JOURNAL OF TROPICAL ENVIRONMENT
Vol. 2, Issue I, (June) 2022

Department of Environmental Management
Faculty of Social Sciences & Humanities
Rajarata University of
Sri Lanka

Cost of household air pollution in Bangladesh

Jishan Ara Mitu* and Tanjuma Khanam[2]

**Dhaka School of Economics,*
(Constituent Institution of the University of Dhaka),
Bangladesh2Former Student,
Economics Discipline, Khulna University, Bangladesh
*jishan.mitu@dsce.edu.bd

Abstract

In Bangladesh, the majority of households use conventional fuels like fuelwoods, biomass, animal waste etc., for cooking and heating purposes that emit various toxic substance like carbon di-oxide, carbon monoxide and other high level of harmful particulate matters (PMs). These (PMs) have created different types of respiratory diseases in the family member of the household. Women and children are becoming more vulnerable with the emission of these PMs, as they are spending more time in the indoor environment. The purpose of this study is to assess the health cost due to household air pollution (HAP) for the use of traditional cooking fuel using cost of illness method. A total of 160 urban and rural household were surveyed in Khulna districts of Bangladesh to estimate the associated health cost due to HAP. The study found that due to poor ventilation system and congested kitchen area, the majority of the households are exposed to smoke duringthe time of cooking. The most suffered diseases are headaches, eye irritation, cough, asthma, and skin diseasesconnected with the emission of smoke from biomass. The treatment cost increases by BDT 205.729 for urban households than the rural households who use traditional stove. It is also revealed that 32 percent of the HH use improved stove in removing smoke. Therefore, if households' members in the urban areas fall sick, the treatment cost is higher by BDT 445.056 compared to the rural area. To recommend, the attempt of the NGOs can play a participatory role to provide HH financial help to undertake cleaner fuel and abate HAP.

Keywords: *Treatment cost, household air pollution (HAP), biomassfuel, cost of illness, Bangladesh*

1. Introduction

In developing countries, including Bangladesh, Household Air Pollution (HAP) is one of the responsible factors for causing health risk at the household level (Lim et al., 2012). Around 41 percent of global household, are dependent on solid fuel for cooking purpose in 2010 (Bonjour et al., 2013). Solid fuel is the primary cooking fuel in Bangladesh; around 86 – 88 percent of the total population is relied on it (NIPORT et al., 2013).Consequently, the major source of HAP is the use of traditional fuel for cooking and heating purpose. Household is considered as a unit of analysis because the use of every fuel carries a cost to the household. Some have direct costs; others have indirect costs, while others have both in different proportions. This study focuses on estimating indirect health costs due to HAP. Hence, this paper will destine health hazards affiliated with HAP. The fundamental purpose of this paper is to examine the extent to which domestic cook experience health threats related to the cooking environment.

Traditional and open fire stoves for cooking and heating generate a high level of health-damaging pollutants. HAP is thought to cause about a-third of acute respiratory infection, one of the leading causes of child mortality globally. This makes solid fuels the second most environmental cause of the disease after contaminated waterborne disease(Bruce et al., 2006). Another study indicates that environmental insults can have long-lasting influences on health and productivity (Almond, 2006).The major environmental health problem in Nepal is the burning of solid biomass fuel for cooking. Around 85 percent of Nepalese households are dependent on biomass for cooking purposes. Most household cook in a poorly ventilated kitchen using inefficient stoves, leading to indoor air pollution and, consequently, health problems. This pollution level is 15 times higher than the recommended safe level, leading to higher health expenditures (Thakuri, 2009). People in developing countries use solid fuels because of their availability and affordability (Smith et al., 1994).

In developing countries, households with limited ventilation exposures experienced by household members, mainly women and young children who spend most of their time indoors (Bruce et al., 2006). Air pollution levels significantly affect human health, especially the infant and young children (Duflo et al., 2008). There is evidence that is a relationship between HAP and health problems such as acute respiratory infections and chronic obstructive pulmonary disease (COPD) and women's lung cancer(Ezzati and Kammen, 2002). Approximately, 1.5 percent of death is responsible for HAP. Infants remain at home and breathe indoor smoke, and are exposed to these hazardous pollutants. Consequently, 56 percent of deaths occur in children under five years of age due to Indoor Air Pollution. (Chandramohan et al., 2010).

It is important to look other than the major effects on health in measuring the costs of indoor air pollution. As the individual is in poor health, they may not be able to perform arduous or unrelenting work. This minimizes his labor market opportunities and paid lower wages. The household cannot always afford to pay for goods that could improve his health, which are- better fuel, more nutritious foods, doctor's visit, and, therefore, improve his working capability. Thus it becomes a vicious circle of poverty (Dasgupta et al., 2004a).

Another study uses morbidity relationship for the diseases responsible for HAP in terms of sick days. The health burden from 1.6-2.0 billion days of work days lost in India (Smith, 2000). Interventions in many forms can reduce indoor air pollution. For reducing exposure to indoor air pollution, a wide range of interventions are required. These can be categorized into three headings: sources (type of stove, fuel); living environment (housing, ventilation); user behavior (protection of child, fuel drying)(Schrinding et al., 2000). Interventions fall into two categories: access to improved ventilation and access to cleaner fuel (Smith, 1987).

