4: Amount willing to pay for reducing kitchen smoke (% of households)

Amount (in Rs.)	Districts									
	All	Bilaspur	Chamba	Hamirpur	Kangra	Mandi	Shimla	Sirmaur	Solan	Una
Up to 50	2.29	-	-	-	-	4.55	-	10.00	-	-
51 – 100	4.58	-	-	16.67	-	9.09	-	10.00	4.35	-
101 – 300	14.50	20.00	-	16.67	-	18.18	4.76	20.00	26.09	20.00
301 – 500	12.21	10.00	-	-	27.27	4.55	19.05	15.00	4.35	-
501 – 1000	29.01	20.00	50.00	16.67	31.82	18.18	38.10	35.00	26.09	40.00
1001 – 2000	19.08	20.00	50.00	50.00	18.18	27.27	23.81	0.00	13.04	20.00
More than 2000	11.45	20.00	-	-	13.64	4.55	14.29	10.00	13.04	20.00
No idea	6.87	10.00	-	-	9.09	13.64	-	-	13.04	-
Average (Rs.)	1340	1344	1500	1142	1645	953	1590	859	1537	1840
Base: Households willing to spend money	131	10	2	6	22	22	21	20	23	5

The options to avoid smoke can be fuel substitution (kerosene or LPG) or effort to avoid smoke through good ventilation. Our results suggest that distribution of clean fuels viz., kerosene and LPG is satisfactory in the State. But the use of clean fuels is not high, even in the households where kerosene/ LPG is used for cooking; its use is limited to making small meals or snacks. The reasons for its limited use are mainly non-affordability. Demand of kerosene at an average market price of Rs. 5 (during survey period) is estimated to be 9 litres per month per sampled household.

6 PRELIMINARY ANALYSIS OF POSSIBLE VULNERABLE GROUPS

6.1 MULTIVARIATE ANALYSIS

We have carried out statistical analysis to examine whether an the prevalence of respiratory symptoms and respiratory diseases in each vulnerable group are linked to any individual and socio-economic variables (characteristics), and to what extent it is significant. In some cases we have found that even if the prevalence is not statistically significant but odds ratios (or risks) are high.

We have also used Discriminant Analysis for developing a set of independent variables to classify people in a vulnerable group having respiratory symptom or not. Through this analysis we have developed a linear combination of variables (called Discriminant Function) for predicting classification of people into symptomatic or non-symptomatic based on these variables. Just as in regression, we have used stepwise model to enter one variable at a time.

The linear discriminant analysis can be used to classify people into two or more groups based on the knowledge of some variables (characteristics) related to them. Discriminant analysis is very similar to the multiple regression technique. The discriminant function is in the form of :

$Y = a + k_1 x_1 + k_2 x_2 + \ldots\ldots + k_n x_n$

where Y is the dependent variable which is in categorical nature (unlike in regression analysis, where it is continuous), $x_1, x_2, \ldots x_n$ are independent variables, $k_1, k_2, \ldots k_n$ are the coefficients of the independent variables, and 'a' is a constant.

The classification (discrimination) of the existing data points is done using this equation. The accuracy of the model is determined through what percentage of the existing data points is correctly classified by the model.

In addition, we have also used Binary Logistic Regression to validate our findings. Logistic regression is useful for situations in which we want predict the presence or absence of an outcome based on values of a set of predictor variables. It is similar to a linear regression model but is suited to models where the dependent variable is dichotomous.

6.2 ANALYSIS SUMMARY

The summary of the above analysis is presented in the following Table 6.1.

Table 6.1: Summary Table of Susceptibility of Possible Vulnerable Groups to Respiratory Symptoms

	Children		15-30 years of age		30-45 years of age		45-60 years of age		60+ years of age	
	< 5 years	**5-14 years**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
Prevalence										
No. of persons in the sample	386	803	697	603	396	374	242	252	174	173
Proportion reported symptomatics	6.0%*	0.1%	1.7%	1.0%	7.6%	4.5%	14.5%	10.3%	21.8%	34.1%
Proportion having disease symptoms	5.7%*	0.1%	0.3%	0.0%	0.8%	2.1%	4.1%	4.8%	10.9%	19.7%
Household Characteristics										
Biofuel vs. clean fuel using HHs (Odds ratio)	1.52	1.00	0.50@	Infinity	2.41	Infinity	1.25	1.75	Infinity	2.73
High hilly areas vs. low hilly areas (Odds ratio)	1.33	0.00	6.34	1.42	9.38	1.43	1.70	9.56	3.97	1.53
Low HH income (<=Rs.24,000 p.m.) vs. high HH income (>Rs.50,000 p.m.) (Odds ratio)	1.47	0.00	3.68	1.58	1.90	3.45	1.23	3.65	1.34	2.61
HHs with single room vs. HHs with more rooms (Odds ratio)	1.19	0.00	2.07	0.00	4.29	2.40	1.32	2.61	2.37	1.26
Individual Characteristics										
Illiterates vs. literates (odds ratio)	-	Infinity	10.41	4.39	2.24	5.30	2.26	2.35	2.57	2.26
High fuel index (> 6.15) vs. low fuel index (<= 6.15) for females (Odds ratio)	-	-	3.08	-	5.35	-	0.31&	-	1.13	-
Smokers vs. non-smokers for males (Odds ratio)	-	-	-	11.44	-	2.65	-	2.29	-	2.81
Dusty jobs vs. non-dusty jobs for males (Odds ratio)	-	-	-	3.42	-	1.27	-	0.81$	-	0.99+

