DEPARTMENT OF COMMUNITY HEALTH FACULTY OF

MEDICINE ADDIS ABABA UNIVERSITY

EXPOSURE ASSESSMENT TO INDOOR SMOKE POLLUTION IN A RURAL ETHIOPIA

BY

Berhanu Eshete, M.D

THESIS PRESENTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF PUBLIC HEALTH

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Exposure assessment to indoor smoke pollution in rural Ethiopia

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LIST OF ABBREVIATIONS

ETS	Environmental tobacco smoke
Rn	Radon
VOC	Volatile organic compounds
SNNPRS	Southern Nations Nationalities and peoples regional state
PAs	Peasant associations
UDAs	Urban dwellers associations
BRHP	Butajira Rural Health Project
ARI	Acute respiratory tract infection

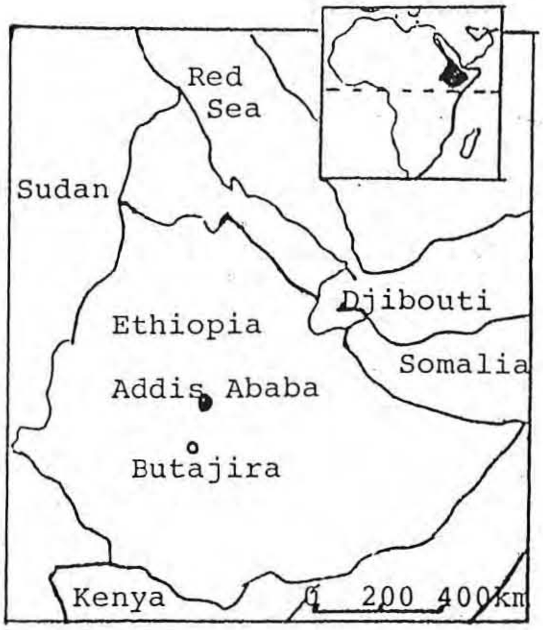

Fig. 1. Map of Ethiopia indicating the Butajira study site.

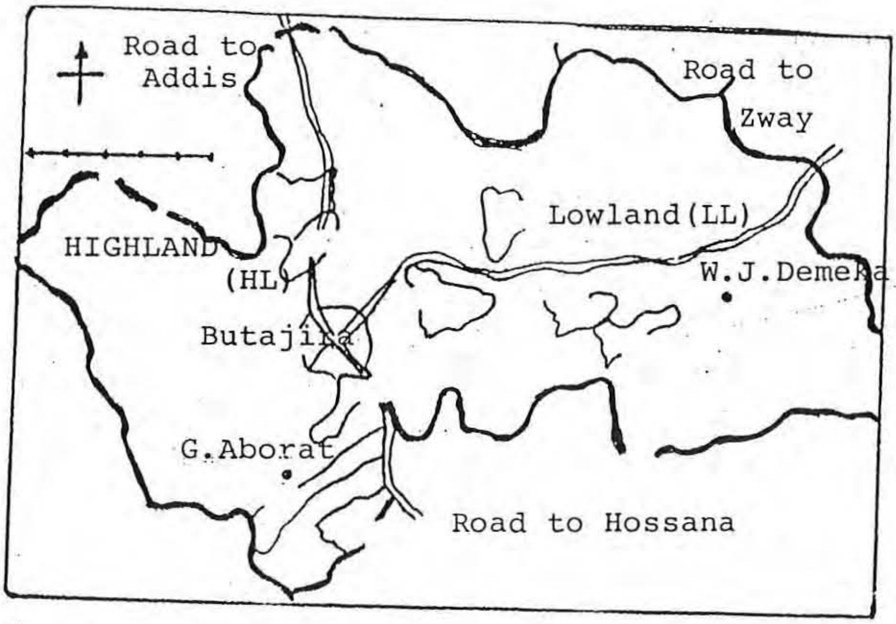

Fig.2. Map of Butajira district indicating the selected 3 Study sites.

ABSTRACT

Very little effort has been made in Ethiopia to assess the effect of indoor air pollution at a community level. The aim of the study was to assess exposure to indoor air pollution at a household level and find out the feasibility of using questionnaire in determining exposure level for indoor air pollution. Cross-sectional study design was utilized. Data were collected using structured questionnaire, in-depth interview with key informants and child movement recording. Data entry and analysis was done using Epi Info version 6 statistical software. A total of 600 households from the three study areas(rural high land, rural lowland and town)were assessed. Three hundred thirty four(55.7%)of the households had high exposure level to indoor smoke. Rural households were less likely to have adequate smoke clearance compared to urban households (OR=0.3;95% CI=0.16,0.54). Being muslem, married, Mother illiterate and and low economic status were less likely to be in the low exposure status with adjusted OR(95%CI) of 2.24(1.39,3.54), 0.41(0.18,0.82),0.36(0.2,0.66)and 0.34(0.22,0.54), respectively. The main source of indoor smoke was biomass fuel used by 98.5% for cooking and 29.6% for heating. The majority (94.9%) were using open type of stove without flue or chimney. The median(SD)of exposure time by the interview and observation was found to be 180(202) and 125(148) minutes, respectively. From this we conclude and recommend that biomass fuels are the principal sources for the indoor smoke, the poor socio-demographic and environmental factors expose children to indoor smoke and collecting information about exposure time of under five children using interview and observation methods has no statistically significant difference. Using cleaner fuels, improving social, economic, cultural and environmental conditions could improve the exposure level to indoor smoke.

1. INTRODUCTION

Air pollution refers to the impairment of the normal composition of air by the addition of foreign matter, such as particulates or gases. Naturally occurring phenomena such as volcanic eruptions, tree and grass pollination and swamp gas have always polluted the air(1). Indoor air pollution from human activity is probably as old as our ability to start a fire but the large scale air pollution from industrial activities is a relatively recent development(1).

In many developing countries major indoor air pollution is still caused by biomass fuel combustion. Biomass fuels are defined as fuels from organic matter such as wood, leaves, agriculture residues and animal dung(2). Biomass smoke contains a significant amount of pollutants such as particulate, carbon monoxide, hydrocarbons and, to a lesser extent, nitrogen oxides(3).

Although biomass fuels today supply a relatively small fraction (10%) of the global energy requirement in terms of total energy content, they provide the largest proportion of energy in terms of the number of people using them since population density is highest in developing countries. It is estimated, for example, that about half of the world's households cook daily with biomass fuels, and that approximately 30% of urban households and 90% of rural households in developing countries rely on biomass fuel for cooking(4). It is conservatively estimated that some 500 million people, mostly women and children, are exposed to levels of indoor air pollution that are well above those considered safe. The magnitude of the problem is often increased by the usually accompanying poor ventilation and crowding(5).

Even though our knowledge of the toxins from biomass fuel combustion is limited, they are believed to contribute to the increased incidence of chronic obstructive lung disease, corpulmonale(right-sided heart failure), cancer of the lung and naso pharynx and increased morbidity and mortality due to acute respiratory tract infection(ARI)(5). However,there is scarcity of relevant epidemiologic data to show the magnitude of the problems associated with indoor air pollution at a community level,because of the lack of appropriate methods of exposure assessement in rural developing country setting. The aim of the study was to assess exposure to indoor air pollution at a household level and the feasibility of using questionnaire in determining exposure level for indoor air pollution.

LITERATURE REVIEW

Five principal classes of indoor air pollutants are identified(6). Those derived from products of combustion, building materials, household products, infectious agents, and allergens. Each class is briefly discussed here:(2,7,8).

(I) Products of combustion.

These include pollutants such as carbonmonoxide,particulates, sulfur and nitrogen oxides emanating from cooking stoves ,space heaters and cigarettes (environmental tobacco smoke-ETS).

The improper ventilation of home cooking and heating units due to design defects and mechanical or structural failures of the gas venting system, has been recognized for a long time(9). However, the 1973-74 energy crisis marked a significant raise in air pollution due to decreased ventilation of homes and use of auxiliary unvented combustion devices, such as kerosene heaters, to minimize the usage of expensive electricity and oil for heating(9).

