COOKING HABITS AND HEALTH EFFECTS IN RURAL COMMUNITIES OF NORTHERN GHANA

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PRESENTATION OVERVIEW

- Introduction and Background;
- Materials and Methods;
- Results and Discussions;
  - Detrimental Effects in the Acquisition of Household Energy;
  - Health Impacts of Indoor Air Pollution;
  - Result of the Kitchen Concentrations to International Standards;
  - 24-hr Household Variation and Cross-household Variations;
  - Extrapolation of the Kitchen Concentrations: Health Implications;
  - Local Health Problems Associated with IAP
- Conclusion

INTRODUCTION AND BACKGROUND

- It is estimated that worldwide more than two billion people use fuelwood as their only fuel.
- In Ghana's rural sector fuelwood is the main domestic fuel, used by approximately 94 per cent households, mainly for cooking.
- Due to poverty, fuelwood will continue to dominate the energy supply of rural communities in the foreseeable future.

INTRODUCTION AND BACKGROUND

- Inefficient burning of these fuels leads to very high concentrations of indoor air pollutants such as carbon monoxide (CO) and fine particulate matter ($PM_{2.5}$).

- Since women and children spend large amounts of time in the kitchen, they are disproportionately affected by the high pollution levels and the health impacts associated with exposure to them.

INTRODUCTION AND BACKGROUND

- Estimates, prepared solely on the basis of risks derived from developing-country studies, indicate that up to 3,960 premature deaths in children under 5 years, 1,640 deaths from chronic respiratory disease in women, and less than 10 per cent cases of lung cancer may be attributable to solid fuel use.

- Despite strong epidemiological evidence, relatively few studies have been carried out to determine people's exposures in these settings.

INTRODUCTION AND BACKGROUND

- In some of the earliest studies to determine levels of indoor air pollutants associated with biomass combustion, measurements were recorded only during cooking periods.

- With more recently, systematic, 24-h measurements of respirable particulates, there is only a weak association between personal and ambient concentrations, most likely because people spend most of their time indoors.

INTRODUCTION AND BACKGROUND

- Further, many past studies in Ghana have been carried out in the southern part, leaving out the large populations in the Northern parts.

- Given that socio-cultural (including different food habits), housing, and climatic conditions affecting indoor concentrations vary considerably across the country, there is a need to collect this information on a regional basis.

INTRODUCTION AND BACKGROUND

- Based on this rationale, the present study was designed to collect better and systematic quantitative information about actual levels of exposure to indoor air pollution experienced by rural people in the Bongo district (using $PM_{2.5}$ and CO as the indicator pollutants) and to identify key household level determinants of this exposure.

MATERIALS AND METHODS

- This study was conducted in the Bongo District in the Upper East Region of Ghana, with an estimated population of 77,885 and a population density of 183 people per sq. km.

- Based on the multi-stage sampling design, 625 households were selected for collecting primary data on several household-level parameters through door-to-door survey of households.

MATERIALS AND METHODS

- Fine particulate matter was measured in each of the households using the University of California-Berkeley Particle Monitor (UCB PM) with a photoelectric detector every minute (in units of milligrams PM per cubic meter of air, mg/m3).

- Carbon monoxide was measured in each of the households with the HOBO CO logger which recorded the CO concentration every minute (in units of parts CO per million parts of air (ppm)).

MATERIALS AND METHODS

- In addition, as a backup, CO was also measured by a CO diffusion tube in each of the 45 households.

- The particulate and CO measurement devices were placed on the wall of the kitchen for 24 hours according to the following criteria:
  - Approximately 100 cm from the edge of the combustion zone;
  - At a height of 125 cm above the floor; and
  - At least 150 cm away (horizontally) from doors and windows, where possible

RESULTS AND DISCUSSIONS

1. DETRIMENTAL EFFECTS IN THE ACQUISITION OF HOUSEHOLD ENERGY

- The self-perceived morbidity records furnished by the households include 11 categories of problems
- Five of these problems, including injuries (cuts and sprains), backache, headache, chest pain and pest attacks, are widespread and occur frequently
- Analysis of the field data reveals that the whole phenomenon clearly manifests gender differentiation.
- The total number of problems reported by men was insignificant. This was due primarily to their extremely low engagement in procuring and head-loading fuelwood

