ACCESS TO AFFORDABLE AND RELIABLE ENERGY SOURCES AND WOMEN ECONOMIC STATUS NEXUS IN THREE SELECTED WOREDAS OF OROMIYA REGIONAL STATE, ETHIOPIA.

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Abstract

Access to affordable and reliable energy services reduces the exposure of women and the household to a variety of problems that hinder their economic wellbeing and utilization of their time properly for economically productive activities. In addition, it can reduce the time of collecting fire wood by women and children, thereby increasing their productivity and status. The study has considered the house hold energy type, namely conventional and non conventional, and its accessibility that affect the livelihood of the women in particular and the family in general. Three oromiya woredas that fall around the primate city, Addis Ababa, namely Legetafo, Sululta and Sebeta , were purposively selected. Data and information pertaining to women economic situations and the status of house hold energy services for all selected woredas of oromiya have been collected. Descriptive and inferential statistical techniques have been used to analyze the data. The findings of the study have shown that women economic status in the three studied woredas is generally low and varies considerably with the type of energy they use. The study has also established the existence of strong linkages between energy accessibility and women health status in the studied regions. There are a relatively lower number of economically poor women in areas where there are better accesses to energy services. This implies the need for policy interventions that can help in upgrading and expanding energy infrastructures, adopting an integrated scheme and infrastructure development approach, improving the existing energy schemes, and universalizing energy accessibility in Ethiopia.

Key Words; Affordable, Conventional, Woreda

1. Introduction

Energy has a catalytic role in almost all socio-economic sectors and clearly comes into the picture when provided in its modern form. For instance, time is saved when traditional grain milling is replaced by a modern system; modern transport facilities can carry large volumes or mass of different items and human beings at the same time without being impeded by altitude or other factors; and long distances can be covered within a short period of time. Another example is the difference in the quality of life between rural women who utilize inefficient end-use devices that pollute the indoor environment and those who use modern energy and improved devices with high efficiency and minimal indoor environment pollution.

Access to modern, sustainable, affordable, and reliable energy services is central to addressing many of today's global development challenges, including poverty, gender inequality, climate change, food security, health and education. Yet nearly one-third of human beings lack access to modern energy forms and services (IEA, 2009).Thus, the practical development strategies in any developing countries should focus on substantial investment in energy services and infrastructures. Modern energy services can improve the quality of living through better health, better environment and relief from activity that is literally back-breaking.

Many studies show that the type of energy used in a household has significant consequences for the environment, for the health of family members, and for the lives of women. In most of the developing world, people rely on traditional fuels for cooking and heating owing to the fact that it can be collected without any expense on the part of the household. Nearly 93 percent of Ethiopia's domestic energy needs are derived from biomass. Typically biomass fuels such as fuel wood, dung, or crop residues are burned in traditional stoves, which are highly inefficient and harmful to health (CSA, 2007). Also, the effort and time spent collecting bio fuels have been increasing throughout the developing world because of shortages caused by localized deforestation. The primary group that is affected by this increasing drudgery is women, as in most developing regions they are largely responsible for collecting and using the fuels—and therefore play a crucial role in biomass management. Similarly the widespread dependence on kerosene for lighting in rural areas limits the possibility of reading by family members, and this might possibly lead to lower levels of education for children. Access to the use of lights, television, and energy-saving appliances through household electrification then becomes important for improving the lives of women. Thus, energy strategies have both short- and long-term impacts on poverty alleviation and the health of rural people, and consequently on the lives of women.

In the mean time the government of Ethiopia is strongly committed to extending the availability of modern energy to those who do not yet have access to it, in order to facilitate an accelerated national socio-economic development. Provision of electricity to rural areas through the Universal Electrification Access Programme (UEAP) is implemented directly by the Ministry of Mines and Energy through the Ethiopian Electric Power Corporation (EEPCo), and makes grid electricity accessible to villages. Using the grid system is proceeding vigorously. The rate of electrification in 2004 was 13% and now has increased to 22%. In this program, power is generated either from small hydroelectric plants or from solar and wind energy sources and then

connected directly to households. But all these efforts do not address the immense demand for various energy services by the rural women in particular, because they cannot afford to pay electricity bills or purchase the relatively expensive electric cooking stoves since most of them are dependent on the income of their husbands.

In addition, the government's endeavor is not based on critical survey of women's economic and social burden due to lack of affordable, accessible and reliable energy services particularly in rural areas. Therefore, this paper tries to highlight on the impacts of lack of accessible, reliable and affordable energy services on health and economic well being of rural women on selected woredas of Oromiya Regional state.

1.1Objectives

1. Identify the impact of various energy types on specific tasks for which women are primarily responsible
2. Examines the economic and health impact of various household energy types and their availability and affordability on women's lives.
3. To identify household energy needs and utilization patterns in rural communities;
4. To examine the role of women in household energy systems;

2. Literature Review

There are not many studies in Ethiopia or other sub-Saharan African countries that systematically address issues covering access to affordable and reliable energy for different socio-economic groups, especially to capture the demand for clean energy services in rural areas. Moreover, systematic reporting on health impacts is not done in Ethiopia. However, Census data do provide information on type of fuels used for cooking by different households. But they do not give a complete picture of the situation, including aspects such as availability of affordable energy services and stakeholders' desire to switch to these energy sources. The then energy and mining ministry of Ethiopia conducted a study in 1997 for ''Survey of rural energy consumption in Ethiopia''. The objectives of the survey were to estimate the consumption of energy in the rural areas of Ethiopia and bring out the differences in energy usage in different environments. It also looked into the issues of pattern of domestic energy consumption and gathering and purchase issues.

In 2000, EECE carried out a study on ''Domestic fuel survey with special reference to kerosene'' [Kebede 2005]. This was a comprehensive study and it looked into the issues of availability and affordability of kerosene in both rural and urban areas. Again in 2001, a survey by FFEE, covering 16,000 households and 173 woredas from the four regional states of Ethiopia (Amhara, Oromiya,Tigray and SNNPR) looked into the ''Trends in firewood consumption in rural Ethiopia'' [Mesfin, 2004]. The survey reveals that the relative share of fuels in overall energy consumption has changed. For example, the share of firewood logs in rural energy use went down dramatically (97% to 86 %) from 1998 to 2001 and that of the other forms of biomass, such as firewood twigs and crop residues, remained the same or increased marginally. The share of dung decreased marginally. The FFEE survey also revealed that a greater percentage of households were dependent on their forested lands than on public forest lands for fuel-wood supply.