(ii)Building materials and the ground under the building.

Dwellings may include materials in their construction that are potentially hazardous. These includes asbestos used to insulate heating ducts; radioactive radon contained in stone; and particle board and urea foam insulation ,which emit formaldehyde.

About 30 years ago scientists began expressing concern about radon gas being a health hazard inside dwellings; already 222 Rn and its daughters had been recognized as the probable causative agent of the excess lung cancer found in uranium miners(9). Radon is the radioactive decomposition product of radium, which in turn, is a descendant of the long-lived uranium-238. Many rocks, particularly granite, as well as soils, contain tiny concentrations of uranium. All the other radioactive elements in the series of decompositions from uranium are solids ,which remain fixed in the rock. Radon, however, is a gas, so it can diffuse out of the rock or soil and then into the cellar or basement of a house through cracks or openings in the foundation. The radon then mixes with the indoor air ,and thus is inhaled and enters the lungs. There are no acute health symptoms associated with radon (1).

(iii)Household products

The indoor use of cleaning fluids, paint thinners, glues, and other volatile organic substances, particularly with inadequate ventilation, can lead to toxic concentrations of their vapors.

Volatile organic compounds(VOC) make up a large and diverse group of organic substances that vaporize into the atmosphere at normal room temperatures. Formaldehyde (which is also present in products of combustion), the VOC of greatest public concern, has been extensively investigated in the past 10 years. However, hundreds of other VOC have been detected in indoor air, even though it is not present in biomass combustion. Concern has been raised about the potential of VOC, even at low concentrations, to cause both acute and chronic health effects(10).

(iv) Infectious agents

Although air-borne viruses and bacteria often are considered not to be an environmental health problem, they are treated by many authors as indoor air pollutants. This is because they may be more concentrated in indoor than outdoor air, so the chances of transmission are accordingly greater indoors. Indeed, morbidity and mortality from influenza and pneumonia are greater during the winter months, when people spend more time indoors.

(v) Allergens

"Natural pollutants" such as mold spores, dander and dusts may occur in greater concentrations in indoors than outdoors. Household items such as rugs and draperies serve as reservoirs for particulates such as these. Discarded or forgotten food items are sources of mold(7,8).

The commonest cause of indoor air pollution in the developing-country has been combustion products. Biomass fuels include a wide range of materials in different physical forms.

Crop residues, dried dung from large animals, Scrub plants, weeds cactus, and other miscellaneous forms of biomass are also used.

The most important source of pollution , of course, has always been fire wood, though each species of wood may have different chemical and physical characteristics(4). The pattern of biomass usage varies dramatically with local conditions and in some areas seasonal variation are observed(4).

After tobacco, the most common indoor pollution sources of concern in developed-country studies has been gas cook stoves. In the global context, however, gas stoves are near the upper end of an evolution in the quality of household fuels in what is reffered as energy ladder(11). Those households that rely on dried animal dung and scavenged twigs and grass for cooking constitute the bottom. The next step might be crop residues, followed by wood, and then charcoal. The first non-biomass fuel might be kerosene, as in India, or coal, as in China. Highest on the ladder lie bottled and piped gasses and for some rich communities, electricity. In general, each step involves an increase in the cooking system's level of technology, cleanliness, efficiency and cost(7).

Exposure levels to indoor air pollution

On a global scale, it is estimated that more than half of the world's households cook daily with unprocessed solid fuels, i.e. biofuels or Coal. An unknown, but significant, proportion of cooking activities takes place in conditions where much of the air borne effluent is released into the living area. Even when ventilation rates are high, the emission factors for such fuels are so great that indoor concentration and exposures can be quite significant compared with gas stoves, for example, wood stove typically release fifty times more pollution in cooking an equivalent meal compared to using one of the cleaner biofuels(11)

Although less prevalent, space heating with unprocessed solid fuels can also lead to high indoor air pollution levels. For part of the year in high altitude areas of developing countries, unvented space heating with biomass fuels is more common. In addition, in much of temperate China, significant indoor air pollutant concentrations, have been observed as a result of the high emission rates of coal fuel in simple stoves, although the pollution is less serious with venting, compared to pollution levels in most Chinese cities(7).

It has been impossible to make a reliable estimate of the total developing country population exposed to what might be termed "excessive" indoor concentration. This is because there are few internationally recognized standards for household concentrations. Assuming that they would be at least as stringent as outdoor standards, the total number of people exposed clearly exceeds that exposed to excessive ambient concentrations in all the world's cities. Given the greater time spent indoors and the known magnitude of concentrations in many situations however, the total global dose-equivalent(amount actually inhaled) is probably higher for some important pollutants, e.g.particulates(12).

Identifying the actual pollution exposure is complicated due to the inability of distinguishing in house and out side sources(7).

In developing countries, young children who often stay close to their mothers during cooking are highly exposed to pollution from biomass fuels. Furthermore, at night and during cold seasons in highland communities, families often spend many hours sleeping in heavily polluted rooms(4).

Particulate concentrations in cooking areas of African households have been reported to range between 100-7900 micro grams per cubic meter depending on the altitude of the area(14). This is very high compared to the maximum standard set by the united states Environmental Protection Agency for 24-hour limit, which is 260 ug/m^3(14).

Factors influencing exposure levels

Studies showed that the following factors influence exposure to indoor air pollution in developing countries(4).

(I) Socio-demographic characteristics(such as age, literacy, employment, family economic status, ethnicity, family size, marital status).

If the economic status of the family is good and the more the mother's are educated in school the tendency for using cleaner fuels is greater. Also such households live in an improved housing and ventilation conditions that are less likely to be heavily polluted(4).

(ii) Characteristics of the household environment(such as size, shape, presence of kitchen, child bed room and windows).

If the house is spacious, well ventilated and has a flue or chimney to carry emissions to the exterior from the fire, the indoor air will be much less polluted than if there is inadequate ventilation and no flue or chimney(4).

(iii) Fuel characteristics (such as the fuels used for cooking heating and lighting, seasonality).

Clearly the risk is greater if, for instance the fuel contains lead as a contaminant or if there is un usually high content of polyaromatic hydrocarbons in the smoke(4).

(iv) Cooking habits (such as length of time required to prepare the meals, time of day of burning fuels, location of cooking).

Burning fuels for a long period of time in the living room increases the indoor pollutant concentration markedly and affect the inhabitants(4).

(v) Cultural factors or child- rearing practices (e.g.,keeping children indoor, whether they are kept in a place far from the stove).

In developing countries, young children often stay close to their mothers during cooking and exposure to pollution from biomass fuels can occur at these times(22).

Factors influencing indoor air pollution concentration

The indoor concentrations of pollutants is influenced by outdoor levels, the rate of exchange between indoor and outdoor air ,and the characteristics of housing structure that influence pollutant dispersion and removal, pollutants from outdoor sources can enter a building through mechanical ventilation systems and through the natural infiltration of air(16).

personal exposure to air pollutants represent the average of the pollutant concentration encountered in various environments with weigting proportional to the time spent in each location (see fig.3) (16).

Fig. 3 Framework for considering the relationships among pollutant concentration, personal exposures, doses of pollutants to target tissues, and health effects.

As indoor air is enclosed substances emitted into it may reach high concentrations quite easily. Hence pollution concentration depends directly on ventilation (air flow and mixing volume). With poor ventilation rate even small emission rates can result in indoor concentrations that exceed those out doors.

In the developing world most houses lies in the tropical and sub tropical regions and typically has much higher ventilation rates . In the above mentioned climatic conditions, it takes fairly high emission rates to produce significant pollutant levels. Several hundred million people in developing countries requires space heating for a significant part of the year , and share with developed countries the difficult trade-off between space heating fuel efficiency, ventilation and indoor air quality(7).