RESULTS AND DISCUSSIONS

TABLE 1- SELF-REPORTED MORBIDITY IN RELATION TO BIOMASS COLLECTION AND USE

Self-reported morbidity	Number of household reporting	Women	Men
Injuries	575	434	140
Snake bites	172	138	35
Insect & Pest bites	445	336	109
Headaches	350	271	79
Chest pains	376	299	77
Fatigue	495	484	11
Stiff neck	434	434	0
Backache	424	412	12
Skin irritation	487	480	7
Fungus infection	384	384	0
Sinus problems	127	127	0
Waist pains	523	523	0

Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

2. RESULTS OF THE IAP MONITORING EXERCISE

TABLE 2: AVERAGE KITCHEN CONCENTRATIONS OF PM AND CO

IAP Measurement	Minimum	Maximum	Mean	Std. Deviation
PM: Average (mg/m³)	.05	6.39	.7056	.98840
PM: Minimum (mg/m³)	.02	5.36	.1825	.80554
PM: Maximum (mg/m³)	.80	76.04	37.7013	22.33790
PM: Highest 15-min ave.	.32	50.60	12.2196	11.62236
PM: 2nd Highest 15-min ave	.14	33.05	7.7820	7.86929
PM: 3rd Highest 15-min ave	.13	24.71	5.6578	6.03955
CO: Mean , HOBO (ppm)	2.90	45.60	12.6311	9.96110
CO: Maximum, HOBO (ppm)	26.60	432.60	128.8200	92.87469
CO: Mean Tubes (ppm)	1.90	43.00	8.8133	9.05367

Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

3. COMPARISON OF THE KITCHEN CONCENTRATIONS TO INTERNATIONAL STANDARDS

TABLE 3: COMPARISON OF IAP WITH INTERNATIONAL STANDARDS

Pollutant.	24-hr Mean Concentration (in this study).	WHO interim target -1	WHO Air Quality Guideline.
PM2.5	706ug/m^3	75 ug/m3 (24-hr mean)	25 ug/m3 (24-hr ave)
CO	14.49mg/m^3	NA	10 mg/m3 (8-hr ave)

Source: Survey Analysis, January – April, 2006

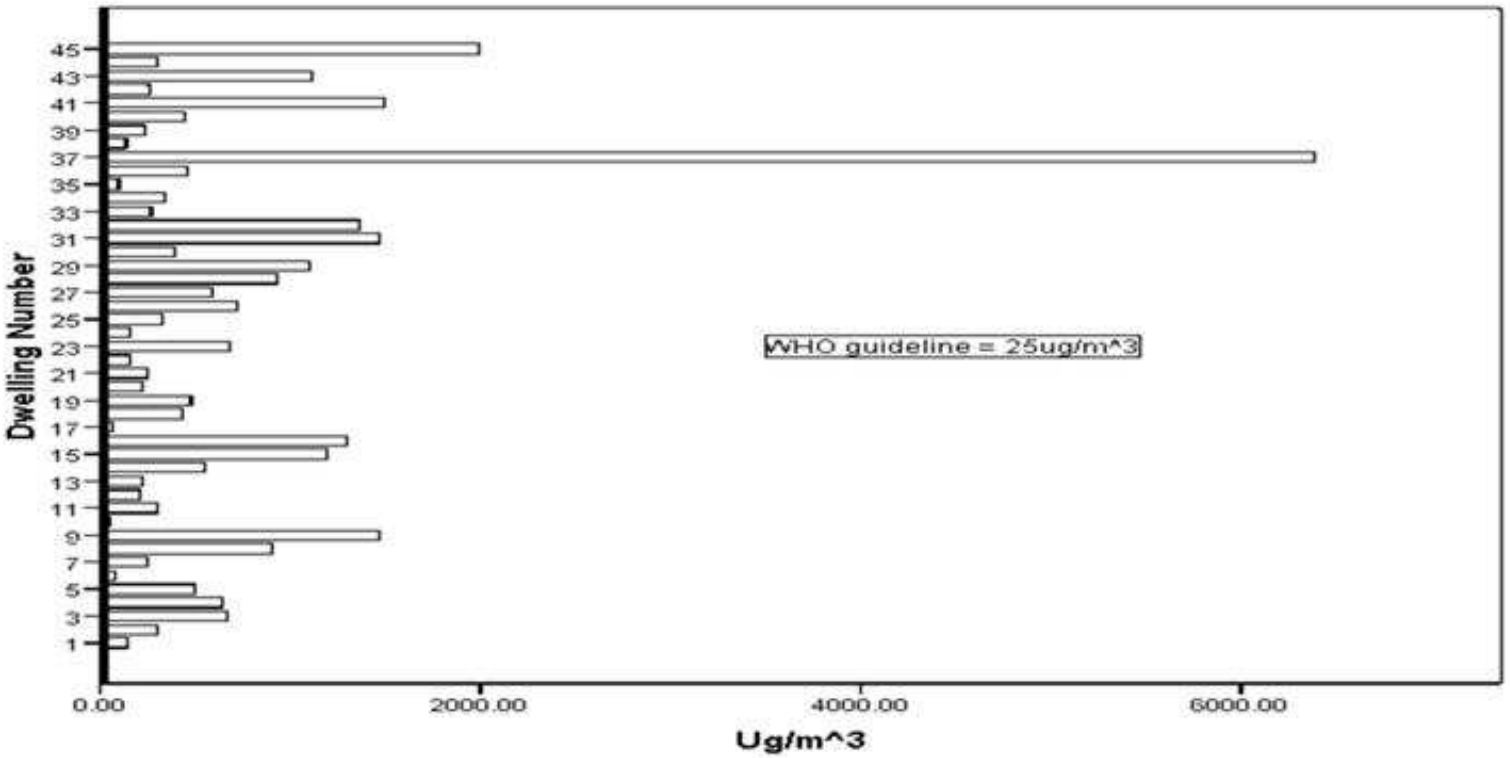
As can be seen from table 3 above both $PM_{2.5}$ and CO monoxide concentrations were well above the permissible levels recommended by the WHO