A rural energy survey, ‘‘Energy strategy for rural Oromiya:’’ sponsored by the joint UNDP/Oromiya Biomass Development Bureau was carried out in all zones of the Region, in detail analysis of woreda level in the year 2006. This survey looked into various issues such as rural energy consumption patterns, estimates for energy needs in rural regions, factors underlying fuel preferences, review of existing policy initiatives, opinions and attitude of the rural population regarding currently available forms of energy and potential alternatives. The survey reports significant shifts in rural energy use. About 80 % of the rural people surveyed expressed their concern about the shortages of fuel wood in their surrounding wood lands. In Arsi,Shewa and Western Haraghe, the percentage of households using fuel-wood declined by 30 to 40. The study revealed two conflicting trends in moving away from fuel-wood affecting different groups and/or geographical areas: a switch-over both to commercial fuels and ‘‘lower-value’’ fuels, such as dung and straw. Many other studies have covered issues of rural energy from one or another angle [Kebede et al., 2001; Mesele et al., 2002; Mesfin and Deginetu, 1997; Sadat, 1997; Sinha etal., 1994; Smith, 1996]. None of the above surveys address the issue of health impact, socio-economic factors and fuel consumption pattern from the women perspective. Also, this is perhaps the first sample surveyed for linking energy and health issues and economic status with women in Oromiya Regional State of Ethiopia, other similar studies should be conducted in other parts of Ethiopia.

3. Methodology

This paper reports the study conducted in the rural areas of Oromiya Regional State covering 8,200 individuals in 1,640 households in 13 Rural Peasant Associations from 3 woredas. The study was conducted during the period end-April to mid-June 2011. The questionnaire was designed in English and translated into Oromiffa for better understanding by the surveyors and the respondents. To check the accuracy of the translation, the questionnaire was translated back into English. A two-day training session was conducted for the data collectors before going into the field and the questionnaires were checked and verified in the field by the researcher. The respondent for socio-economic and other variables except health-related issues was the woman in the household. For health-related issues the queries were put directly to all adult individuals present during the survey. For absentee members and children proxy answers were recorded from the main respondents/mothers. Women surveyors were also purposively assigned to ensure close interaction with the woman respondent in case she was hesitant to talk to male data collectors.

Table 1: Number of households and Peasant Associations selected using PPS sampling method

	Woredas			
	All	Sululeta	Sebeta	Legetafo
Total households	1,640	540(3)	590(5)	510(5)

1. *Numbers in the parenthesis indicate peasant associations*

3.1. Sampling Techniques

The households were selected by using multi-stage stratified sampling technique to obtain a representative sample. In the first stage, the Finfine Zuria Zone of Oromiya was stratified on the basis of its woreda boundary. The list of study woredas was divided into 3 broad geographical groups (North, west and south of Finfine). The selection of one woreda per geographical group was based on population median class. Accordingly, three woredas, viz., Sululta, Legetafo-Legedadi and Sebeta, were selected. In Stage 2 a number of peasant associations were allocated to each woreda on the basis of the universe distribution of rural peasant associations in these woredas. Then the woredas were stratified by peasant association population size. The peasant associations were divided into 4 strata on the basis of population, as enumerated in the Census of 2007. In Stratum 1, Peasant Associations with population less than 1000 were included; Stratum 2 had Peasant Associations with population 1000-3000, while in Stratum 3 Peasant Associations with population 3000-5000 were included. The 4th stratum covered the Peasant Associations having population of more than 5000. Stratum 4 was excluded from the sample because these Peasant Associations resemble semi-urban areas. The selection of the Peasant Association from each stratum was done using the probability proportion to size (PPS) sampling method. Households within a selected Peasant Association were selected using systematic random sampling. The selection of Peasant Associations and households from each stratum is given in Table 1.

3.2. Data Sources and Types

The survey was conducted at four levels, viz., individual, household, Peasant Associations, and nearby health-care facility (health centre) which villagers generally use (for example, primary health centers, public health centers, government hospitals). Village-level and health centre (HC) surveys were conducted to validate data acquired at household and individual levels, and also to get an overall picture of the village.

The data at household level were collected to get a comprehensive picture of socio-economic conditions, energy use pattern, housing characteristics, cooking behavior, willingness to pay to reduce indoor air pollution and environmental considerations. Energy use pattern included information on consumption of bio-fuels and commercial fuels for cooking, place of procurement of cooking fuel, time and effort involved in procurement, rate at which procured, progress along the energy ladder, etc. Housing characteristics included information on number of rooms, type of house and type of kitchen, location of kitchen, and number of doors and windows in the kitchen. Further information was collected on cooking behavior, including number of meals cooked using different fuels in a day, hours of cooking, cooking involvement in different age groups and type of involvement. People's willingness to reduce the impact of indoor air pollution included information on people's desire for type of intervention, reason for not using conventional fuels, willingness to pay for additional amount of conventional fuel and additional demand for relatively conventional fuel in the area.

The individual health data were collected on various characteristics of the individual, i.e., physiological characteristics including age, sex, height, and weight. Behavioral data and health profile data included information on smoking habits, literacy, occupation, employment involving dusty environment, time activity pattern, cooking involvement, years of cooking and other

behavior that might lead to respiratory diseases. Further information related to adverse pregnancy outcomes was also recorded for married women.
The Medical Research Council (MRC) questionnaire, 1986, UK, for respiratory symptoms was followed. It includes questions regarding six symptoms. The inquiry was directed at those who were present during the survey for the analysis, according to the MRC procedure. In addition, proxy responses for those who were absent during the survey were obtained from the chief cook and respondent for the household survey and mother's responses for children below 15 years. According to the MRC procedure only these direct responses can be analyzed for respiratory diseases. Therefore, the information collected for absent members and children is analyzed separately. This gave us a picture of overall prevalence of respiratory diseases for adults and also for children.