@ Relatively small sample for clean fuel using HHs.

& Relatively small sample for females with low fuel index.

$ Relatively small sample for males worked in dusty jobs.

+ Relatively very small sample for males worked in dusty jobs

For the above analysis districts covered in the survey were classified into high hilly areas, mid-hilly areas and low hilly areas as follows:

	District	No. of sample household	No. of sample individuals
High hilly areas	Chamba	59	305
Mid-hilly areas	Kangra and Shimla	254	1553
Low hilly areas	Bilaspur, Hamirpur, Mandi, Sirmaur, Solan and Una	399	2242

The results of Table 6.1 are discussed in detail below.

6.3 DETAILED ANALYSIS

The detailed analysis of each possible vulnerable group is shown below.

6.3.1. Group 1: Children below 5 years of age

Among this group Lower Respiratory Infection/Acute Respiratory Infection (LRI/ARI) are the main prevalent respiratory diseases. The prevalence rate is observed to be around 6% (23 cases out of 386) and almost all cases required medical attention.

The chances of getting this disease are higher among children from biofuel using households as compared to those from clean fuel using households (odds ratio 1.52). Even among biofuel using households, the risk further increases if these children are from households with low income as against children from high income households (odds ratio 2.67).

However, through multivariate analysis no suitable discriminant function or predictive variables could be found to predict LRI/ARI incidence.

a) Prevalence

No. of children < 5years	: 386
LRI/ARI cases (23)	: 6.0%
LRI/ARI cases required medical attention (22)	: 95.7%
Referred to private doctor (11)	: 50%
Referred to hospital (11)	: 50%

Outcome Cured (19)	: 86.4%
Continues to have cough symptom (3)	: 13.6%
No. of children < 5years in HHs using biofuels	: 103
LRI/ARI cases (8)	: 7.8%
Odds ratio against clean fuels	: 1.52
LRI/ARI cases required medical attention (8)	: 100%
No. of children < 5years in HHs using clean fuels	: 19
LRI/ARI cases (1)	: 5.3%
LRI/ARI cases required medical attention (1)	: 100%
No. of children < 5years in HHs using mixed fuels	: 264
LRI/ARI cases (14)	: 5.3%
LRI/ARI cases required medical attention (13)	: 92.9%
No. of children < 5years in households with low income (Up to Rs. 24,000 p.a.) using biofuels	: 51
LRI/ARI cases (6)	: 11.8%
Odds ratio against high income	: 2.67
LRI/ARI cases required medical attention (6)	: 100%
No. of children < 5years in HHs with High income (more than Rs. 50,000 p.a.) using biofuels	: 21
LRI/ARI cases (1)	: 4.8%
LRI/ARI cases required medical attention (1)	: 100%
No. of children < 5years in households with single room	: 87
LRI/ARI cases (6)	: 6.9%
Odds ratio against more rooms	: 1.19
LRI/ARI cases required medical attention (6)	: 100%
No. of children < 5years in households with 2 or more rooms	: 290
LRI/ARI cases (17)	: 5.9%
LRI/ARI cases required medical attention (16)	: 94%

b) Discriminant Analysis

Variables considered : Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Household income, Single room vs. more rooms in the house.
No suitable discriminant function could be found to predict LRI/ARI incidence with these variables.

Binary Logistic Regression

Here again no main predictive variable is found.

6.3.2. Group 2 : Children between 5-14 years of age

The reported prevalence of any respiratory symptom is the lowest among this group (1 case out of 803). The chances of getting respiratory symptom are obviously higher among illiterate children as compared to literate children (odds ratio is infinity) since illiterate children do mostly dusty and dirty work in the house or field whereas literate children go to school and remain away from indoor air pollution.