RESULTS AND DISCUSSIONS

- Nevertheless when concentrations are averaged over 24-hr, averages can fall below guidelines if baseline levels are low, thus creating a false sense of safety.
- This problem can place many individuals, particularly women and children at risk.
- Figures 1 and 2 give a more detailed analysis of $PM_{2.5}$ and CO averages across the individual households surveyed compared with WHO guidelines.

RESULTS AND DISCUSSIONS

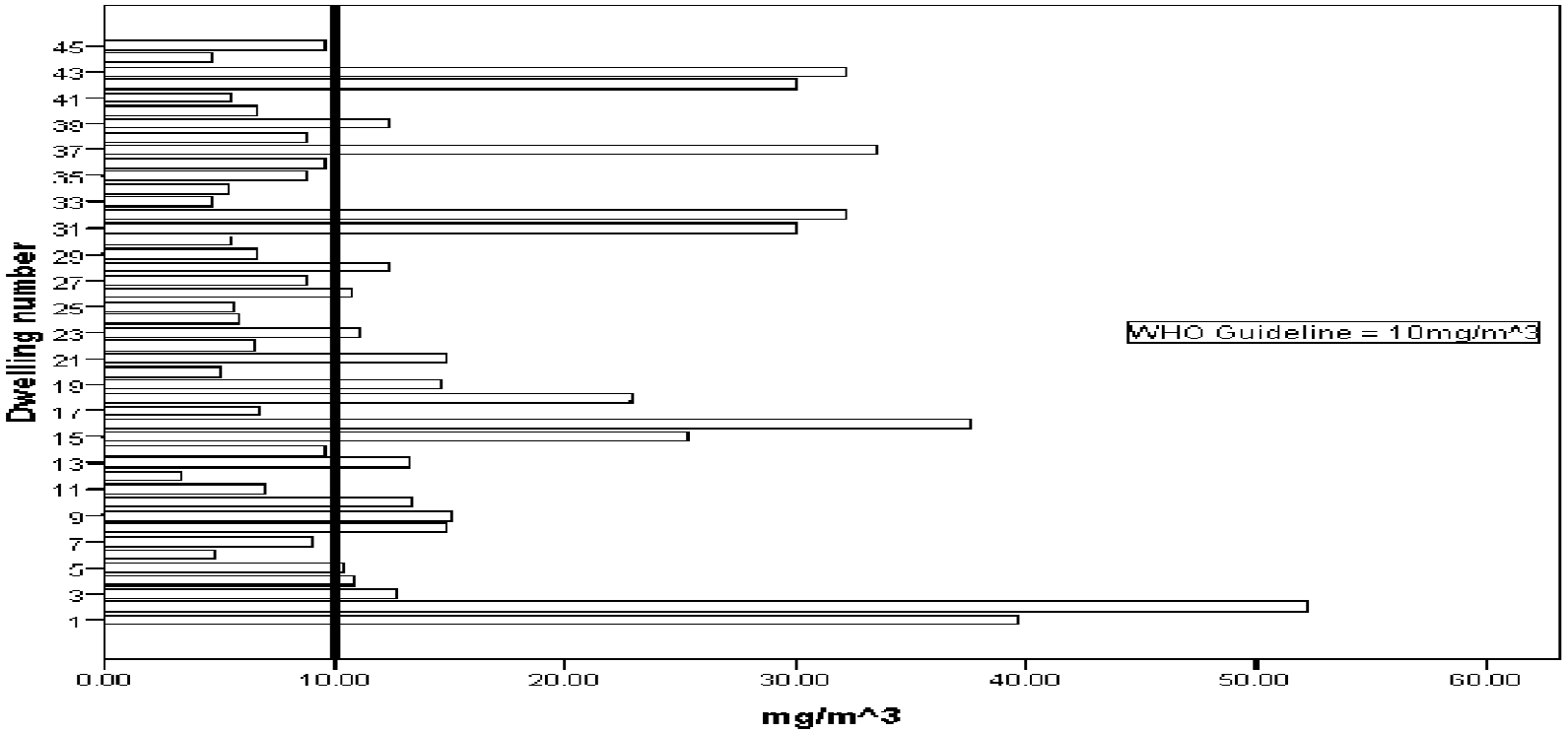
Figure 1: 24-hour PM $_{2.5}$ Mean Concentrations Across Sampled Households



Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

Figure 2: 24-hour CO mean concentrations across sampled households



Source: Survey Analysis, January – April, 2006

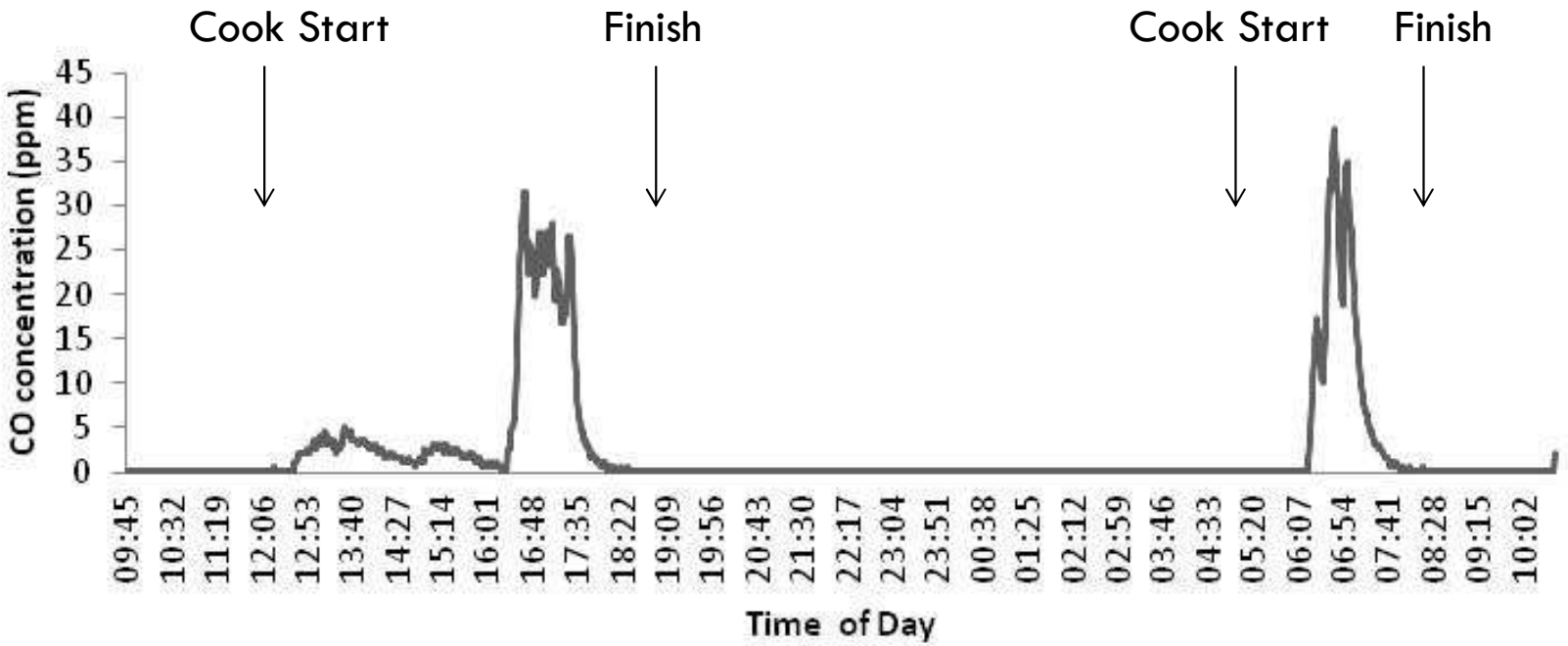
RESULTS AND DISCUSSIONS

4. 24-hr Household Variation and Cross-household Variation

- Smoke emissions from a biomass stove exhibit very large variability throughout the day, including large peaks of short duration.
- It became evident from the study that, often peaks in emissions corresponded with approximate times when fuel use was recorded.
- This pattern indicates that some household members are consistently closest to the fire when pollution level is the highest.