Health hazard and effect of biomass smoke

Biomass fuel emissions present a health hazard whose effects vary in type and severity depending on the local situation, the type of fuel used and the population at risk(4). Biomass smoke contains significant amounts of several of the important pollutants: carbonmonoxide, particulate, hydrocarbons and, to a lesser extent, nitrogen oxides. Perhaps more important, however, is that the aerosol contains many organic compounds that are thought to be toxic, carcinogenic and mutagenic (13). Coal smoke contains all this plus additional pollutants such as sulfur oxides,inorganic ash particles and heavy metals such as lead. It is difficult to make generalizations about the relative amounts of each kind of pollutant, however, because emissions can change with relatively small changes in fuel quality, configuration and combustion, comparatively little detailed research has focused on such conditions(6).

While many health effects of indoor air pollution remain controversial, epidemiologic and clinical researches have identified some health effects(6). Even though the major health effect of pollutants is on the respiratory tract each part of the fuel cycle (production, collection, processing and combustion) can affect other systems of the body.

Coming to the commonest respiratory problem it could have acute, sub-acute and chronic effects, depending on the action of the pollutant. Acute effects on health are the result of smoke inhalation and of carbon monoxide poisoning; both are life threatening and cause rapid death if sufficient concentrations occur in air. Sub-acute effects are the result of the irritant or inflammatory action of the pollutant on the conjunctiva and mucus lining of respiratory tract from the nose to the bronchi(4). It becomes difficult to draw a distinction between acute and sub acute effect when considering the natural history of respiratory disease in infants and small children exposed to wood smoke. The sub acute inflammatory reaction caused by recurrent exposure to irritant and cilia-toxic and mucus-coagulating emissions make the trachea, bronchi and bronchioles, especially in infants, susceptible to infection which may manifest itself as acute infective bronchitis, bronchiolitis or pneumonia(17).

There are some studies in African countries concerning health effects of biomass smoke.

In Zimbabwe, 244 children under three years studied and presence of an open wood-fire was found to be a significant ARI risk factor(2). In a study of 500 children in Gambia, girls under five years carried on their mothers back during cooking were found to have a six times higher risk of ARI(2).

In a study of a series of 132 infants with severe lower respiratory tract disease seen in South Africa, 93 (70%) had a history of heavy exposure to wood smoke(4). A study on the natural history of chronic obstructive pulmonary disease (COPD) in Papua New Guinea 194 people exposed to wood smoke and found high prevalence of abnormal pulmonary signs; the pathological changes suggest that air pollution was the most important factor in the development of lung disease(4). In a recent study in Nepal, Pandey found a strong statistical correlation between the prevalence of chronic bronchitis in children and an index of domestic wood smoke(18).

The total number of people exposed to high concentration of smoke is estimated to be several hundred million in the world .

However, too few resources have been allocated to studies of air pollution and for particularly for the determination of actual exposure level in the household. Available technology to asess exposure require extensive laboratory work. Hence, the need for exploration of a simple method of doing that in developing countries is high.

Therefore this study was conducted in the rural village of Southern Ethiopia(Butajira District) to asses indoor exposure due to smoke and the feasibility of using a questionnaire in determining exposure levels. The findings of this study is believed to be valuable for policy makers, development programme planners and health professionals in devising measures to avoid exposure to indoor smoke pollution .

3. OBJECTIVES

3.1 GENERAL OBJECTIVE

To asses exposure to indoor air pollution in Butajira, Ethiopia.

3.2 SPECIFIC OBJECTIVES:

(a). To asses sources of domestic smoke pollution in the study community.

(b). To identify factors related to indoor air pollution at a household level(e.g, characteristics of the household environment, customs, habits, cultural factors, etc.).

(c). To asses the feasibility of using questionnaire in determining exposure level for indoor air pollution.

4. METHODOS

1. STUDY DESIGN

This is a community-based, cross-sectional study supplemented with in-depth interview and direct observation.

2. STUDY AREA

The study was conducted in the densely populated Butajira district, 130 km south of Adds Ababa, Ethiopia (Fig.1).

Butajira district, situated in the Southern Nations Nationalities and Peoples Regional State (SNNPRS), is connected by an all-weather road to Addis Ababa. According to the 1994 Population and Housing Census of Ethiopia(21), the estimated population of the district was 227,135. The district population is divided into urban 29,440 (13%) and rural 197,695 (87%); Butajira town had a population of 20,509(21). From the total district population, there were 113,095(49.8%) males and 114,040(50.2%) females. In 1994 there was a total of 40,595 households in the district, with an average of 4.7 persons per housing unit(19,21).

The altitude of the district ranges from 1500 to 2300 meters above sea level; the climate of the highland (>2000) is temperate while that of the lowland (< 2000 m) is tropical(19,20).

The rural population of the district is divided in to 82 peasant associations(PAs) and the urban population of Butajira town into four urban dwellers associations(UDAs)(19,20). The overall adult literacy rate for ages 14-49 years was 24% with marked sex differences 32% for males and 17% for females. Literacy rates varied from 52% in Butajira town to almost zero in the most rural areas. The major ethnic group is Gurage with further division into minor dialetics. The population is predominantly Muslim. Maize and enset(false banana)are the main crops. The people in the rural areas live by subsistence farming while those in the urban area run small shops and bars or have public sector jobs. Rural houses are traditional round huts ("tukuls") made of wood and plastered with clay, thatched roof, and often with no or rather small windows.

3. STUDY POPULATION

The population who are living in Butajira District, Southern Ethiopia, were the source population. The actual study was conducted in two selected rural villages (one in the low land named Woja Jare Demeka and one in the high land named Gidena Aborat) and one of the four kebeles (sectors) UDA of the Butajira town named Kebele 04. Assuming that the three areas could represent the Meskanena Mareko district. According to the 1994 National census the district is predominantly occupied by the Gurages'(21).
The study subjects were mothers with at least one child below the age of five years.

4. SAMPLE SIZE ESTIMATION

Based on the following conservative assumptions 50% prevalence of high level of exposure to indoor air pollution, 95% confidence limit, and 4% margin of error.The calculated sample size was 600.

The required sample size(n) was estimated using the formula for cross sectional surveys. That is:

$$n = \frac{(z\ \alpha/2)^2\ p(1-p)}{d^2}$$

Where, Z is the normal critical value for 95% confidence interval of proportion of indoor air pollution (1.96),

P is the estimated prevalence of level of indoor air pollution exposure (50%), and

d is the margin of error (4%). The calculated and required sample size was 600 households.

5. SAMPLING PROCEDURE

A multi-stage sampling method was used to select a total of 600 households for the study. The selection of the village was made as follows:

i. From the Butajira town one kebele out of three (excluding the village kebele under surveillance in the BRHP, to avoid information bias in the future study to be carried on in this specific kebele about indoor air pollution and ARI) was selected randomly by lottery method.

ii. To select the rural PAS

* The Pas were stratified by high land and lowland. First one PA from each high land and low land areas of the BRHP site was selected randomly. Then four adjacent PAs out side of the BRHP were registered in respect to the above altitudes and one selected randomly by lottery method from each altitudinal areas.

After the selection of the Kebele and PAs a total of 600 households (the study units), 200 from each site were selected , assuming that there are around 600 households in each village and 70% could have atleast one under 5 year children (20,21), the following method was used to meet the required sample size. First we selected a central place in the village(PA) then we select the first household randomly and we identify the other households i.e. the first two out of the three households were identified until the total sample size counts 600 households, it is just to have fair distribution(avoid clustering). If mother who has under five children not available the household was replaced by the next household.

6. DATA COLLECTION

The principal research instruments used in this study was a structured questionnaire. The questionnaire was prepared in English language then translated into Amharic(the national language) and then back-translated to English. A total of six interviewers and one supervisor were recruited from the Butajira Rural Health project (BRHP) office all of them were high school graduates(except the supervisor who is a nurse). They all had training on data collection techniques previously. The interviewers were retrained for five days and thorough discussion was held on the questionnaire which was then pretested out side the study area and minor modifications on some ambiguous words were done. The actual data collection was held in may 1999. Information were collected on socio-demographic characteristics, Characteristics of the household environment, fuel characteristics and cooking habits.