4. Data Presentation and Analysis

4.1. Socio-economic characteristics of the sample

The sample shows that the female/male ratio (sex ratio) in the study rural areas is 982 females per 1000 males. However, the sex ratio in rural Finfinee Zuria Zone of Oromiya regional state is 932 females per 1000 males according to CSA 2007. The difference can be due to the fact that this study included people having houses, and also peasant associations with population above 5000 were not included. The distribution by age shows that about 45 % of the population is below 15 years old, which is in conformity with a high birth-rate in the recent past (Table 2). The level of female literacy is very low as only 21 % of females are literate against 54.3 % female literacy for all Ethiopia [CSA, 2007]. The sample results for the female literacy rate are much below than the Census 2007 report of 30.1 % for rural Oromiya. Among males the literacy (62 %) is also below the national average of 75.96 % according to Census 2007 report, but the difference is relatively smaller than that for female literacy.

Table 2: Male/female age distribution (% of individuals)

Age	Male	Female
Up to 5 years	17	17
6-10 years	16	15
11-15 years	13	11
16-20 years	10	11
21-30 years	17	18
31-40 years	11	12
More than 40 years	16	16
Total	100	100

4.2. Occupation and land-holding pattern

In the study samples 55 % of the adult males are engaged in farm-based activities and 16 % in industry or the service sector. Most of the adult females undertake household work. About 16 % of the adult males were unemployed at the time of the survey (see Table 3). Further, it was observed that about 28 % of the surveyed households are either headed by landless laborers or are engaged in nonfarm activities, and about 48 % of the households are headed by either

marginal (less than 0.8 ha) or small (1.2-2 ha) farmers. Large farmer families (more than 10 ha) are a mere 2%.

Table 3: Occupation pattern of sampled adults

Occupation	Male	Female
Farm-based	**55**	**3**
Industry/service	**16**	**2**
Home-based/housewife	**4**	**83**
Student	**9**	**2**
Unemployed/others	**16**	**10**
Total	**100**	**100**

4.3. Economic status and House hold energy appliances ownership

Many researches approved that economic status influences the choice and quantity of energy use. It is well recognized that with rise in economic status, energy use increases. The survey shows that only about 16 % of households have annual income above 15000.00 birr (highest category in the area) (US$ 1 = approximately 17.3 birr at that time) while about 22 % of households have annual income below 7200 birr. Ownership of durables and livestock was also recorded as proxies for income. Ownership of durables household appliances such as radios/tape-recorders is more widespread than ownership of energy- and fuel-saving devices, even though the low cost of the latter. The data reveals that about 18 % of households own kerosene stove (*Buta gas*), 42% of households own improved stove (Mirt[1] or Gonze[2]) and only about 4 % of households own electric pan cake stove (Injera Mitad). About 1 % of households own a LPG stove (an energy-saving device) (see Table 4). This lopsided asset structure shows that cooking and energy-saving devices are accorded lower priority than luxury goods. The reason could be that women have very little say in decision-making.

Table 4: House Holds Owning Durables

Asset Type	No. of HHs	Percentage of HHs	
Kitchen Appliances			
Kerosene Stove		18	
LPG Stove		1	
Mirt/Gonze Improved Stove		42	
Electric Enjera Mitad		4	
Household (electric) appliances (includes battery-operated radios/tapes also)			
Radio/tape-recorder		85	

[1] Is an improved stove used for cooking with fire wood

[2] Is an improved stove used for multipurpose with fire wood

3.4. Housing characteristics

Teshome [2001] showed the influence of kitchen location on exposure to and concentration of pollutants. About two-fourth of houses have a single room and another one-fourth have two rooms. About 14 % of households live in a three-room house and another 11 % live in a house with four or more rooms. 66 % of houses have their kitchen inside their living-room. 34 % of households have a separate kitchen or cooking space. The linkage of housing characteristics with health impacts is developed in Section 3.9.4. Type of housing, i.e., whether made of cement and bricks or made of local materials such as mud, wood, and grasses, location of kitchen, number of rooms and ventilation conditions are very important variables affecting intensity of indoor air pollution and exposure suffered by different members of the household [Smith,1987].

4.5. Energy Consumption and Related Issues

4.5.1. Energy consumption pattern

Almost 99 % of households in the study area use bio-fuels to meet their energy need. About 87% of the sampled households use fuel wood as a major source of energy for cooking. Dung-cake and crop residues are used in 8.4 % and 2.7 % of households respectively. The average daily consumption of fuel-wood is about 4.3 kg per household, supplemented by other bio-fuel sources (see Table 5). Kerosene is mostly used for lighting and its use for cooking is limited to only 6 % of the households. Only 1 % of households cook with electricity. Within the samples the use of electricity is highest in Sebeta, whereas the use of kerosene for cooking is highest in Legetafo woreda. The use of LPG and biogas for cooking is almost negligible.

Table 5: Woreda-wise distribution of households (number and percentage) using different energy sources

Fuel Type	Woredas			
	All	Sulelta	Legetafo	Sebeta
Fuel wood	87	97	67	92
Dung	8.4	71	99	85
Crop Residue	2.7	22	24	32
Saw dust	0.5	0.6	0.4	0.9
Any Biofuel	**99**	98	100	99
Charcoal	0.03	-	-	-
Kerosene(lighting)	89	89	94	85
Kerosene(Cooking)	6.43	3.34	9.01	7.28
Electricity	0.05			0.13

4.5.2. Procurement of bio-fuels

About 86 % of the households using fuel-wood gather it and the remaining 14 % purchase it. Expenditure on fuel-wood purchase is an important issue that indicates potential for penetration of commercial energy sources such as kerosene and electricity. It is usually more cost-effective to purchase kerosene and electricity than fuel-wood, if fuel efficiency is considered [FFEE, 2001]. If households can afford to purchase fuel-wood, they will be better off purchasing commercial fuels, which are cleaner and more efficient. Therefore, it may be that commercial

fuels are not available easily or the initial investment required is so high, as in the case of electricity, as to discourage households from using clean efficient fuel.
Further, 47 % of households using fuel-wood gather wood from their own land. Only 33 % of households gather it from government forests. In Sulelta woreda, 81 % of households meet their fuel-wood demand from their own fields. This indicates two things: first, that rural household either meets their fuel-wood demand through farm forestry or has switched to lower-grade fuel-wood, such as twigs or very thin branches. It is not captured this in this survey but the data show that out of the 47 % who meet their fuel-wood demand from their own fields only 8 % gather it from their own farm; the rest gather it from their government forest (see Table 6).