Illiteracy is found to be the main discriminating characteristic or predictive variable for this group because of this reason.

a) Prevalence

No. of children between 5-14 years	: 803
Having any respiratory symptoms (1)	: 0.1%
Having any respiratory disease symptom (1)	: 0.1%
No. of children between 5-14 years who are illiterates	: 69
Having any respiratory symptoms (1)	: 1.4%
Odds ratio against literates	: Infinity
Having any respiratory disease symptom (1)	: 1.4%
No. of children between 5-14 years who are literates	: 716
Having any respiratory symptoms (0)	: 0.0%
Having any respiratory disease symptom (0)	: 0.0%
No. of children between 5-14 years in households with single room	: 159
Having any respiratory symptoms (0)	: 0.0%

Odds ratio against more rooms	: 0.00
Having any respiratory disease symptom (0)	: 0.0%
No. of children between 5-14 years in households with 2 or more rooms	: 637
Having any respiratory symptoms (1)	: 0.2%
Having any respiratory disease symptom (1)	: 0.2%

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 3.247 + 3.558*Illiteracy correctly classified 91.3% of original cases. Illiteracy is the main discriminating characteristic for this group.
The computed χ^2 value at degrees of freedom 1 is 10.477, which is significant at 95%.

Binary Logistic Regression

Here again Illiteracy is found to be the main predictive variable.

6.3.3. Group 3: Females between 15-30 years of age

Adult females in this group have a prevalence rate of any respiratory symptom to the extent of 1.7% (12 cases out of 697). The risk of getting respiratory symptom is much higher among females who are illiterates as compared to those who are literates (odds ratio 10.37). Chances of getting such symptoms are obviously higher among females with high fuel index as compared to those with low fuel index (odds ratio 3.10) because fuel index is a composite measure of exposure to indoor air pollution.

Illiteracy is found to be the main discriminating characteristic or predictive variable for this group which could possibly due to the fact that illiterate females are engaged more in household work including cooking.

a) Prevalence

No. of females between 15-30 years	: 697
Having any respiratory symptoms (12)	: 1.7%

Having any respiratory disease symptom (2)	: 0.3%
No. of females between 15-30 years having fuel index > 6.15	: 220
Having any respiratory symptoms (7)	: 3.2%
Odds ratio against fuel index ≤ 6.15	: 3.10
Having any respiratory disease symptom (2)	: 0.9%
No. of females between 15-30 years having fuel index ≤ 6.15	: 477
Having any respiratory symptoms (5)	: 1.0%
Having any respiratory disease symptom (0)	: 0.0%

Note : Fuel index 6.15 is the median value

No. of females between 15-30 years who are illiterates	: 49
Having any respiratory symptoms (5)	: 10.2%
Odds ratio against literates	: 10.37
Having any respiratory disease symptom (1)	: 2.0%
No. of females between 15-30 years who are literates	: 646
Having any respiratory symptoms (7)	: 1.1%
Having any respiratory disease symptom (1)	: 0.2%
No. of females between 15-30 years in households with single room	: 96
Having any respiratory symptoms (3)	: 3.1%
Odds ratio against more rooms	: 2.07
Having any respiratory disease symptom (1)	: 1.0%
No. of females between 15-30 years in households with 2 or more rooms	: 586
Having any respiratory symptoms (9)	: 1.5%
Having any respiratory disease symptom (1)	: 0.2%

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Fuel index, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = -3.624 + 3.908*Illiteracy correctly classified 92.7% of original cases. The computed χ^2value at degrees of freedom 1 is 21.709 that

are significant at 95%.
Thus, the Illiteracy is the main discriminating characteristic for this group.

Binary Logistic Regression

Here again Illiteracy is found to be the main predictive variable.

6.3.4. Group 4: Females between 30-45 years of age

This group of mid-aged females have quite high prevalence rate of any respiratory symptom to the extent of 7.6% (30 cases out of 396). The risk of getting respiratory symptom is much higher among females who are staying at high hilly areas as compared to those who are staying at low hilly areas (odds ratio 9.42), and those who are staying in a single room as compared to those who live in more than one room (odds ratio 4.29).

Chances of getting such symptom are obviously higher among females with high fuel index as compared to those with low fuel index (odds ratio 5.35) as the index is indicative of exposure level to polluted biofuels.

Households with single room vs. households with more rooms, high hilly vs. low hilly areas and fuel index are found to be the main predictive variables for respiratory symptoms.

a) Prevalence

No. of females between 30-45 years	: 396
Having any respiratory symptoms (30)	: 7.6%
Having any respiratory disease symptom (3)	: 0.8%
No. of females between 30-45 years having fuel index > 6.15	: 338
Having any respiratory symptoms (29)	: 8.6%*
Odds ratio against fuel index ≤ 6.15	: 5.35
Having any respiratory disease symptom (3)	: 0.9%
No. of females between 30-45 years having fuel index ≤ 6.15	: 58
Having any respiratory symptoms (1)	: 1.7%
Having any respiratory disease symptom (0)	: 0.0%

* statistically significant at 95% confidence level.