- These episodes typically occur when fuel is added or moved, the stove is lit, the cooking pot is placed on or removed from the fire, or food is stirred

RESULTS AND DISCUSSIONS

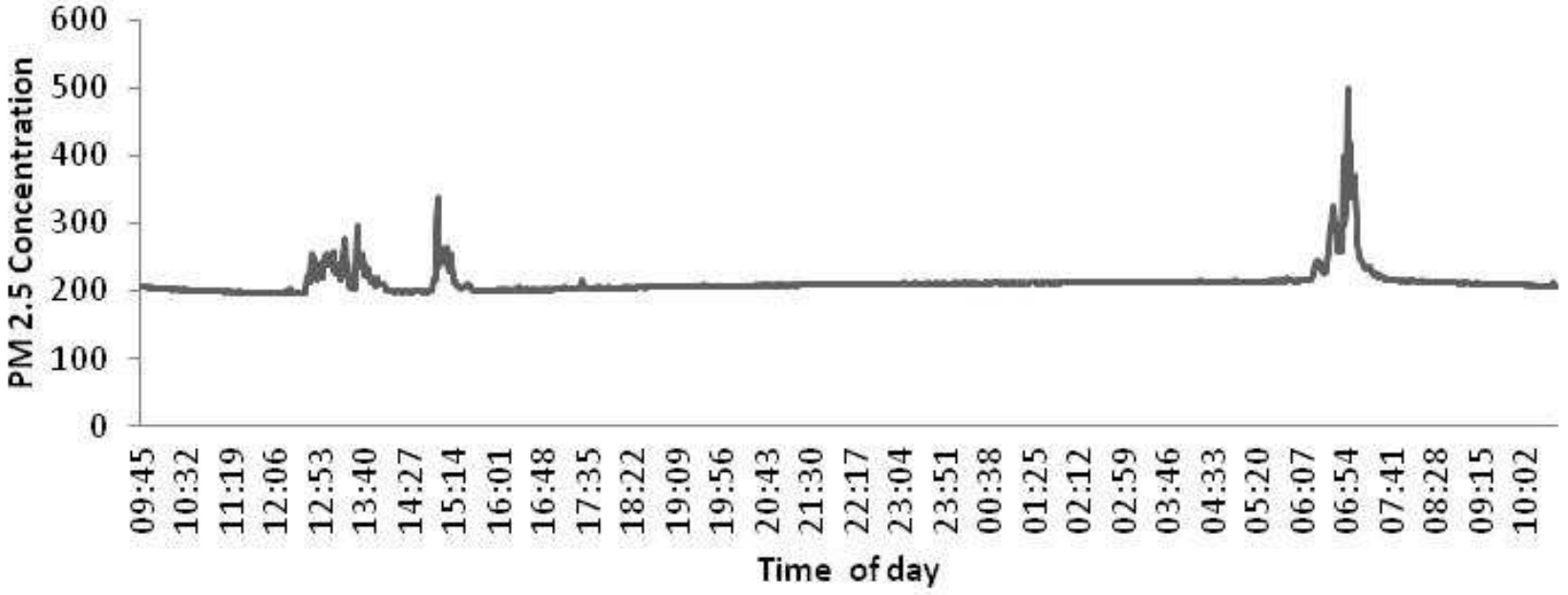
Figure 3: Peaks of emissions for CO (above) and $PM_{2.5}$ (below) Displayed During the Times of Fuel Use



Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

Figure 3 (Cont…): Peaks of emissions for CO (above) and $PM_{2.5}$ (below) Displayed During the Times of Fuel Use



Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

5. Extrapolation of the Kitchen Concentrations: Health Implications

- Given only kitchen concentrations measured in this study, to develop personal exposure concentrations data was pulled from studies that measured both kitchen and exposure concentrations for household members.