The second method used for data collection was in-depth interview of key informants. A total of 24 mothers (eight women from each of thc study areas: high land, low land and the town) were selected with at least one child under five years of age. They were interviewed by the principal investigator in February 1999, using check-list on the above mentioned variables. The discussion was tape recorded and used in preparing the questionnaire and in supplementing the result. The selection was done by the help of the BRHP organizer and the community leaders. As much as possible it was tried to get representative informants from different categories like social class, age group, educational status and employment status.

The third method was observation of child movement to determine exposure to smoke pollution. A child movement recording form was prepared to collect information on smoke generation time, type of fuel used, type of meal prepared and duration of the under five year child exposure to the smoke. The data were collected by the siblings of the children who are attending in Junior and high school in Butajira town. A weekend was chosen for this purpose to take the advantage of having the student siblings at home. Even though it is known that mothers could spent much of their time at home at week ends so it could prolong the exposure time other alternative could not be found in using weekdays. The sibling data collectors were trained for one day on the use of data collection form, then 96 households were selected from the cohort, data were collected on may 1999 for two consecutive days (48 hours).

Data quality were assured by the supervisor and later by the principal investigator by checking the questionnaire each day for completeness and consistency. Incomplete questionnaire were sent to the field to be re filled. The other controlling method used were interview about 5% of the households.

3.7 DATA ENTRY AND ANALYSIS

Data were entered into the computer using the EPI INFO version 6 statistical software. Analysis was done using the same software. Frequencies, odd ratios with 95% confidence interval(95% CI), and chi-square tests were the statistics used to analyze the data.

summary scores(Indexes) used in the study:-

The following indexes are developed entirely for this study by the researcher. Hence we can not use each variable to label some characteristics, we should group some variables even though this subjective scoring is not reliable.

Scores developed for economic status:-

Variables:-	Scores			Maximum Scores
RuRAL				
COW,OX	0	1	2-99	
	0	+1	+2	4
GOAT/SHEEP	0	1-5	6-99	
	0	+1	+2	2
CORRUGATED	YES	NO		
	+1	0		1
Total				7
*URBAN				
ROOF, CEILING	YES	NO		
	+1	0		2
ROOMS	1-2	3-4		
	0	+2		2
KITCHEN	YES	NO		
	+1	0		1
INCOME	<200	200-500	>500	
	0	+1	+2	2
Total				7

Low economic status = $\leq$ 3
Medium economic status = 4-5
High economic status = 5-7

Scores developed for Smoke clearance : -

Variables	Scores		Maximum Scores
	YES	NO	
CHIMNEY	+1	0	1
WINDOW	+1	0	1
AREA ≥ 42.09sq.m	+1	0	1
Total			3

Inadequate= 0-1

Adequate = 2-3

Scores developed for Exposure status:-

Variables:-	Scores YES	NO	Maximum Scores
Cooking ≤ 5 five children room	+1	0	1
BMF for			
cooking,	+2	0	2
lighting	+2	0	2
heating	+2	0	2
chimney	+1	0	1
window	+1	0	1
>2 hours spent around fire	+2	0	1
Stay on mothers' back	0	+1	1
cooking ≥ 3 times/ day	3-4	1-2	
	0	+1	1
size of the house	< 42.09 sq.m.	>42.09 sq.m	
	0	+2	2
Total			13

Low = 0-3
Medium = 4-6
High = 7-13

DEFINITIONS OF TERMS

District:- the administrative unit of a government encompassing variable number of peasant associations and urban dwellers associations (i.e.,woreda).

Household:- all the people living together in a house.

Peasant Associations:- the lowest peasant administrative unit.

Urban Dwellers Associations:- the lowest urban administrative unit.

Functional windows:- windows which provide proper function for ventilation.

Dry season:- seasons from October to June.

Wet season:- seasons which include July to September.

Room:- compartment of the house used for living(not including bath room, corridor, kitchen and store).

5.ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the Department of Community Health and from the Faculty of Medicine, Addis Ababa University. Informed verbal consent was obtained from all mothers participated in the study after explaining to them the purpose of the study.

6. RESULTS

Socio-demographic characteristics

A total of 600 mothers with under five children participated in the study. The age of the mothers range from 13-47 years, about 279(46.5%),147(24.5%) and 144(24.0%) in the age group 25-34, 35-44 and 15-24 years respectively. Three hundred four (50.6%) of the households have family size between 6-13. Five hundred thirty one(88.5%) of the respondents were from Gurage ethnic group, predominantly Meskan 221(36.8%) followed by Siltie 175(29.2%). The majority of the mothers Muslim 445(74.2%),

housewives 479(78.2%), illitrate 483(80.5), and in marital union 556(92.2%). Regarding the spouse educational back ground 356(64.0%) were illiterate and some 12.8% attended secondary school or above. According to the social index developed for this study(see methods),about 446(74.3%) of the households were classified as in low status,140(23.3%) medium and 14(2.3%) as high (Table 1).

The majority of 415(69.2%) of the houses were Tukul huts, 471 (78.5%)of the houses had single room, the remaining 129(21.5%) houses had two or more rooms. A separate child bed room was available only in 34(5.7%) houses. Functional window was available in 189(31.5%) of the houses. Only 121 (20.1%) of the households had separate kitchen (Table 2).

Biomass fuel was used by 591(98.5%) of the households for cooking, 178(29.6%)were using for heating purpose and only 69(11.5%) for mosquito repellant. The majority of the households 478(79.7%) were using kerosine for lighting and 122(20.3%)household were using electricity for lighting mainly in the urban area (Table 3).

Seasonal variation was observed in the use of different kinds of biomass fuels. During wet season and until harvest wood is most common fuel,used by 394(87.0%) of households mostly the urban ones, followed by dried cow dung, used by 213(47.0%)of the households,no variation in the area. During dry season(after harvest)the main fuel is crop residue used by 399(88.1%)of households mostly by the rural households (Table 4).

It was reported that 569(94.9%) were using an open type of stove (the three rock system) and 567(94.5)had no chimney. The majority, 477(79.5%), reported routine cooking at least three times daily (morning, mid day and evening). The majority 484(80.7%) of the respondents reported that smoke usually remain in the room during cooking, and about 550(91.6%) of the mothers also reported that they do not need the smoke to remain in the room but 50(8.3%)

women said they need the smoke to remain. Reasons given for the desire to keep the smoke in the room include: heating (30 women),odor(18 women), mosquito and fly repellant(7 women). Four hundred eighty five(80.8%) of the mothers reported to cook in the under five children sleeping room (Table 5).

With regard to child rearing customs of the households, the majority, 565(94.2%), reported that children under five years of age are confined indoor during cooking. Two hundred twenty seven(53.2%) of the mothers reported the under five children to stay around the fire for two or more hours daily. The mean(SD) of the time spent by under five children were estimated to be 218(147) minutes. Two hundred one(35.5%) of the under five children reported to stay on mothers' back or lap during cooking (Table 6).

The majority of the mothers 565(94.1) reported that the best fuel for cooking if available was wood and about 565(94.6%) of the mothers reported that indoor smoke can be harmful for health. These women reported the major health effect is on the eyes and respiratory system, 539(95.4%)and 253(44.8%),respectively. They also reported that the health effect is mostly on women 540(95.6%) followed by under five children 190(33.6%).The majority 558(93.0%) reported that windows are necessary for smoke clearance and the reasons given for not having windows were 132(34.0%)due to financial problem, 127(32.7%) due to custom or lack of knowledge and 39(10.1%) due to theft (Table 7).

According to the scoring system used to assess smoke clearance level and exposure status of the households 543(90.5%) of the households had inadequate smoke clearance . The rural households are less likely to have adequate smoke clearance with (OR=0.3;CI=0.16,0.54). Regarding the exposure status 37(6.2%), 229(38.2%) and 334(55.7%), of the households had low , medium and high exposure status, respectively. There was statistical significant difference between the rural and urban households in the exposure status. The rural households had a much higher exposure levels compared to the urban households (Table 8).