No. of females between 30-45 years staying in high hilly areas	: 23
Having any respiratory symptoms (8)	: 34.8%
Odds ratio against low hilly areas	: 9.42
Having any respiratory disease symptom (1)	: 4.3%
No. of females between 30-45 years staying in low hilly areas	: 224
Having any respiratory symptoms (12)	: 5.4%
Having any respiratory disease symptom (0)	: 0.0%
No. of females between 30-45 years staying in mid hilly areas	: 149
Having any respiratory symptoms (10)	: 6.7%
Having any respiratory disease symptom (2)	: 1.3%
No. of females between 30-45 years in households with single room	: 61
Having any respiratory symptoms (12)	: 19.7%
Odds ratio against more rooms	: 4.29
Having any respiratory disease symptom (2)	: 3.3%
No. of females between 30-45 years in households with 2 or more rooms	: 333
Having any respiratory symptoms (18)	: 5.4%
Having any respiratory disease symptom (1)	: 0.3%

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Fuel index, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = -3.792 + 1.568*Single room vs. more rooms + 0.877*High hilly vs. low hilly areas - 0.087*Fuel Index correctly classified 74.6% of original cases.
The computed χ^2 value at degrees of freedom 3 is 31.871, which is significant at 95%.
Here, Single room vs. more rooms, High hilly vs. low hilly areas and Fuel index are the important predictive variables.

Binary Logistic Regression

Through this method we find these same variables as the main predictive variables.

6.3.5. Group 5: Males between 15-30 years of age

This male group has slightly lower prevalence rate of any respiratory symptom (1.0%, 6 cases out of 603) as compared to that among females in the same age brackets. The risk of getting respiratory symptoms is much higher among males who are illiterates as compared to those who are literates (odds ratio 4.38).

Chances of getting such symptoms are higher among male smokers as compared to male non-smokers (odds ratio 11.44). Illiteracy is found to be the main discriminating characteristic or predictive variable for this group.

a) Prevalence

No. of males between 15-30 years	: 603
Having any respiratory symptoms (6)	: 1.0%
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years who are illiterates	: 27
Having any respiratory symptoms (1)	: 3.7%
Odds ratio against literates	: 4.38
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years who are literates	: 574
Having any respiratory symptoms (5)	: 0.9%
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years who are smokers	: 51
Having any respiratory symptoms (3)	: 5.9%
Odds ratio against non-smokers	: 11.44
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years who are non-smokers	: 552
Having any respiratory symptoms (3)	: 0.5%
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years in households with single room	: 64

Having any respiratory symptoms (0)	: 0.0%
Odds ratio against more rooms	: 0.00
Having any respiratory disease symptom (0)	: 0.0%
No. of males between 15-30 years in households with 2 or more rooms	: 533
Having any respiratory symptoms (6)	: 1.1%
Having any respiratory disease symptom (0)	: 0.0%

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Smoking habit, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 7.098 + 3.699*Smoking habit correctly classified 91.5% of original cases. The computed χ^2 value at degrees of freedom 1 is 14.359 which is significant at 95%. Thus, smoking habit is the main discriminating characteristic for this group.

Binary Logistic Regression

Through this method also we find smoking habit is the main predictive variable.

6.3.6. Group 6: Males between 30-45 years of age

Here again, this mid-aged male group has lower prevalence rate of any respiratory symptom (4.5%, 17 cases out of 374) as compared to that among females in the same age brackets. The risk of getting respiratory symptoms is much higher among males who are illiterates as compared to those who are literates (odds ratio 5.27).

Chances of getting such symptoms are higher among male smokers as compared to male non-smokers, and those who worked in dusty jobs. Even chances are higher among males from households with a single room as compared to those from households with 2 or more rooms (odds ratio 2.40).

Illiteracy is found to be the main discriminating characteristic or predictive variable for this group.

a) Prevalence

No. of males between 30-45 years	: 374
Having any respiratory symptoms (17)	: 4.5%
Having any respiratory disease symptom (8)	: 2.1%

No. of males between 30-45 years who are smokers	: 157
Having any respiratory symptoms (11)	: 7.0%
Odds ratio against non-smokers	: 2.56
Having any respiratory disease symptom (6)	: 3.8%
No. of males between 30-45 years who are non-smokers	: 217
Having any respiratory symptoms (6)	: 2.8%
Having any respiratory disease symptom (2)	: 0.9%

No. of males between 30-45 years who worked in dusty jobs	: 36
Having any respiratory symptoms (2)	: 5.6%
Odds ratio against non-dusty jobs	: 1.27
Having any respiratory disease symptom (1)	: 2.8%
No. of males between 30-45 years who did not work in dusty jobs	: 338
Having any respiratory symptoms (15)	: 4.4%
Having any respiratory disease symptom (7)	: 2.1%

No. of males between 30-45 years who are illiterates	: 31
Having any respiratory symptoms (5)	: 16.1%
Odds ratio against literates	: 5.27
Having any respiratory disease symptom (4)	: 12.9%
No. of males between 30-45 years who are literates	: 341
Having any respiratory symptoms (12)	: 3.5%
Having any respiratory disease symptom (4)	: 1.2%
No. of males between 30-45 years in households with single room	: 71
Having any respiratory symptoms (6)	: 8.5%
Odds ratio against more rooms	: 2.40