- These studies show the obvious, that the range in the ratio of personal exposure to kitchen concentrations is very large and dependent on the individual situation

- Hence, attempting to assign such a ratio to a new situation, such as that in the Bongo district, is not particularly accurate and introduces much uncertainty.

RESULTS AND DISCUSSIONS

5. Extrapolation of the Kitchen Concentrations: Health Implications

- Nonetheless, a personal/kitchen concentration ratio of 0.50 was used here as the "best" estimate.

- A "high" personal exposure case of 0.8 and a "low" exposure case of 0.25 were also considered.

- Multiplying the kitchen $PM_{2.5}$ concentration average of 706 ug/m3 by the best estimate of 0.50 for the personal/kitchen concentration ratio yielded a personal exposure concentration estimate of 353 ug/m3 or 0.353 mg/m3.

RESULTS AND DISCUSSIONS

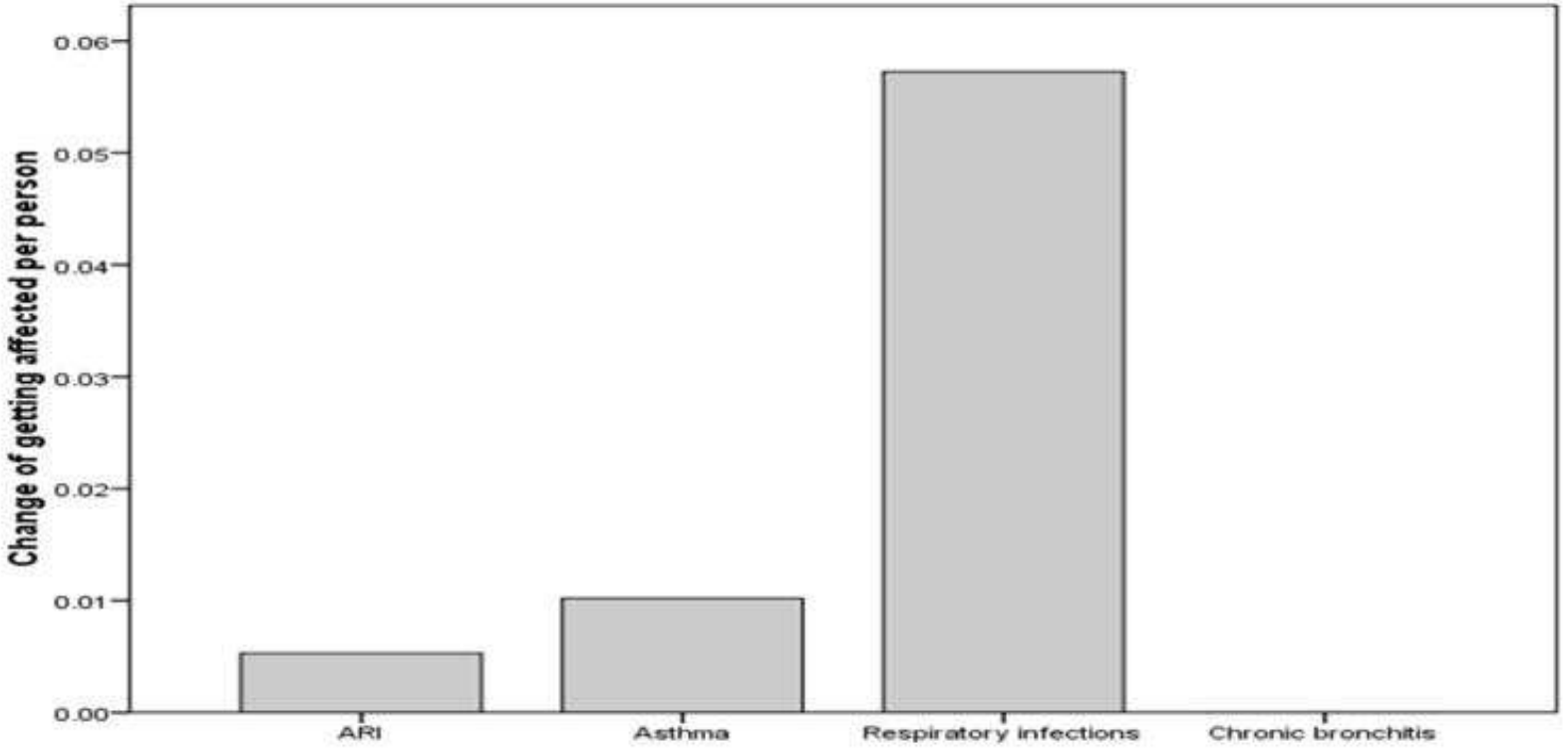
TABLE 4: AVERAGE RELATIVE CHANCE OF BEING AFFECTED BY IAP RELATED DISEASES

	Personal exposure thresholds		
Disease	Low	Best	High
Acute respiratory lower infections	0.023	0.053	0.088
Asthma	0.044	0.102	0.171
Respiratory Infections	0.250	0.572	0.960
Chronic bronchitis	0.000	0.000	0.000

Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

Figure3: Graphical Illustration of the Relative Chance of being Affected by IAP – Related Diseases



Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

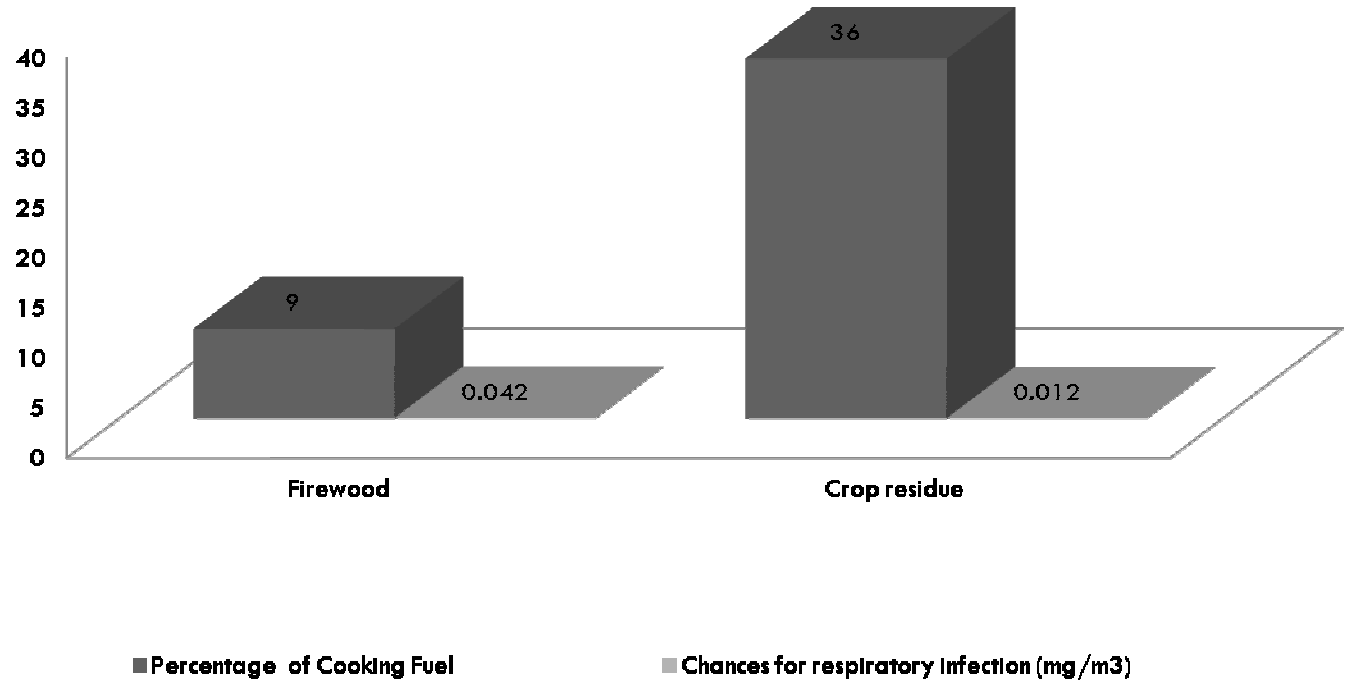
- Respiration infections (wheezing, coughing) dominate, followed by asthma and then acute respiratory lower infections in children.