All of the socio-demographic characteristics except the family size crude analysis with exposure status. Four of these(mother muslem, illiterate, being Married and low family income) were still retained after adjusting for urban residency. Being muslem and married(adjusted OR= 2.24;CI 1.39,3.54) and OR=0.41;CI=0.18,0.82),respectively. Mother illiterate (adjusted OR=0.36;CI=0.02,0.66), were less likely to be in the low exposure status). The relative risk of exposure to indoor smoke among households with medium income status compared with the lowest income status was more than those in the next higher level :0.34 (95%CI:0.22,0.54) (Table 9).

Table 1. Socio-demographic characteristics of the respondents, Butajira district, southern Ethiopia, April 1999. n=600

Variable	Rural(n=400) No(%)	Urban(n=200) No(%)	Total(n=600) No(%)
Marital status			
Currently married	376(94.0)	180(90.0)	556(92.7)
Single*	24(6.6)	20(10.0)	44(7.3)
Family size			
1-5	201(50.3)	97(47.8)	296(49.3)
6+	199(49.8)	105(52.5)	304(50.6)
Ethnicity			
Gurage	390(97.5)	141(70.5)	531(88.5)
Other**	10(2.5)	59(29.5)	69(11.5)
Religion			
Christian	49(12.3)	106(53.0)	155(25.8)
Muslim	351(87.8)	94(47.0)	445(74.2)
Occupation			
Farmer	63(15.8)	5(2.5)	68(11.3)
Worker	12(3.0)	51(25.5)	63(10.5)
Housewife	325(81.3)	144(72.0)	469(78.2)
Educational status			
Illiterate	382(95.5)	101(50.5)	483(80.5)
Elementary and junior	18(4.5)	69(34.5)	87(14.5)
High school and above	0	30(15.0)	30(5.0)
Spouse education			
illitrate	296(78.7)	60(33.3)	356(64.0)
Elementary and junior	69(18.4)	60(33.3)	129(24.4)
High school and above	11(2.9)	60(33.3)	71(13.4)
Family income status* **			
Low	300(75.0)	146(73.0)	446(74.3)
Medium	96(24.0)	44(22.0)	140(23.3)
High	4(1.0)	10(5.0)	14(2.3)

*single: divorced, widowed, un married, separated

**other: Amhara, Oromo

***Family income status using a composite score

Table 2. Characteristics of the household environment, Butajira district, southern Ethiopia, April 1999 (n=600)

Variable	Rural(n=400) No(%)	Urban(n=200) No(%)	Total(n=600) No(%)
House shape			
Tukul hut	389(97.3)	26(13.0)	415(69.2)
Other shapes with corrugated iron roofing	11(2.8)	174(87)	185(30.8)
Number of rooms			
Single	387(96.8)	84(42.0)	471(78.5)
> One	13(3.3)	116(58.0)	129(21.5)
Presence of kitchen			
Yes	14(3.5)	107(53.5)	121(20.1)
No	386(96.5)	93(46.5)	479(79.9)
Presence of child bed room			
Yes	9(2.3)	25(12.5)	34(5.7)
No	391(97.8)	175(87.5)	566(94.3)
No.of functional windows in the house and kitchen			
Yes	55(13.8)	134(67.0)	189(31.5)
No	345(86.3)	66(33.0)	411(68.5)

Table 3. Purpose of using fuels by the households. Butajira district, Southern Ethiopia, April 1999, n=600

Variable	Rural(n=400) No(%)	Urban(n=200) No(5)	Total(n=600) NO(%)
Using biomass fuel for cooking			
Yes	394(98.5)	197(98.5)	591(98.5)
No	6(1.5)	3(1.5)	9(1.5)
Using biomass fuel for heating			
Yes	133(33.3)	45(22.5)	178(29.60
No	267(66.8)	155(77.5)	422(70.3)
Sources of light in the home			
Kerosine	400(100.0)	78(39.0)	478(79.7)
Electricity	0	122(61.0)	122(20.3)
Using biomass fuel for mosquito repellant			
Yes	61(15.30)	8(4.0)	69(11.5)
No	339(84.8)	192(96.0)	531(88.5)

Table 4. Seasonal variation in the use of different type of fuels, Butajira district, southern Ethiopia, April 1999.n=600

Characteristics	Number(Percent)					
	Oct.- June			July-September		
	Rural	Urban	Total	Rural	Urban	Total
Wood	55(16.7)	73(58.9)	128(28.8)	299(90.9)	95(76.6)	394(87.0)
Crop residue	319(97.0)	80(64.5)	399(88.1)	169(51.4)	44(35.5)	39(8.6)
Cow dung	88(26.7)	27(21.7)	115(25.4)	28(8.5)	11(8.9)	213(47.0)
Charcoal	1(0.3)	25(20.5)	26(5.7)	2(0.6)	55(55.6)	57(12.6)

*Percentage does not add up to 100% because of multiple response

Table 5. Cooking conditions and habits of the households. Butajira district, southern Ethiopia, April 1999(n=600)

Variable	Rural(n=400) No(%)	Urban(n=200) No(%)	Total(n=600) No(%)
Type of stove			
Open	392(98.0)	177(88.5)	569(94.9)
Other	8(2.1)	23(11.5)	31(5.1)
Chimney			
Yes	21(10.5)	12(3.0)	33(5.5)
No	179(89.5)	388(97.0)	567(94.5)
Want smoke to remain in the cooking room			
Yes	36(9.0)	14(7.0)	50(8.3)
No	364(91.0)	186(93.0)	550(91.6)
Smoke remain in the cooking room			
Yes	130(65.0)	354(88.5)	484(80.7)
No	70(35.0)	46(11.5)	116(19.3)
Frequency of cooking/day			
≥ 3	327(82.0)	150(75.0)	477(79.5)
1-2	73(18.0)	50(25.0)	123(20.5)
Cooking in the under five sleeping room			
Yes	380(95.0)	105(52.5)	485(80.8)
No	20(5.0)	95(47.5)	115(19.1)

Table 6. child-rearing practices of the households, Butajira district, southern Ethiopia, April 1999(n=600)

Variable	Rural(n=400) No.(%)	Urban(n=200) No(%)	Total(n=600) No(%)
Average time spent daily around fire by under five children			
>2 hrs	152(53.0)	75(53.6)	227(53.2)
≤ 2 hrs	135(47.0)	65(46.4)	200(46.8)
Under five children stay at home during cooking			
Yes	394(98.5)	171(85.5)	565(94.2)
No	6(1.5)	29(14.5)	35(5.8)
Usually under five children stay on mothers' back or lap			
Yes	145(37.3)	56(31.8)	201(35.5)
No	244(62.7)	120(68.2)	364(64.4)

Table 7.Knowledge of the mother about the harm of smoke inhalation, Butajira district, Southern Ethiopia, April 1999 (n=600)

Variable	Rural(n=400) No(%)	Urban(n=200) No(%)	Total(n=600) No(%)
Best fuel for cooking			
Biomass	397(99.0)	168(84.0)	565(94.1)
Non-biomass	3(0.8)	32(16.0)	35(5.8)
Smoke cause ill health			
Yes	377(94.2)	188(94.0)	565(94.1)
No	23(5.7)	12(6.0)	35(5.4)
Harm of indoor smoke*			
Respiratory	150(39.8)	103(54.8)	253(44.8)
Eye problem	357(94.7)	182(96.8)	539(95.4)
Who are most affected*			
Women	365(96.8)	175(93.1)	540(95.6)
<5 years children	58(30.9)	132(35.0)	190(33.6)
Windows are necessary for smoke clearance			
Yes	371(92.8)	187(93.5)	558(93.0)
No	29(7.3)	13(6.5)	42(7.0)
Reasons for not having window			
Financial	112(34.8)	20(30.3)	132(34.0)
Custom(lack knowledge)	108(33.5)	19(28.8)	127(32.7)
Theft problem	35(10.9)	4(6.1)	39(10.1)

*Percentage does not add up to 100%

Table 8. Smoke clearance and exposure status of the households, Butajira district, southern Ethiopia, April 1999. n=600