Having any respiratory disease symptom (5)	: 7.0%
No. of males between 30-45 years in households with 2 or more rooms	: 297
Having any respiratory symptoms (11)	: 3.7%
Having any respiratory disease symptom (3)	: 1.0%

b) Discriminant Analysis

Variables considered : Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Smoking habit, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 3.324 + 3.632*Illiteracy correctly classified 89.8% of original cases.
The computed χ^2 value at degrees of freedom 1 is 10.157 which is significant at 95%. Illiteracy is the main discriminating characteristic for this group.

Binary Logistic Regression:

Through this method as well we find Illiteracy is the main predictive variable.

6.3.7. Group 7: Elderly females between 45-60 years of age

This group of elderly females have much higher prevalence rate of any respiratory symptom to the extent of 14.5% (35 cases out of 242). Chances of getting such symptoms are higher among females from households with a single room as compared to those from households with 2 or more rooms (odds ratio 1.32).

Fuel index, which measure the life time exposure to indoor air pollution, appear to be the main discriminating characteristic or predictive variable for this group.

a) Prevalence

No. of females between 45-60 years	: 242
Having any respiratory symptoms (35)	: 14.5%
Having any respiratory disease symptom (10)	: 4.1%
No. of females between 45-60 years having fuel index > 6.15	: 209

Having any respiratory symptoms (25)	: 12.0%
Odds ratio against fuel index ≤ 6.15	: 0.31#
Having any respiratory disease symptom (6)	: 2.9%
No. of females between 45-60 years having fuel index ≤ 6.15	: 33#
Having any respiratory symptoms (10)	: 30.3%*
Having any respiratory disease symptom (4)	: 12.1%
No. of females between 45-60 years in households with single room	: 22
Having any respiratory symptoms (4)	: 18.2%
Odds ratio against more rooms	: 1.32
Having any respiratory disease symptom (1)	: 4.5%
No. of females between 45-60 years in households with 2 or more rooms	: 215
Having any respiratory symptoms (31)	: 14.4%
Having any respiratory disease symptom (9)	: 4.2%

* statistically significant at 95% confidence level. # small base for females having fuel index ≤ 6.15.

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Fuel Index, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 2.271 + 0.104*Fuel index correctly classified 69.8% of original cases.
The computed χ^2 value at degrees of freedom 1 is 4.339, which is significant at 95%. For elderly females, Fuel index, which measure the life time exposure to indoor air pollution, appear to be the main discriminating characteristic.

Binary Logistic Regression

Through this method also we find fuel index as the main predictive variable.

6.3.8. Group 8: Elderly females 60 years and above age

The old-aged female group has very high prevalence rate of any respiratory symptom to the extent of 21.8% (38 cases out of 174). Chances of getting such symptoms are higher among

females from households with a single room as compared to those from households with 2 or more rooms (odds ratio 2.37).

Cooking location and type of fuels used in the household are the main discriminating characteristics or predictive variables for this group.

a) Prevalence

No. of females 60 years and above	: 174
Having any respiratory symptoms (38)	: 21.8%
Having any respiratory disease symptom (19)	: 10.9%
No. of females 60 years and above having fuel index > 6.15	: 92
Having any respiratory symptoms (21)	: 22.8%
Odds ratio against fuel index ≤ 6.15	: 1.13
Having any respiratory disease symptom (10)	: 10.9%
No. of females 60 years and above having fuel index ≤ 6.15	: 82
Having any respiratory symptoms (17)	: 20.7%
Having any respiratory disease symptom (9)	: 11.0%
No. of females 60 years and above in households with single room	: 19
Having any respiratory symptoms (7)	: 36.8%
Odds ratio against more rooms	: 2.37
Having any respiratory disease symptom (3)	: 15.8%
No. of females 60 years and above in households with 2 or more rooms	: 152
Having any respiratory symptoms (30)	: 19.7%
Having any respiratory disease symptom (16)	: 10.5%

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Fuel Index, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 5.881 + 1.624*Cooking location +

1.511*Type of fuels used correctly classified 69.5% of original cases.
The computed χ^2 value at degrees of freedom 2 is 9.719, which is significant at 95%. For elderly females, Cooking location and Type of fuels used appear to be the main discriminating characteristics.

Binary Logistic Regression

Through this method as well we find Cooking location and Type of fuels used are the main predictive variables.

6.3.9. Group 9: Elderly males between 45-60 years of age

This group of elderly males have high prevalence rate of any respiratory symptom to the extent of 10.3% (26 cases out of 252). Males who are staying at high hilly areas are at higher risk of getting respiratory symptoms as compared to males who are staying at low hilly areas (odds ratio 9.56). Even chances of getting such symptoms are higher among males from households with a single room as compared to those from households with 2 or more rooms (odds ratio 2.37).