Table 6: Percentage distribution of households using fuel-wood by sources of gathering

Fuel wood sources		Woredas			
		all	Sululeta	Sebeta	Legetafo
From own land	Own forest	38.7	73.21	28.10	19.71
	Own farm	8.25	7.66	14.05	5.26
Sub- Total		46.95	80.87	42.15	24.97
From others' Forest	Gov't	33.51	11.14	19.72	58.44
	Village	6.52	4.93	4.99	8.64
Sub-Total		40.03	16.07	24.71	67.08
Other Sources		13.03	3.06	33.14	7.96

4.5.3. Time and effort involved in gathering fuel-wood

Gathering fuel-wood involves a lot of hardship in walking long distances and carrying heavy-loads of fuel-wood that can cause health disorders in individuals (mostly women and children). Wickramsinghe [2001] and Parikh [2002] have drawn attention to the health impact of collection and carrying heavy loads of fuel on the neck, back and head. The average distance walked to collect fuel-wood by women and children is about 2.5 km. Fuel-wood gatherers on an average make about 16 trips per month and spend three hours per trip, thus spending about 50 hours a month in fuel-wood collection. Fuel-wood is collected for about ten months in a year and the stock of fuel-wood is maintained for the rest of the time since July and August are rainy seasons of central Ethiopia. Table 7 gives the details of efforts made and time spent in gathering fuel-wood. This effort, if put to some productive use, can help reduce the drudgery of women and girl children, as they are the ones generally associated with gathering, processing and transportation of fuel-wood. Crop residues and dung are generally gathered from own fields and livestock. The purchase of these sources of bio-fuels is not common in the rural areas of the study woredas.

Table 7: Time and effort involved in fuel-wood collection (% of households)

Type of effort to collect fuel wood		Woredas			
		all	Sululeta	Sebeta	Legetafo
D/s walked to collect fuel wood	Up to 1 Km	29	34	39	20
	1-2 Km	30	32	35	25
	2-3 Km	23	20	17	29
	More than 3 Km	18	12	9	26
Average time spent per trip (hrs)		3.2	2.3	3.6	3.6
Average no. of trips per month per HH		15.6	18.4	8.3	16.5

Average time spent per month per household (person-hrs.)	49.9	42.3	29.9	59.4

4.6 Use of conventional fuels (conventional energy sources)

The use of conventional sources of energy such as kerosene and Electricity for cooking is very low in the study woredas for various reasons. Out of those 10 % of all households that use conventional fuels, only 1 % exclusively uses conventional fuels for cooking, whereas the other households use them along with bio-fuels. Kerosene is mostly used for lighting in 89 % of the households, mainly because of an available and inadequate electricity supply.

4.6.1 Kerosene consumption and procurement

The quantity of kerosene consumption depends on the purpose for which it is being used. The survey results show that households using it for all lighting and some cooking (during shortage of fuel wood) need 18 liters per month. The households using kerosene for cooking with other fuels and for some lighting (during power cuts) need about 7.5 liter per month. These households use kerosene only for emergency cooking and sometimes for making tea/coffee. The households that use kerosene only for lighting need about 5 liters per month (see Table 8). Thus, the quantity supplied through retail shops is not sufficient even to meet the lighting demand of kerosene-using households. Among households using kerosene for cooking and lighting in the study woredas, about 96 % buy it from nearby retail shops. About 76 % also buy it from the open market (Gullets[3]), where the price is usually much higher than the fuel stations' price and therefore it is not affordable by many of the households. Even at the open market price, the availability of kerosene is not good. However, most of the households that use kerosene only for lighting procure it from retail shops. Thus, there are accessibility problems where the demand exists but not the supply. These have to be addressed with correct policies.

Table 8: Average kerosene consumption by kerosene-using households

Purpose	Quantity (L/month)
For all cooking and some lighting	18
As mixed fuel for cooking and some lighting	7.5
Only for Lighting	5

4.6.2. Reasons for not using conventional fuels

Traditionally, it is assumed that conventional fuels are not used because they are not affordable because of high price and the low purchasing power of the rural households. This study has sought opinions on kerosene only, as kerosene has wide accessibility and use in the rural areas, and is the next conventional fuel on the energy ladder after fuel-wood [Leach, 1992]. The households that were not using kerosene at the time of the survey were asked for the reasons for not using conventional fuels. The survey shows that there are convincing and important reasons (other than affordability), such as lack of availability as given in Table 9. As Table 9 suggests, about 68 % of the households cite non-availability as the reason for not using conventional fuels, while about 66 % of the households do not use conventional fuels because they are expensive. About 22 % of the households are not interested in changing the fuel used and a small percentage of households cite other reasons. Thus, Table 9 reveals that in the rural areas of the study woredas non availability of kerosene restricts its use more than un affordability. The issue is not

[3] Are traditional rural open market places

of just a simple ‘‘yes’’ or ‘‘no’’ but the degree to which affordability is the cause for not using kerosene and even other conventional energy sources. Therefore, the next level of enquiry is that of additional demand.

Table 9: Reasons for not using kerosene for cooking

Reason for not using	% of House holds
Not available	67.54
Not interested in changing the fuel in use	21.83
Afraid of using	7.62
Not convinced of the advantages	2.44
Fuel used for cooking helps in heating the house	1.25
Expensive	65.83
Changes food taste	9.61
Never thought of such option	6.14
Wood smoke works as a repellent for insects	2.16
Wood smoke increases the life of thatched roof	1.25
Changes food taste	9.61
Base: households not using kerosene for cooking	1,640

4.6.3 Additional demand for kerosene

Demand for kerosene at Birr 8.9/liter (average price at fuel stations at the time of survey) is estimated to be about 11 liter/household/ month as against the current average consumption of 5 liter/household/month. If kerosene supply is improved this demand can be satisfied. Doing so can reduce health impacts and the drudgery of women. Also, it could provide an opportunity to participate in other income-earning activities and improve social, economic and living conditions.