- A health profile in the district showed that respiratory diseases were the second commonest disease after malaria, lending credence to the evidence that exposure to biomass cook stove smoke may contribute to a number of patients suffering respiratory infection in the study area.

- Different fuels have different emission factors and ill-effect (Households using crop residue has a 0.012 relative chance of being infected with respiratory infections, whiles firewood has 0.042 relative chance of being infected with respiratory infections).

RESULTS AND DISCUSSIONS

Figure3: Graphical Illustration of the Relative Chance of being Affected by IAP – Related Diseases



Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

6. Local Health Problems Associated with IAP

- ***General Observations***: The effects of smoke inhalation on the respondent, especially women and children were noticeable in observations of village life.

- ***Local Knowledge and Behaviour***: Across all households and socio-demographic groups, the majority of respondents were aware that smoke from cooking and heating poses a health hazard.

- ***IAP- health related symptoms:*** A high percentage of sampled individuals reported experiencing respiratory symptoms that may be related to exposure to Indoor Air Pollution.

RESULTS AND DISCUSSIONS

Table 5: Prevalence of Smoke-related Disease Symptoms Among Males, Females and Children (Aged < 6) by 625 Households

Disease symptoms	Women	Men		Children (aged<6)
		Smokers	Non-smokers	
Cough	457	6	51	494
Chest / breathing problems	369	2	2	41
Tired /Stress	420	0	1	11
Eye irritations /tearing	464	5	58	508
Loss of appetite	135	0	0	0
Rise in body temperature	193	0	1	38
Phlegm	224	0	0	1
Headache	442	1	11	54

Source: Survey Analysis, January – April, 2006

RESULTS AND DISCUSSIONS

6. Local Health Problems Associated with IAP

- ***Regression Analysis of Health Symptoms:***
  - On the basis of direct response data of females, logistic regression analysis are made about the patterns of the relationship between the top two smoke related health symptoms and other variables.
  - The odds ratio from the logistic regression estimated for women respondent reporting coughing and eye irritation are presented in table 6.

RESULTS AND DISCUSSIONS

Table 6: logistic regression on the relationship between household characteristics and self-reported respiratory disease symptoms

	Coughing		Eye irritation	
Variable	Odds ratio	Z-value	Odds ratio	Z-value
Age	0.986	-0.81	0.965*	-1.65
Education (1= illiterate)	3.625**	2.28	5.739**	2.64
Occupation (1= farming)	5.172**	2.34	0.576	-0.93
Cooked 2 meals per day (1 =yes)	0.370**	-2.04	0.688	-0.50
Window (1= yes)	0.381**	-2.23	0.935	-0.12
Lighting (1= electricity)	0.096	-0.06	0.756	-0.37
Cooking fuel[t]				
Firewood	0.214**	-3.31	4.166	1.35
Others	0.284	-1.29	0.654	-0.40
Wealth Index	0.979	-0.56	0.954	-1.08
McFadden Pseudo R –Square	0.1460		0.1396	

Source: Survey Analysis, January – April, 2006

CONCLUSION

- According to the Ghanaian Constitution, every person has a right to an environment that is not harmful to his or her health or well-being.
- However cooking with biomass fuels in traditional stoves emit sever gaseous pollutant like CO, CO_2 SO_2, NO_2 and even PM.
- Those pollutants are highly hazardous for human health especially for women and children who are exposed to that air for a long time.

CONCLUSION

- The findings suggest that IAP is indeed a problem in study households, and that occupants are currently facing health risks from exposure to IAP.

- Based on this research averagely, users are exposed to pollutant concentrations (CO, $PM_{2.5}$) ten times compared to those allowable by international organizations such as WHO, and women and children are the most affected by theses high concentrations.

- Extrapolation of diseases with PM concentration showed that households were in a higher risk of being infected with respiratory diseases from the use of biomass fuels.

CONCLUSION

- However, local knowledge about how to mitigate IAP related issues is lacking in the communities surveyed.

- This is because such symptoms are considered to be normal and are not taken seriously in the community.

- Apart from IAP health related issues, the collection of firewood also have drudging effects on the health of users. Among the common cited cases were injuries (cuts from branches) headaches, chest pains, waist burns and stiff necks.