High hilly areas is found to be the main predictive variable for respiratory symptomatic.

a) Prevalence

No. of males between 45-60 years	: 252
Having any respiratory symptoms (26)	: 10.3%
Having any respiratory disease symptom (12)	: 4.8%
No. of males between 45-60 years who smoke	: 130
Having any respiratory symptoms (18)	: 13.8%
Odds ratio against non-smokers	: 2.29
Having any respiratory disease symptom (8)	: 6.2%
No. of males between 45-60 years who do not smoke	: 122
Having any respiratory symptoms (8)	: 6.6%
Having any respiratory disease symptom (4)	: 3.3%

No. of males between 45-60 years from households using bio fuels	: 62

Having any respiratory symptoms (14)	: 22.6%
Odds ratio against clean fuels	: 1.75
Having any respiratory disease symptom (8)	: 12.9%
No. of males between 45-60 years from households using clean fuels	: 14
Having any respiratory symptoms (2)	: 14.3%
Having any respiratory disease symptom (1)	: 7.1%
No. of males between 45-60 years who worked in dusty jobs	: 23
Having any respiratory symptoms (2)	: 8.7%
Odds ratio against non-dusty jobs	: 0.81
Having any respiratory disease symptom (1)	: 4.3%
No. of males between 45-60 years who did not work in dusty jobs	: 229
Having any respiratory symptoms (24)	: 10.5%
Having any respiratory disease symptom (11)	: 4.8%
No. of males between 45-60 years who stayed in high hilly areas	: 20
Having any respiratory symptoms (8)	: 40%*
Odds ratio against low hilly areas	: 9.56
Having any respiratory disease symptom (3)	: 15%
No. of males between 45-60 years who stayed in low hilly areas	: 138
Having any respiratory symptoms (9)	: 6.5%
Having any respiratory disease symptom (4)	: 2.9%
No. of males between 45-60 years who stayed in mid hilly areas	: 94
Having any respiratory symptoms (9)	: 9.6%
Having any respiratory disease symptom (5)	: 5.3%
No. of males between 45-60 years in households with single room	: 29
Having any respiratory symptoms (6)	: 20.7%
Odds ratio against more rooms	: 2.61
Having any respiratory disease symptom (3)	: 10.3%
No. of males between 45-60 years in households with 2 or more rooms	: 220
Having any respiratory symptoms (20)	: 9.1%
Having any respiratory disease symptom (9)	: 4.1%

* significant statistically at 95% confidence level.

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Smoking habit, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 3.924 + 1.434*High hill vs. low hilly area correctly classified 63.5% of original cases.
The computed χ^2 value at degrees of freedom 1 is 17.126, which is significant at 95%. High hilly vs. low hilly areas works out to be the main discriminating characteristic for this group.

Binary Logistic Regression

Through this method also we find high hilly vs. low hilly areas is the main predictive variables.

6.3.10. Group 10 : Elderly males 60 years and above age

The old-aged male group has extremely high prevalence rate of any respiratory symptom to the extent of 34.1% (59 cases out of 173). Males who are smokers are at higher risk of getting respiratory symptoms as compared to males who are non-smokers (odds ratio 2.81). Even chances of getting such symptoms are higher among males from households using biofuels as compared to those from households using clean fuels (odds ratio 2.73).

Smoking habit and type of fuels used in the household are found to be the main predictive variables for respiratory symptomatic.

a) Prevalence

No. of males 60 years and above	: 173
Having any respiratory symptoms (59)	: 34.1%
Having any respiratory disease symptom (34)	: 19.7%

No. of males 60 years and above who smoke	: 92
Having any respiratory symptoms (41)	: 44.6%*
Odds ratio against non-smokers	: 2.81
Having any respiratory disease symptom (26)	: 28.3%
No. of males 60 years and above who do not smoke	: 81
Having any respiratory symptoms (18)	: 22.2%
Having any respiratory disease symptom (8)	: 9.9%
No. of males 60 years and above from HHs using biofuels	: 46
Having any respiratory symptoms (24)	: 52.2%
Odds ratio against clean fuels	: 2.73
Having any respiratory disease symptom (14)	: 30.4%
No. of males 60 years and above from HHs using clean fuels	: 7
Having any respiratory symptoms (2)	: 28.6%
Having any respiratory disease symptom (1)	: 14.3%
No. of males 60 years and above who worked in dusty jobs	: 3
Odds ratio against non-dusty jobs	: 0.97
Having any respiratory symptoms (1)	: 33.3%
Having any respiratory disease symptom (0)	: 0.0%
No. of males 60 years and above who did not work in dusty jobs	: 170
Having any respiratory symptoms (58)	: 34.1%
Having any respiratory disease symptom (34)	: 20.0%
No. of males 60 years and above in households with single room	: 18
Having any respiratory symptoms (7)	: 38.9%
Odds ratio against more rooms	: 1.26
Having any respiratory disease symptom (3)	: 16.7%
No. of males 60 years and above in households with 2 or more rooms	: 152
Having any respiratory symptoms (51)	: 33.6%
Having any respiratory disease symptom (31)	: 20.4%
* Significant statistically at 95% confidence level.	