4.6.4. Willingness to Pay (WTP) for kerosene

‘‘Willingness to Pay’’ (WTP) estimates the probable demand for kerosene. Though it can provide only approximate estimates in the absence of other reliable and quantifiable methods, it leads to an appreciation of market size and helps to know people’s demand and preferences. WTP analysis is based on a systematically framed questionnaire that is focused on knowing how rural consumers would behave if they were offered a set of options. The survey revealed that at the fuel station price, almost all the sampled households (99 %) are willing to purchase an additional quantity of kerosene.

4.7. Cooking Practices

As this survey was intended to understand the health impacts of different energy sources, it was necessary to know the cooking practices followed -- such as number of meals cooked, (degree of) involvement in cooking, and type of stove used -- that influence exposure to indoor air pollutants from burning of bio-fuels. These behaviors are interdependent and are influenced by variables such as income and landholdings that have been discussed earlier.

4.7.1. Number of meals cooked

The study reveals that 91 % of households using bio-fuel and 88 % of households using conventional fuel cook two meals a day. About 8 % of households using bio-fuel and 12 % of households using conventional fuel cook three meals a day and a small fraction of households

cook one meal a day. Users of conventional fuels (like kerosene) reserve them for immediate cooking needs (such as tea) and special cooking so that ‘‘hard-to-get’’ fuel lasts longer and regular cooking or water-heating is done using bio-fuels.

4.7.2. Responsibilities in cooking and baking Injera

Cooking and baking of Injera is traditionally a women’s job in Ethiopia, but it is interesting to note that females of a particular age group serve as chief cooks in most households. To assess the health impacts of cooking, it is essential to know the individual’s type and degree of involvement in cooking such as chief cook, assistant, occasional helper, or not involved in cooking at all. In the age group 16-20 years, approximately 70 % of females are chief cooks whereas 14 % always assist in cooking and 11 % are not at all involved in cooking. Even in the age groups 21-30 years and 31-40 years, the percentage of females involved as chief cook is quite high, i.e., 65 % and 50 % respectively (see Table 10).

Table 10: Extent of cooking involvement of females in different age groups

Age Group	**Involvement in cooking (percent of female in the age group)**			
	Chief Cook	Always assist	Sometimes assist	Not Involved
10-15	14	39	34	13
16-20	70	14	5	11
21-30	65	6	3	26
31-40	50	4	4	42
41+	25	11	12	52

This is very important from the policy viewpoint, as 16-40 years is the active child-bearing age. Many problems related to pregnancy, such as still-birth and low birth weight, are linked in the literature with exposure to pollutants from bio-fuels. The survey reveals that after 40 years of age females’ involvement as chief cook reduces to only 25 %, whereas 52 % of females in this particular age group are not at all involved in cooking. This could be due to the involvement of older women in other responsible tasks. Other reasons such as daughters or daughters- in-law taking over the responsibility of cooking also affect the predominance of a particular age group. The time required to cook all the meals on an average is about two and half hours per day.

4.8. Health impacts of indoor air pollution

Cooking with traditional methods without proper ventilation has adverse impacts on human health [Smith, 1996]. The linkages of health hazards with bio-fuel use were established on the basis of self-reported symptoms of respiratory diseases. Self-reported respiratory symptoms offer an easy understanding of the prevalence of disease. They also help in firstly checking the validity and secondly understanding the correctness of reported symptoms. Out of 3,278 individuals covered through this survey,2,008 adult individuals were covered through direct interviews, particularly for administering the MRC questionnaire, and the rest were covered through answers from other respondents answering on their behalf; hence the term ‘‘proxy’’ or ‘‘indirect’’ response. Children below 15 years of age were covered through their mothers’ responses. Although the prevalence of diseases and other health analysis are presented only for the direct responses, the proportion of symptoms is also presented for proxy interviews in Table 11.

Table 11: Share of adults and children for direct and proxy responses

		Total individuals	**Direct (all individuals at the time of survey)**	**Indirect (through proxy response: from adults present at the time of survey)**
Adults	Female	1,108	635	473
	Male	900	547	353
Children	Female	1340	-	1340
	Male	1112	-	1112

4.8.1. Prevalence of reported respiratory disease symptoms

The study revealed that the prevalence of ''some'' respiratory disease symptoms was as high as 15 %, as shown in Table 12. The highest reported single disease symptom is breathlessness (9 % of individuals). It is worth noting that there is no significant difference between non-smoker males and females for prevalence of all symptoms and there is a large difference between smoker males versus females and non-smoker males as shown in Table 12.

Table 12: Prevalence of respiratory disease symptoms among males and females (% of direct responses)

Disease Symptoms	All	Females	Male	
			Smokers	Non-Smokers
Cough				
Cough first thing in the morning in winter	12	9	25	10
Cough during the day or at night in winter	11	8	23	9
Cough most days for 3 months each year	7	5	14	7
Phlegm				
Bring up phlegm in the morning in winter	9	6	19	9
Bring up phlegm for 3 months each year	8	5	18	9
Bring up phlegm during day or night in winter	5	3	12	6
Breathlessness				
Troubled by shortness of breath when hurrying	10	10	23	10
Get short of breath when walking with other people	10	9	17	9
Stop for breath when walking at own pace	9	8	15	8
Wheezing				
Had attack of wheezing in last 12 months	6	5	12	6
Had attack of shortness of breath with wheezing	6	5	13	6
Was breathing absolutely normal between attacks	4	3	8	4
Woken at night by attack of shortness of breath	4	3	7	4
Chest illness				

Had chest illness in past 3 years	7	5	11	7
Brought up more phlegm in such illness	5	3	9	5
Had more than one illness in past 3 years	3	2	7	4
Blood in sputum				
Coughed blood in the past	4	3	8	5
Base: All individuals (direct interviews)				

Therefore, the results suggest that male smokers are more highly vulnerable to most of the disease symptoms than male non-smokers and females. Even non-smoker males have somewhat higher prevalence of symptoms and are more vulnerable than females for cough, phlegm, wheezing, chest illness and blood in sputum. It had been expected that males would provide the control group, as they are from the same households and generally do not cook. However, during the study I got other insights. These are as follows.