Variable	Rural No.(%)	Urban No.(%)	Total No.(%)	chi-square	p-value
Smoke clearance level					
Adequate	23(5.8)	34(17.0)	57(9.5%)	18.34	0.001
Inadequate	377(94.3)	166(83.0)	543(90.5%)		
Exposure status					
Medium	129(32.3)	100(50.0)	229(38.2%)	39.44	0.001
High	271(67.7)	63(31.5)	334(55.7%)		

Table 9. Socio-demographic characteristics and exposure status of the households, Butajira district, April 1999.

n=600

Variable	Exposure status* Medium No.(%)	High No.(%)	Crude OR(95% CI)	**Adjusted OR(95% CI)
Family size				
1-5	106(46.3)	181(54.2)	0.73(0.51,1.04)	0.69(0.48,1.0)
6+	123(53.7)	153 (45.8)		
Ethnicity				
Gurage	191(83.4)	315(94.3)	0.3(0.16,0.54)	0.5(0.27,1.02)
Other	39(26.6)	19 (5.7)		
Religion				
Muslim	151(65.9)	287(85.9)	3.15(2.05,4.87)	2.24(1.39,3.54)
Christian	78(34.1)	47(14.1)		
Occupational status				
Worker	48(20.9)	57(17.3)	1.29(0.82,2.02)	1.13(0.7,1.8)
Housewife	181(789.1)	277(82.9)		
Marital status				
Married	205(89.5)	320(95.8)	0.37(0.18,0.77)	0.41(0.18,0.82)
Single	24(10.5)	14(4.2)		
Educational status				
Illiterate	167(72.9)	308(92.2)	0.23(0.13,0.38)	0.36(0.2,0.66)
Literate	62(27.1)	26(7.3)		
Spouse educational status				
Illiterate	122(53.3)	240(71.8)	0.58(0.39,0.85)	0.91(0.59,1.42)
Literate	83(46.7)	94(28.2)		
Family income status				
Low	151(65.9)	277(82.6)	0.4(.26,0.62)	0.34(0.22,0.54)
Medium	73(31.9)	54(16.2)	1.00****	
High	5(2.2)	4(1.2)	0.92(0.2,4.34)	0.4(0.05,2.68)

*the low category is omitted for the sake of analysis
**Adjust for rural-urban differences
***referent category

THE IN-DEPTH INTERVIEW

In-depth interview with 24 participants were conducted and the major findings are presented below.

1. Cooking habits

Almost all women in the rural high land and low land areas said, they use commonly wood, crop residue and cow dung for cooking .In dry season they use commonly wood and crop residue and in wet season mostly cow dung. In the urban area the mothers claimed to use wood and crop residue in all season. Beside cooking in wet season the high landers claim to use wood for space heating and in dry season the low landers claim to use biomass fuel smoke for mosquito repellant. All women said they cook usually two-three times per day. All except four said they do not want the smoke at home, but the four claimed that it is necessary for mosquito and fly repellant and to strengthen the thatch. All women said they cook in the same place where under five children slept, hence all of the rural and five out of eight from the urban residents were living in a single room and also they do not have separate kitchen. All claimed to use open type of stove(with three bricks).

2. Maternal knowledge

All the women except four said they donot want the smoke hence it could affect health especially of the children. Almost all claimed that windows are necessary for smoke clearance but the commonest reason given for not having windows were financial problem and custom.

Results from the child movement records:

The exposure-time patterns of the children for the indoor smoke were taken using both interview (questionnaire) and observation(recording made by students with siblings under five years of age). The media(SD) exposure time to fire smoke was 180(202) minutes, with the minimum, maximum and mean values 5, 900 and 264 minutes. With regard to the observed result the median(SD)were

125(148) minutes and the minimum, maximum and mean values were 10, 610 and 158 minutes respectively.

Table 10. Exposure time records of under five year children by observation and interview, Butajira, April 1999.

	M(SD)*	Minimum	maximum	n	p-value	Wilcoxon-test
Interview	180(202)	5	900	96	0.08	2.989
Observation	125(148)	10	610	96		

* median(Standard deviation)

** Time in minutes

Discussion

The findings are unlikely to be due to selection bias as data were collected systematically all over the village in the selected areas and making repeated visits in the town to include the non response. The majority of questions in the questionnaire were close ended to reduce subjectivity in recording the answers. The questionnaire were designed not to create any recall bias by avoiding questions which need answers in specific times in the past and for some of the questions only 72 hours recall period were desired. Even though there is still a gap for interviewer and respondent bias(information bias)maximum effort was done to control in the training period of the data collectors to have a good communication skill and importance of quality data for the success of the study.

Housing conditions such as houses with single room 471(78.5%), no kitchen facility, no separate child bed room and no functional window in the house observed in this study are similar to findings in other developing countries (4,19). These conditions would be directly related to the exposure to indoor air pollution. This situation is similar to findings reported by others (22).

The study has shown that households mainly use biomass fuels for cooking, heating and mosquito repellant purposes. The extent of using biomass fuel for cooking was consistent with other studies done by World Bank which was found to be 90% (4,7).In addition they use biomass fuel for heating, specially in the high land area, is in agreement with other studies in the developing countries(7). The use of biomass fuel for mosquito repellant, has been also reported in a study in West India(2). All of the above mentioned facts indicate biomass fuels are the main sources of domestic smoke pollution in Butajira and else where so it would be better to have cooking activities outdoor or replace biomass fuels by other cleaner types of fuels.

Seasonal variation in using different types of fuels shows that in wet season indoor smoke pollution could be higher, Even though wood is better than other biomass fuels in the quality(7), as the wood becomes wet and produce more smoke also its use for heating purpose in this season prolongs the duration of smoke in the house. This finding is supplemented by the result from the in-depth interview. Studies done in parts of Northern India has also reported a similar observation(7). The pattern of biomass usage changes with seasons mainly wood at one season, crop residue at the other times(4).

Most 569(94.9%) of the households were using open type of stoves and with no chimney or flue, that may also add to the exposure level of indoor smoke pollution. This supports earlier studies in Nepal and Vermont(26). This is also important variable to consider in the intervention programme to minimize the exposure status of the households to indoor smoke pollution.

Most of the households cook three or more times per day and it was shown also from the in-depth interview that mostly the under five children stay around fire during cooking that aggravates the situation of exposure to the high indoor smoke level. Similar finding from Nepal study shows cooking frequency 2 times per day. Only small number of the mothers 50(8.3%) reported to need smoke at home all the time for the following purposes: to strengthen the thatching in the tukul, as mosquito and fly repellant and to preserve health. All these factors contribute to the high indoor smoke pollution level. Similar findings were reported from Offawa and Nepal(27,22). In our study in 485(80.8%) of the households cooking is done in the same room where under five children slept, that could be due to absence of separate kitchen and being a single room. This finding is consistent with the study done in Addis Ababa (22).

This study showed that higher proportion of children confined at home most of the time during cooking. Usually under five children carried on mothers' back or lap , which can contribute also for the high exposure status to indoor smoke. Similarly other studies in Gambia also reported the same finding(2).

More than 50% of the children was reported to spent $\geq$ 2 hours around fire, the average time spent by under five children were around 4 hours. This shows that the longer the children stay at home during cooking the more would be the exposure.

Concerning the knowledge of the mothers about the harm of smoke inhalation most(94.6%) had good knowledge. Comparable result found in a study in West India indicated that 85% of the respondents associated indoor smoke to ill health(2). Out of those who had a good knowledge about 96.8% reported it could have eye problem and 54.8% respiratory problem, similar finding were found from Fiji(2). Almost all(93%) of the mothers knows about the necessity of the window for smoke clearance, despite most of the houses were without windows, that could influence the exposure status of the households. The reason given for not having windows were financial, custom or lack of knowledge and theft problem. This finding is supplemented by the findings with the in-depth interview and also the low economic and literacy status could contribute to the finding.

High indoor pollution concentration and exposure are observed in the developing countries both in the rural and urban households(2). This study has shown that there were statistical significant difference between rural and urban households, in which the rural households were more likely to be in the high exposure status compared to the urban households. In this study it was found that the exposure status to be 6.2%, 38.2% and 55.7%: low, medium and high respectively. This finding is consistent with another study conducted in Addis Ababa 25.8% and 53% in medium and high exposure level(22). The difference in the lowest group which is higher in the Addis Ababa study(21.1%), could be due to the study site which took entirely urban households.