b) Discriminant Analysis

Variables considered: Type of fuels used, Cooking location, Hours of cooking in a day, High hilly vs. low hilly areas, Smoking habit, Illiteracy, Household income, Single room vs. more rooms in the house.
Discriminant function: Respiratory disease symptom (Y) = - 4.261 + 1.370*Smoking habit + 1.264*Type of fuels used correctly classified 60.7% of original cases.
The computed χ^2 value at degrees of freedom 2 is 14.529, which is significant at 95%. For elderly males of 60+ years, Smoking habit and type of fuels used in the household appear to be the main discriminating characteristics.

Binary Logistic Regression

Through this method also Smoking habit and type of fuels used are found to be the main predictive variable.

Additional Analysis

An over analysis has also been made to see the impact on respiratory symptoms of biofuels and clean fuels vis a vis illiteracy of female adults.

Households using	Illiterate females		Literate females		Odds ratio (illiterates vs. literates)
	No. of persons	No. of symptom-matics	No. of persons	No. of symptom-matics	
Biofuels for cooking	175	35 (20.0%)	187	9 (4.8%)	4.94
Clean fuels for cooking	16	2 (12.5%)	58	3 (5.2%)	2.62

Illiteracy has influence on respiratory symptoms even in clean fuel using households.

6 SUMMARY

Given the recent concern about indoor air pollution due to use of bio-fuels, it is essential to do comprehensive survey so that ground realities are captured and interventions are properly selected and channelised. A comprehensive survey was conducted in 9 districts of rural Himachal Pradesh, India covering 712 households from 54 villages during Mid February to Mid March, 2000. This document summarises preliminary results of selected indicators covering a) socio-economic characteristics b) fuel consumption pattern, c) cooking practices, d) exposure to indoor air pollutants, e) health profile, and f) environmental concerns. The data related to socio-economic conditions, fuel consumption pattern and cooking practices were collected from the chief cook of the household. The health profile data were collected for respiratory disease symptoms using Medical Research Council 1986 questionnaire. Physicians examined all those reporting any symptom and present during the survey. The nutritional status (height, weight, and age) was also recorded. The analysis reveals some very important and conclusive facts.

- The survey shows that in rural Himachal Pradesh most of the villages have some road net work and mode of transportation. Almost all the villages have access to primary school and health care facilities with an average of 1/2 doctors per health centres. Majority of villagers (60 percent) are landless and about 36 percent of the villagers are either small or marginal farmers. The income structure is such that only 11 percent of the households have average annual income less than Rs. 10,000.

- Bio-fuels are the main source of cooking for about 93 percent households. Use of dung cake is not very common in the area. In most of the villages the distance travelled to collect fuel wood is less than 2 km. Average consumption of fuel wood is 7.4 kg per household per day and fuel is generally gathered from the nearby forests. The average distance travelled to collect wood is about 2 km and in a month 30 km distance is being travelled by each household. Kerosene is mostly used for lighting. This is reflected by the very small amount of kerosene consumed per households, i. e. 7.8 litres per household per month. Nearly 49 percent households own kerosene stoves. However, 31 percent are actually using kerosene for cooking.

- What are the preferences of interventions to avoid smoke? These can be fuel substitution (kerosene or LPG) or effort to avoid smoke from the biofuels. Our results suggest that distribution of clean fuels viz., kerosene and LPG is quite good in the area. But use of clean fuels is restricted, even in the households where kerosene is used for cooking, its use is restricted for making small meals or snacks. The reasons for its restricted use are mainly non-affordability and hesitant of using it. All other speculations often made in literature are not supported by the survey in Himachal Pradesh state. Demand of kerosene at market price of Rs. 5 is estimated to be 2.7 kilolitres per month in the sampled households. This latent demand can be tapped to reduce health impacts and drudgery of women.

- Willingness to pay for ventilation in the house is higher than for improved stoves. As 13 percent households are willing to go for improving ventilation whereas, only 5 percent are willing to install improved chulha. Only 18% of households are willing to spend money to improve air quality in the kitchen per se.

- The health centres study reveals that there is prevalence of air and water pollution related diseases in the area. However, there is no seasonality as such for these diseases.

- In the study area most of separate kitchens are semi-pucca type (86 percent, n = 626 HHs having separate kitchens) and about 18 percent houses have only one room. Location of the kitchen in 9 percent houses is inside the living room itself. 88 percent households have separate kitchen. 57 percent of these separate kitchens have open entrance without any door. Most of the households (58 percent) cook twice a day. Total time required to cook all the meals on an average is about 3 hours 25 minutes. Mostly females of age 15 to 45 years are the chief cooks.