- Males are also exposed to smoke from cooking fuels, which can be termed as exposure from ‘‘passive cooking’’ [Parikh et al., 2001].
- Males may be subjected to more dusty environments during their day-to-day work, for example on the farm, in agro-processing or construction work or factory work that causes exposure to dust.
- Males report their troubles clearly and are more vocal and expressive about their health condition than females.
- The genetic make-up of males is different and they are more susceptible to respiratory diseases.
- The sample of males is not sufficiently representative: the original purpose of the study was to study females cooking with bio-fuels. The survey was designed to have a random representative sample of females. However, whenever the males were present during the survey they were also queried. Further studies are needed to understand the variation in health impacts due to gender differences to resolve the above anomalies.

4.9. Linkage between socio-economic variables and respiratory disease symptoms

It is often observed that occurrence of disease is linked to various demographic and socio-economic variables such as income, sex, occupation, age, and population of villages (the last of which influences availability of medical facilities). On the basis of direct response data of females of age 15 years and above, the researcher estimated patterns of the relationship between health and other variables. I looked into the linkages for females only, as the study was aimed at studying the health impact of the use of bio-fuels for cooking.

Table 13: Individual characteristics and self-reported respiratory disease symptoms

	Disease symptoms per thousand based on direct response from female adults present during the survey							
	Cough	Phlegm	Breathlessness	Wheezing	Chest illness	Blood in sputum	Any respiratory symptom	Any eye Irritation
Age								
Up to 30 yrs	26	16	39	17	16	14	61	84
More than 30 yrs	67	44	110	44	27	34	152	281

Total	48	31	77	32	22	25	110	137
Z value -	-4.24	-3.51	-5.87	-3.34	-1.61	-2.88	-6.44	-6.31
Odd ratio	2.56	2.67	28	2.51	1.65	2.43	2.48	2.16
Smoking habits								
Smokers	158	107	158	87	66	36	270	235
Non-smokers	36	23	68	26	17	24	92	126
Total	48	31	77	32	22	25	110	137
Z value	7.57	6.45	4.46	4.64	4.44	1.00	7.56	4.21
Odd ratio	4.37	4.69	2.31	3.39	3.84	1.49	2.93	1.87
Fuel index (females over 15 yrs - direct)								
Up to 20	102	51	119	51	68	51	169	186
More than 20	47	31	76	31	21	24	108	135
Total	48	31	77	32	22	25	110	137
Z value -	1.95	.89	1.21	.86	2.43	1.28	1.48	1.13
Odd ratio	2.18	1.67	1.56	1.64	3.28	2.09	1.57	1.38
Literacy								
Illiterate	34	23	165	31	19	19	87	117
Literate	117	64	122	44	32	44	198	230
Total	57	35	81	35	22	26	119	150
Z value	-5.59	-3.49	-3.29	-1.06	-1.43	-2.49	-5.38	-4.96
Odd ratio	3.46	2.76	1.88	1.39	1.73	2.35	2.78	1.96

Notes

Critical value of Z (0.95) = 1.96, critical value of Z (0.99) = 2.58

The higher the Z value, the more important is that variable. Negative sign means the symptom decreases with increase in that variable over the other variable with which it is compared.

Tables 13 and 14 show the proportion of individuals that suffer from various disease symptoms and their relationships with individual- and household-level characteristics Statistical significance is validated through normal z-statistic tests and odd ratios [2] are calculated to know the likelihood of disease confirmation.

Table 14: Household characteristics and self-reported respiratory disease symptoms

	Disease symptoms per thousand based on direct response from female adults present during the survey							
	Cough	**Phlegm**	**Breathlessness**	**Wheezing**	**Chest illness**	**Blood in sputum**	**Any respiratory symptom**	**Any eye Irritation**
No. of meals cooked in a day								
Cooked 2 or fewer meals	43	27	73	28	19	22	102	127
Cooked more than 2 meals	97	75	118	65	48	59	183	231
Total	48	31	77	32	22	25	110	137
Z value	-3.25	-3.64	-2.20	-2.69	-2.56	-3.12	-3.34	-3.95
Odd ratio	2.24	2.83	1.62	2.28	2.50	2.74	1.78	1.82

Hours of cooking								
Cooked for 2 hrs or less in a day	44	23	71	29	14	22	102	115
Cooked for more than 2 hrs in a day	56	43	88	37	34	30	124	170
Total	49	32	78	33	23	26	112	140
Z value	-1.20	-2.44	-1.32	-1.02	-2.88	-1.08	-1.49	-3.46
Odd ratio	1.27	1.84	1.23	1.29	2.41	1.35	1.21	1.48
Kitchen location								
Cooked indoors	48	34	77	33	28	25	108	135
Cooked outdoors (open air)	48	26	78	29	12	25	113	139
Total	48	31	77	32	22	25	110	137
Z value	0.08	0.96	-0.09	0.51	2.33	0.11	-0.29	-0.21
Odd ratio	1.02	1.30	0.99	1.14	2.40	1.03	0.96	0.98
Type of kitchen								
Gojo type kitchen	42	84	76	21	21	27	103	131
Non Gojo type kitchen	32	24	63	44	24	12	79	111
Total	39	30	72	29	22	22	95	124
Z value	0.69	0.74	0.61	-1.73	-0.24	1.35	1.04	0.76
Odd ratio	1.33	1.41	1.19	0.48	0.88	2.30	1.30	1.17
Annual household income								
Annual income up to 15,000 birr	58	38	80	33	24	25	119	151
Annual income > . 15,000 birr	32	19	73	29	19	26	95	111
Total	48	31	77	32	22	25	110	137
Z value	2.63	2.32	0.57	0.54	0.66	-0.22	1.64	2.49
Odd ratio	1.83	1.97	1.10	1.15	1.23	0.94	1.25	1.36

Notes

Negative sign means the symptom decreases with increase in that variable over the other variable with which it is compared.