With regard to the smoke clearance level of the households, 543(90.5%) were found to have inadequate and only 57(9.5%) adequate smoke clearance. There was statistically significant difference between rural and urban households with p-value 0.001 and chi-square of 18.34. The rural households are more likely to have inadequate smoke clearance. This finding was inconsistent with the findings of a study in Addis Ababa(22) where inadequate smoke clearance were found only in 23.6% of the households, that could be possibly explained by the difference in the scoring system used in both study areas.

After adjustment for urban residency among socio-demographic characteristics, exposure status was significantly and independently associated with religion, marital status, maternal illiteracy and income status. Ethnicity and spouse education were not statistically significant after adjustment.

Being muslem and married is less likely to be in the low exposure status to indoor smoke pollution with adjusted OR(95% CI)of 2.24(1.39,3.54) and 0.41(0.18,0.82), respectively. This could be due to the cultural influence than muslem mothers spent most of their time at home and being busy in cooking activities and those married took more time to prepare meals for the family so both can predispose for larger exposure duration. In our study high maternal illiteracy rate was found to be less likely in the low exposure status to indoor smoke pollution with adjusted OR(95% CI) of 0.36(0.2,0.66). Study in Nigeria found significant association between under five mortality due to indoor pollution and paternal illiteracy (25). The study showed statistically significant association between household income and exposure status to indoor smoke pollution. The under privileged (low income groups) are in the high exposure status.

The comparison of the two methods used for data collection in the average time spent around fire by the under five children (interview and observation by students of the under five children) using the Wilcoxon-test showed no statistically significant difference with p-value of 0.08 and Wilcoxon-test = 2.989. So it is advisable to use the most feasible method of data collection on this regard depending on the available resource and time.

STRENGTHS AND LIMITATIONS OF THE STUDY

Strengths of the study

1. The main strength of this study is that it uses a mixture of methods for data collection.

2. The absence of similar studies in Ethiopia is also a strength, hence it gives a clue about the exposure level of the rural households and points potential area to generate research hypothesis.

3. Simple random sampling was used in the design to control for selection bias.

4. Training of interviewers was done to control for possible observer bias.

5. Only three days(72 hours) recall period was desired to control for recall bias.

6. Stratified analysis was done to control for possible confounding Effect.

Limitations of the study

1. It is unlikely that the social and environmental problems which exposes children to indoor smoke exhaustively investigated due to the complex nature of the problem.

2. There may be under or over reporting/recording of social problems both by the interviewer and respondents since measurement was based on self reports.

3. Using estimation of prevalence rate to calculate sample size was also a limitation hence no previous prevalence rate in the rural community available.
4. Absence of sampling frame was also a limitation for sampling technique.

MAJOR CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Biomass fuels are the principal sources for the indoor smoke pollution(the predominant sources of biomass fuel in the households were wood, crop residues and cow dung).

2. The poor socio-demographic, cultural, economic and environmental factors are always a risk factors for the exposure status of the households.

3. Collecting information about exposure time pattern of under five children using interview(questionnaire) or observation has no difference.

RECOMMENDATIONS

1. Improving social, economic, environmental and housing conditions in order to minimize the exposure status of the households to the indoor smoke.

2. Collect information about exposure time to indoor smoke by the most feasible method depending on the availability of resources.

3. Development of cheap, effective, acceptable, and really appropriate cooking stoves with improved combustion efficiency coupled with "smokeless" cooking stove.

4. Using alternative fuel source like biogas which could replace biomass fuels.

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APPENDICES

APPENDIX 1.

February 25, 1999

CHECK LIST FOR IN-DEPTH INTERVIEWS WITH KEY INFORMANTS(MOTHERS WHO HAVE UNDER FIVE CHILDREN)

I. INTRODUCTION

Respected respondent, I extend my greeting to you. This is to ask your permission to participate in an interview on issues relating to indoor air pollution. This information will be used for a later study which will help the community in improving the health status with regard to exposure to smoke inhalation. For designing a good data collection tool(questionnaire), it is very crucial to get information from the community and make the language local and communication easier.

Your full support and willingness to respond to my questions is very much appreciated .

Thank you!!

II. Objectives

To extract the necessary information for the study and update the questionnaire about indoor biomass smoke pollution and factors associated to exposure status of the < 5 children in the household

COLLECTION OF INFORMATION ON:-

- Sources of indoor air pollutant
  - *Biomass fuels
- Types of biomass fuels used in the area and their local names.
  - *Fossil fuels: types used
- Types of fuels used for different purposes(cooking, heating, lighting, mosquito repellant, others).
- Types of cooking stoves
- Cooking habits (location of cooking stove, how many times per day do you cook, cooking in the child bed room, etc.)
- Children's habits and movements (who carries children during cooking, activities of child during cooking, etc).
- Defining the seasons by the local terms
- Seasonal variation in the use of different types of fuels(dry/wet, harvest/non-harvest).
- How do people perceive and measure time(in terms of hours spent on various activities).
- Cultural factors and customs related to the indoor air pollution (child rearing practices, etc.)

- Income status (how do they catagorize people into rich/poor).

APPENDIX 2.

EXPOSURE ASSESSMENT TO INDOOR AIR POLLUTION

CHILD MOVEMENT RECORD FORM 1991 E.C BUTAJIRA

General guide:-this form is expected to be filled by the siblings or relatives of the < 5 children who are learning in junior or high school.

Date__________

House No.______

Child No.

1. Name_______________ Sex_____ Age_______

1. Name_______________ Sex_____ Age_______

1. Name_______________ Sex_____ Age_______

Fire event	Fire On (Hour/minute)	Fire off (Hour/minute)	Type of meal prepared	child In/ child out Hour/minute		
				Child 1	Child 2	Child 3

APPENDIX 3 APRIL 27, 1999

QUESTIONNAIRE FOR THE ASSESSMENT OF EXPOSURE TO INDOOR AIR POLLUTION

(English version)

GENERAL OBJECTIVES OF THE STUDY AND CONFIDENTIALITY

To conduct a study to assess exposure to indoor air pollution and to identify factors relating to indoor air pollution in a community setting in Butajira district (e.g. characteristics of the environment ,of the household customs, habits, etc.)

CONSENT ________________

Respondent: Mother who has at least one child under five years of age.

Please make a (x) mark to indicate the respondents' decision regarding participation in the study.

The purpose of the study and confidentiality procedures have been explained to me and I on my own

a. agree to participate ( )

b. not willing to participate( )

General guidelines

Respected respondent, I extend my greeting to you. This is to ask your permission to participate in an interview on issues relating to indoor air pollution. This information will be used later by the policy makers or other responsible bodies as the background information for improving the health status of the community with regard to exposure to smoke inhalation.

We assure you that whatever information you provide will only be used for the purpose of this research and will not be made available to anyone outside of the research team.

Your full support and willingness to respond to my questions is very much appreciated .

Thank you!!

Directions (for interviewer)

Please,

A) Use pen

B) Circle all that apply

C) Fill in the blank with appropriate answer in the space provided

Household/mother questionnaire.