- The health data show that smoking habit is not prevalent in women. The data further reveals that on the basis of self reported (1,580 cases) and proxy responses (2,520) about symptoms of respiratory illness, men were found to be suffering more or less same from the respiratory symptoms than the women.

- The linkages of health with bio-fuel use were also established on the basis of self-reported symptoms of respiratory diseases. The symptoms of phlegm and breathlessness

are significantly high in case of households using biofuels than the households using LPG.

- Prevalence of some respiratory symptoms was as high as 17 percent in Himachal Pradesh. Twenty one percent of adults reported 'any' respiratory symptoms.

- Impact of air pollution appears to be less because of separate kitchen, good ventilation and use of clean fuels. Thus, there is small difference between male non-smokers and females for all symptoms in spite of females' exposure to indoor air pollution due to cooking.

- Age, smoking habit and illiteracy has significant influence on almost all the respiratory symptoms.

- High odds ratio indicate that females using biofuels are more susceptible to cough, phlegm, wheezing, chest illness and blood in sputum as compared to females using clean fuels.

- Analysis is underway to identify the vulnerable groups. Preliminary analysis has been made through univariate analysis of individual and household characteristics. Also used multivariate discriminant analysis and binary logistic regression for this. Ten possible age and gender groups were analysed using some important individual and household characteristics.

- It is observed that proportion of reported symptomatics are much higher among age groups 45-60 years and 60+ years.

- Smoking has a high damaging effect among males between 15-30 years.

- Both males and females from biofuel using households have shown higher chances of getting respiratory symptoms as compared to those from clean fuel using households.

- Males and females from low-income households are also at a higher risk of respiratory symptoms as compared to those from high-income households.

- Again males and females from households with one room are at a higher risk as compared to those from households with more than one room.

- In the survey area respondents place the highest priority on sanitation across all the income levels followed by reduced kitchen smoke. It seems that sanitation is a short term and immediate problems. On the other hand health effect of air pollution is a long-term issue.

More rigorous statistical analysis is underway to examine number of variables and their relationships for 4 states viz., Rajasthan, Himachal Pradesh, Tamil Nadu and Uttar Pradesh. However, we wish to report on the preliminary analysis of Himachal Pradesh, as to increase awareness about the database to those who are interested in these issues.

Comprehensive data collected during the survey also describe the health effects and interrelationships among variables covering water supply, sanitation facilities, standard of living and the overall household environment. Further analysis is being carried out to inter connect the above issues. Similar surveys are also being carried out in other northern India covering Rajasthan and Uttar Pradesh. The preliminary analysis of data is going on.

REFERENCES

1. Census of India, 1991. Office of Registrar General and Census Commissioner, India.
2. Jamuna Ramakrishna, (1990): Patterns of domestic air pollution in rural India, April**,** *IDRC-MR254e.*
3. IGIDR and SRMC, (2000): Indoor air quality monitoring in rural households of four districts in Tamil Nadu, *UNDP Project Report* 2000.
4. NFHS (1995): *National Family Health Survey (MCH and Family Planning):* India, 1992-93, International Institute of Population Sciences, Mumbai.
5. Ostro, B., Sanchez, J. M., Aranda, C., Eskeland, G. S., (1995): Air Pollution and mortality results from Santiago, Chile. *World Bank Policy Research paper,* 1453.
6. Parikh, J., (1995): Gender issues in energy policy. *Energy Policy,* 23: 745.
7. Parikh, J.,Smith, K. and Vijaylaxmi, (1999): Indoor air pollution : A reflection on gender bias, *Economic and Political Weekly*, 34,(9): 539.
8. Parikh, J. , Balakrishana, K., Vijay Laxmi, Biswas, H. Exposure to air pollution from combustion of cooking fuels: A case study of rural Tamil Nadu, India. Submitted to *Energy*, The international Journal.
9. Raiyani, C. V., et.al, (1993): Characterisation and problems of indoor pollution due to cooking stove smoke, *Atmospheric Environment*, 27A, (11): 1643
10. Smith, K. R. (1987): *Biofuels, air pollution and health*, Plenum Press, New York,.
11. Smith, K. R. (1993): Fuel combustion, air pollution exposure, and health: the situation in developing countries', *Ann Rev Energy Environ,* 18:529-566
12. Smith, K. R., (1996): Indoor air pollution in India. National Medical Journal of India, 9 (3): 103-104
13. CSE, (1999): The citizens' fifth report, State of India's Environment, Part-1, A National Overview.
14. Udwadia, F. E, Sunavala, J. D, Shetye, V. M. (1987): Lung function studies in healthy Indian subjects. *JAPI*, 36, (7): 491.