4.9.1 Individual characteristics

For a reader-friendly explanation, it is better to interpret the first box of Table 13. Table 13 says that 26 females suffer cough out of 1000 females below 30 years of age. The prevalence is higher among those above age 30: 67 persons suffer out of 1000 persons above 30 years of age. Thus, the odds for those above 30 are 2.5 times higher than for those up to 30. The z value is higher than 1.96, which confirms that this variable is statistically significant. In general, age and smoking habits have a significant influence on almost all the respiratory disease and eye irritation symptoms, as revealed through higher odd ratios and higher z values. Smokings, and then age, are the most important variables with an influence on health in order of significance. Cough, phlegm, breathlessness wheezing and eye irritations are significantly higher among illiterates. Fuel index, which is a composite variable of number of years of cooking using different types of fuels and involvement in cooking, shows significantly higher incidence of cough, phlegm, breathlessness, blood in sputum and eye irritation in female adults. Female adults with higher fuel index are more vulnerable to respiratory diseases than females with lower fuel index.

Prevalence rates of respiratory symptoms such as cough, phlegm, breathlessness, wheezing, chest illness and blood in sputum are influenced by age. As age increases the rate of prevalence of these also increases. From Figure 1 it can be observed that prevalence rates of cough, phlegm and breathlessness increase quite sharply from age 35 onwards and it also shows that wheezing increases sharply from the age of 55. Prevalence rates of respiratory symptoms like cough, phlegm, breathlessness, wheezing, chest illness and blood in sputum are also related to the education of female adults. From Figure 2 it can be observed that the prevalence rates of these respiratory symptoms decrease quite sharply for literate females.

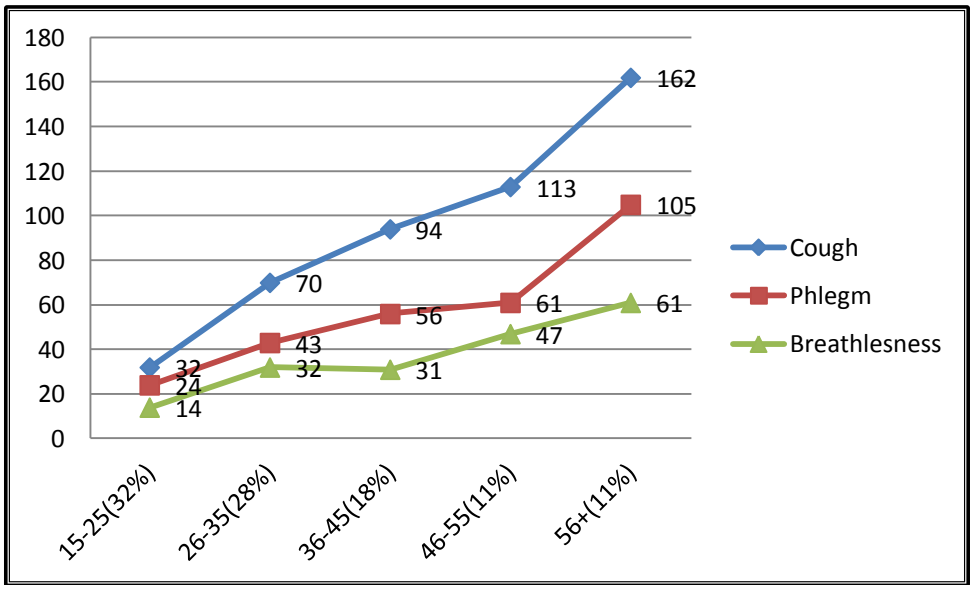

Figure 1: Linkage of respiratory symptoms with age of female adults (direct)

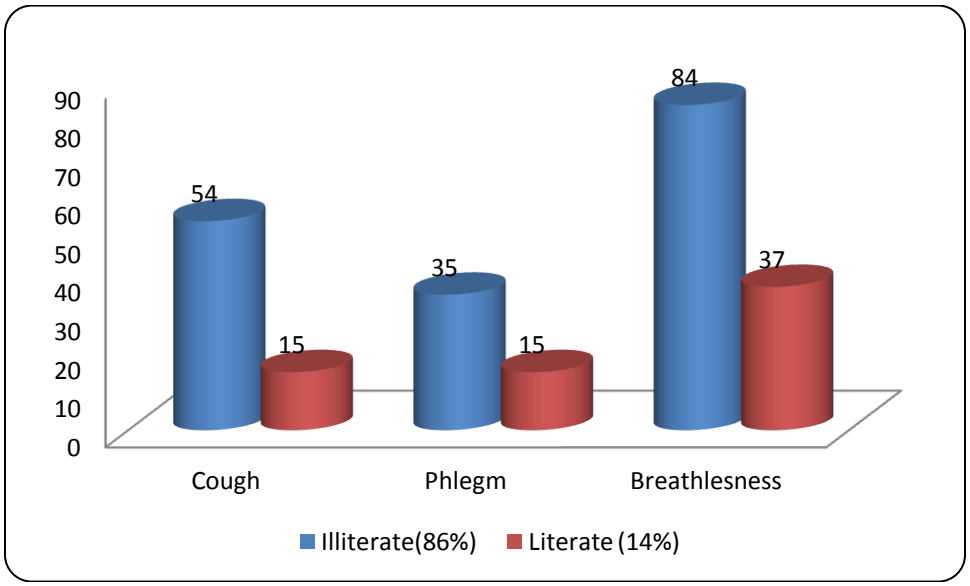

Figure 2: Linkage of respiratory symptoms with literacy of female adults

Prevalence of all respiratory symptoms such as cough, phlegm, breathlessness, wheezing, chest illness and blood in sputum is related to the fuel index for female adults. Prevalence rates of these symptoms increase with increase in fuel index, which is a composite measure of lifetime exposure to kitchen pollution. From Figure 3 it can be observed that the prevalence rate of these respiratory symptoms increases quite sharply with fuel index above 20. However, prevalence of chest illness reduces after the index crosses 30. This may be because age is a component of fuel index calculation and older females are not able to tell their age correctly.