1.Date of interview ____________________

2.Name of interviewer ____________________

3.Name of village(Identification number of kebele or peasant association)

4.House hold number______________

5.Name of head of household _________________________

6.Name of respondent ___________________________

7.Duration of residence in this house(kebele) _________ years

A. SOCIO-DEMOGRAPHIC CHARACTERISTICS OF family:

1. Age of mother _____
   1. < 15 years
   2. 15- 24 years
   3. 25- 34 years
   4. 35- 45 years
   5. >45 years
2. Number of residents in the same household _________
3. Number of children in the same household
   a. Less than or equal 5 years of age
      Name and age of child 1._________________
      2._________________
      3._________________
   b. Older sibling in junior or higher class
      1. Yes____ 2. No______

4. What is your religion?
   1. Orthodox Christian
   2. Protestant Christian
   3. Catholic Christian
   4. Muslim
   5. None
   6. Other(specify ___________________)

5. What is your ethnic origin?
   1. Wolenie

2. Sodo
3. Dobie
4. Meskan
5. Mareko
6. Seltie
7. Amhara
8. Oromo
9. Other(specify ____________________)

6. What is your occupation?
1. Farmer
2. Merchant
3. Governmental employee
4. Private enterprise employee
5. Student
6. Daily laborer
7. House wife
9. Other(specify) ________________

7. What is your literacy status?

1. Illiterate
2. Only Read or/and Write
3. Some elementary and junior school(Grade 1-8)
4. Some high school(Grade 9-12)
5. 12th grade completed
6. Education after grade 12

8. What is your marital status?

1. Currently married
2. Single/never married
3. Separated
4. Divorced
5. Widowed

9. What is your husband's literacy status ?

1. Illiterate
2. Only Read or/and Write
3. Some elementary school (grades 1-6)
4. Some high school
5. 12th grade completed
6. Education after grade 12

10. Which of the following animals do you own; and how many of each?

1. Oxen -number____________

2. Cows-number ________________

3.Goats and sheeps-number______________

4.Chicken-number_______________

5.Other(specify)number___________

11.What is your household's average income per month (Birr)?
1.<100
2.100-200
3.201-400
4.401-1000
5.>1000
6.Do not know

B. INDOOR AIR POLLUTION EXPOSURE RELATED INFORMATION :

I. CHARACTERISTICS OF THE HOUSEHOLD ENVIRONMENT:

12. For what purpose do you use the house ?
1. Residence only
2. Residence and workplace?
9. Other(specify ____________________)

13. How many rooms are there in your home?(excluding bath rooms,showers, toilets,kitchens,store rooms,entrance halls)
1. One
2. Two
3. 3-5
4. >5

14. Do you cook where the children < 5 years of age are sleeping?
1. Yes 2. No

15. Is there a separate child bedroom in the house?
1. Yes 2. No

16. If yes, how many persons sleep in the child bedroom other than the <5 children?
1. None
2. One
3. Two
4.> Two

17. Does the smoke remain inside the home during cooking?
1. Yes 2. No

18. Do you want to keep the smoke in the home?
1.Yes 2.No

If yes, explain why____________________________

II. POTENTIAL SOURCES OF INDOOR AIR POLLUTANTS:

19. For what purpose do you use fuels at home from the following? (check all that apply)

1. Cooking
2. Heating
3. Lighting
4. Incense
5. Mosquito repellant
9. Other(specify ____________________)

20. At what time of day do you burn fuels?

1. Morning
2. Mid day
3. Night
4. Throughout the day
9. Other(specify____________________)

21. What fuel do you use most for cooking ? Why (explain)?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify ___________)

Why(explain)____________________________

22. What fuels do you use most as the source of light in the home?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify ___________)

23. What fuel do you use most to heat the house in the cold(rainy) season?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify ___________)

24. Are there any differences in the types of fuel you use during different (dry/wet ,harvest/non-harvest)seasons for cooking?

1. Yes 2. No

If no, go to Q 29

25. Which kind of fuel do you use most for cooking in this dry season?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify __________)

26. Which kind of fuel do you use most for cooking in the previous wet(rainy) season?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify __________)

27. Which kind of fuel did you use most for cooking in the period of harvest last year?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene
6. Gas cylinder
7. Electricity
9. Other(specify __________)

28. Which kind of fuel did you use most for cooking in non-harvest time last year?

1. Wood
2. Animal dung
3. Crop residues
4. Coal
5. Kerosene

6. Gas cylinder
7. Electricity
9. Other(specify __________)

29. Does anyone smoke cigarettes inside the house?
1. yes 2. No

30. Is there a separate child bedroom?
1. yes 2. No

31. Does anyone smoke cigarettes in the child bed room?
1. yes 2. No

III. COOKING HABITS:

32. How many times a day did you cook ?

a. Usually	b. Yesterday
1. Once	1. Once
2. 2-3 times	2. 2-3 times
3. >3 times	3. >3 times

33. Which specific time did you cook ?
a. usually__________________
b. last three days__________________

34. How long did it take you to prepare each meal?
a. Usualy
1. Meal_____________ Time hh______ mm________
2. Meal______________ Time hh_______ mm_________
3. Meal_______________ Time hh________ mm__________

b. last three days
1. Meal_______________ Time(hh________mm__________)
2. Meal_______________ Time(hh________mm__________)
3. Meal_______________ Time(hh________mm_________)

IV. CULTURAL FACTORS AND CUSTOMS:

35. Are children <5 years of age confined indoors for much of the time during cooking?
A. Usually
1. Yes
2. No If No, specify where they are kept

____

B. Last three days
1. Yes
2. No If No, specify where they are kept

____

36. If yes,check where they mostly stay?
   1. On mothers' back
   2. Close to mother
   3. Carried by someone other than the mother(specify whom)________________
   9. Other (specify)__________________

37. What was the average time spent near the fire place by the <5 children in the last three days?

Child no.
1. One______________
2. Two_________________
3. Three__________

38. Activities of children < 5 years during cooking yesterday?

Child no.	Name	Age	Activity/location
1.	_____________		
1.	__________		____________________
2.	____________	_____________	____________________
3.	__ __________	______________	____________________

39. Is there any seasonal variation in the time spent indoors by children <5 yars of age?

1. Yes   2. No

If yes, explain _________________________)

V. KNOWLEDGE OF THE MOTHER ABOUT THE HARM OF SMOKE INHALATION:

40a. Which fuel do you think is best for cooking?
   1. Wood
   2. Animal dung
   3. Crop residues
   4. Coal
   5. Kerosene
   6. Gas cylinder
   7. Electricity
   9.Other(specify ___________)

b. Why(explain)__________________________________

41.Do you think that indoor smoke can be of any harm?
   1.Yes
   2.No
   3.I do not know

If No,or I do not know, end of the interview

42.If yes, what harm do you think indoor smoke can have?
   1.Respiratory problems
   2.Eye problems

3.Other(specify________________________)

43. Whom do you think are the most likely to be harmed?(check all that apply)
1.Women
2.Men
3.Elderly
4.Infants and children under five years
9. Other (specify)______________________________

44.Are there functional windows in the living room or kitchen?
1.Yes 2.No
If no,go to Q 43
45. Do you think that windows has any value for ventilation?
1.Yes 2.No
46. If yes,please explain why you don't have windows at all or don't use the available ones

____

OBSERVATION CHECK LIST (TO BE FILLED BY THE INTERVIEWER)

VI. PHYSICAL HOUSING CHARACTERISTICS:
47.Shape of the house?
1. Tukul hut
9. Other(specify__________________)

48.Construction material of the floor ?
1. Mud/Earth
2.Wood tile
3.Cement/Concrete
4.Plastic sheets
9.Other(specify________________________)

49.Construction material of the walls?
1.Wood and mud
2.Wood and thatch
3.Stone and mud
4.Blocket and cement
5.Stone and cement
9.Other(specify_________)
50.Construction material of ceiling ?
1. No ceiling
2. Cloth
3. Wood
4. Hard board
9. Other(specify__________________)
51.Construction material of roof?
1.Corrugated iron sheets
2.Thatched
3.Concrete and cement
9.Other(specify__________________)
52. Is there a chimney or flue in the room which is used for

2.one

3. > one(specify the number______________

55. Is there a separate child bed room?

1.yes 2.No

56.If yes, number of functional windows in the child bedroom?

1.None

2.One

3.>one(specify the number________________)

57. Is there a separate kitchen?

1.yes 2.No

58. If yes,number of functional windows in the kitchen?

1.none 2.one 3.> one

59.Location of cooking?

1.In the living room

2.Separated from the living room

3.In no.1 and 2

60.Size of the house ?

Tukul

a. Radius

__________ meter_____cm

Rectangular shaped

a. Width ______________meter_______cm

b. Length _____________ meter_______cm