3.9.2. Household characteristics

Table 14 shows the impact of household-level characteristics and practices. The interpretation of Table 14 is along the same lines as for Table 13 but with respect to household characteristics rather than personal or individual attributes. The impact of bio-fuels vs. conventional fuels could not be compared very well because there are few exclusive conventional fuel-users. Moreover, the symptomatic among them are negligible. Odd ratios show very high (infinity) impact of bio-fuels on women's health. Almost all the respiratory symptoms show significant z values and odd ratios with change in number of rooms. Symptoms such as cough, phlegm and blood in sputum are significantly higher among members of households with one room than in the case of households with two or more rooms. The number of rooms in the house also has an impact on respiratory disease symptoms like cough, phlegm, breathlessness, wheezing and chest illness. Prevalence rates of these symptoms decrease with increase in number of rooms. From Figure 4 it can be observed that the prevalence rates of these respiratory symptoms decrease quite sharply from one-room households to households with two or more rooms. Therefore, we can say that for those who cook inside the home and have one room only, even a partition between the kitchen and the living space can greatly reduce the adverse health impact of indoor air pollution.

Small land-holdings and low household income show significant influence on cough and phlegm. Duration of cooking (time spent for cooking) has significant impact on phlegm, chest illness and eye-related problems. All respiratory symptoms and eye irritation are significantly higher among those who cook more than two meals a day than among those who cook two or fewer meals. Reported respiratory symptoms did not show significant difference between members from households with *''Gojo''* type of kitchens and those with *''non-Gojo''* type of kitchens. This could be due to the ventilation provided by the *non-Gojo* type of kitchen. A *Gojo* house is generally made of grass, sticks, mud or any other material, which allows easy air exchange, whereas in the case of *non-Gojo* type of houses the proper placement of the chimney (exhaust) facilitates easy air exchange. But *Gojo* houses are also dustier than the *non-Gojo* type.

3.10. Environmental priorities

The need for sound environmental conditions is being increasingly felt because of rapid environmental degradation and awareness of its adverse impact on human health. The preferences reported below show women's understanding of the problems about environment-related issues. The main environmental concerns of the female respondents are displayed in Table 15.

Table 15: Main environmental concerns (% of households)

Environmental concern	All	sululeta	Sebeta	Legetafo
Better water quality	85.87	88.77	81.43	86.45
Reduced kitchen smoke	71.19	66.31	74.30	73.15
More forest around the village	69.58	72.08	67.92	68.63

Better sanitation	66.37	49.17	83.30	69.26
More grazing area around	55.10	54.78	60.04	52.07
Better outdoor air	46.41	36.87	53.10	49.81
Others	9.00	7.89	2.44	14.30

Table 15 shows that the majority of the women in the study area accord primary importance to better water quality (86 % households) followed by better air quality in the kitchen (71 % households), more forest around the village (70 % households), better sanitation (66 % households), more grazing area around (55 % households) and better outdoor air (46 % households). The preference however varies across woredas. In Sebeta, sanitation is allotted the first priority (83 % households), followed by better water quality (81 % households). In Sululta, after better water quality, the second issue of concern is more forest around the village (72 % households). This shows that people place a higher value on immediate needs and short-term health impacts. Water pollution has an immediate health impact and water is also in short supply in Study woredas. Therefore, it gets more importance than indoor air pollution, which has a longer-term, cumulative, impact.

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4. Conclusion and Recommendation

4.1. Conclusion

- Almost 99 % of all households use bio-fuels and the majority of them use fuel-wood. The hardship faced by rural women in the study woredas to access cooking fuels is very high.
- About 21 million tonnes of bio-fuels are used per year for cooking and heating purposes.
- The study reveals that approximately 47 % of households gather fuel-wood from their own fields and 33 % gather it from government forests. This indicates that either accessibility of forests is poor or households are switching to lower-grade fuel wood, viz., twigs, thin branches, etc. This might cause more problems related to respiratory health.
- A lot of time and efforts of women are required for collecting fuel wood. Approximately 50 person-hours per month are required for households gathering fuel-wood. Generally women and female children are involved in collection and transportation of fuel-wood. This would mean girl children missing school days or dropping out. Less time is left for adult women to attend to other household work or self-fulfillment or leisure.
- The use of commercial sources of energy for cooking is limited to only 10 % of households, although approximately 99 % of households have shown their willingness to buy additional quantities of kerosene (the first clean cooking fuel on the energy ladder above fuel-wood) at the ration price, and 34 % of households are willing to buy additional quantities of kerosene even at prices above the market price. Further, rural households have shown that the problem of accessibility to kerosene is more constraining than affordability. This clearly shows a gap between demand and supply. Filling the gap may require coordinated and collective action of all the stakeholders at the levels of policy-makers, NGOs and grassroots. Improved market access by removing bottlenecks in the kerosene and ENJERA METAD markets can help many households that are willing to pay the market price.
- The health impacts of the use of bio-fuels are quite high for adults, as approximately 6 million people suffer from respiratory or eye-related problems. The study reveals that in the rural areas of study woredas about 4 % of adults suffer from bronchitis, 1 % from asthma, 4 % from tuberculosis and 3 % from chest infection. Thus, about 1 million adults

suffer from pulmonary tuberculosis, 0.9 million from chest infection and 0.4 million from bronchial asthma

4.2 Recommendation

The linkages between many socio-economic variables and respiratory impacts show that health impacts can be reduced by increasing female literacy, reducing exposure, and reducing number of meals cooked and hours of cooking. Even changes in the structure of housing such as ventilation or separation of kitchen from living-room by a partition can have a significant impact. We would like to stress here that not all respiratory or eye diseases are due to burning of fuels; there may be other reasons also. But a large proportion is attributable to this cause.

The loss incurred because of problems related to cooking energy in the form of women's work days spent and illness of both men and women is quite high. Much of this expenditure can be avoided through proper planning and policy, for which inter-ministerial coordination and cooperation is required. Even if we can reduce these losses by some fraction, that can give a boost to the rural economy and improve women's welfare. We need the coordinated, consistent and focused cooperation of all stakeholders at the grassroots, policy-making and implementation levels. Thus, inadequate supply of conventional fuels in the rural areas causes much hardship, ill-health and economic loss. Action-oriented programmes should also include a treatment strategy at public health centres to help suffering women.

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