The potential determinants of exposure to indoor pollution are: time spent on cooking, fuel type, structure of houses, location of cooking, and household ventilation. The indoor air quality vary depending on the type of cooking style, type of fuel, hours of burning fire, ventilation and location of kitchen and stove (Dasgupta et al., 2004). In 2000, more than 1.6 million deaths and over 38.5 million Disability-Adjusted LifeYears (DALYs) were attributable to indoor smoke from solid fuels. Cooking with solid fuels is responsible for a significant proportion, about 3 percent global burden of disease (Smith et al., 2004).A major sources of HAP and related illness is the use of traditional biomass fuels for cooking which is used by many rural households (Plant, 2008).

A study from Bangladesh links the level of (Indoor Air Pollution) IAP with wall and roof, location of the kitchen and its openness to other rooms in the house. The construction wall and roofs have a significant effect on IAP concentration. The fuel choice is considered less important than ventilation factors explaining variation in IAP among poor households. Moreover, lack of awareness among rural households is the prime factor in preventing the severity of HAP (Dasgupta et al., 2004).

Regarding the other's relevant studies, the main focus of this study is to estimate the health cost of household air pollution in both rural and urban areas of Bangladesh. Tobit model is used to estimate the treatment cost due to HAP in different perspectives. The cost of illness method is applied to estimate the different cost scenarios in urban and rural areas regarding five types of HAP-related diseases. In the study area, urban dwellers incur more health costs than rural people. Variuos factors are responsible behind the higher treatment cost in urban areas, for example, congested kitchen space, poor ventilation system, higher living cost, etc.

2. Methods of Data Collection

To attain the objective of this study, the author selected the Khulna district of Bangladesh as the study area. Khulna district consists of 9 Upazila (sub-district) and one City Corporation (BBS, 2011). On the basis of the administrative boundaries, Khulna City is considered as an urban sample area and Batiaghata Upazila is randomly considered as a rural sample area. Questionnaire survey method was implemented for the purpose of data collection amd majority of the questions are in a structured form.

Households, where fuelwood is partially or fully used for cooking and heating purpose, are considered as sample data. A total of 160 households have been surveyed for this study using the multistage sampling technique.

Khulna City Corporation (KCC) consist of 31 wards, including 184 Mahallas (BBS, 2011). Among 31 wards of KCC, three wards have been selected randomly.

Out of 9 Upazilazs of Khulna District, Batiaghata Upazilahas been selected for the convinence; it consists of 7 unions and 172 villages (BBS. 2011). The two unions have been randomly chosen among the 7 unions of this Upazila. Under each union from the village population list, two villages have been chosen randomly for the study

Thus 80 households from urban area and 80 from rural areas (a total of 160 households) have been selected for the study. As the main purpose of this study is to estimate the health cost of household air pollution (HAP) in the household (HH) sector, it is convenient to trace out the health cost of HAP related diseases like eye irritation, headaches, coughing, pulmonary disease, etc. at HH sectors.

Analytical Framework

At households sector, use of biomass fuel like fuelwood, plant and animal residues for cooking and heating purpose that deteriorates the HH air quality compared to the benchmark of international ambient air quality (Larsen, 2016). As women and children are situated in the house most of the time, they are the main exposure to HAP. There are some specific effects of HAP like increase the health cost of affected people, reduces the workdays, etc. In this paper, the cost of illness (COI) method is applied to estimate the health cost of HAP. COI is the most commonly and popularly used method which is defined as the cost of medical care resulting from sickness plus lost productivity due to sickness (Freeman, 1993).

Estimation of Treatment Cost

An important characteristic of the survey data on mitigating activities is that it usually has several observations where the medical expenditure is zero. This feature of the data destroys the linearity assumption; hence the application of the least-squares method is inappropriate. Therefore, to estimate the treatment cost of illness in both urban and rural area, the author uses a Tobit model (Atreya, 2007). In the Tobit model author has considered the upper and lower limit of the data of the related variables.

$$M_i = \sum_{i=1}^{n} \gamma X_i + e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, *Mti* is the Treatment costof illness

γ is the vector of the regression coefficient for the individual's treatment expenditure

Xi is the vector of the exogenous independent variable. The variables used in the treatment cost analysis are explained in Table 1:

Table 1: Variables for Treatment Cost Analysis

Explanatory Variable	Unit of Measurement	Exp. Sign	Reference
Age	Years	+	Author's Compilation
Income	BDT/Year	+	(Thakuri, 2009)
Smoke	1= Yes, 0=Otherwise	+	(Thakuri, 2009)
Chronic illness	1= Yes, 0= Otherwise	?	(Thakuri, 2009)
Distance to hospital	Km	+	(Thakuri, 2009)
Size of family	No.	?	Author's Compilation
Frequency of illness	Frequency/Year	+	(Thakuri, 2009)
Fuel consumption	Kg/month		Author's Compilation
Hours of cooking	Hours/Day	+	(Thakuri, 2009)

N.B.: Dependent Variable: Treatment Cost (BDT/person).
Source: Author's Compilation, 2021

N.B.: Dependent Variable: Treatment Cost (BDT/person).

Source: Author's Compilation, 2021

Cost of Illness Calculation

Here, $L = \sum_{i=1}^{n} (A_{ij}) D$ ……………… (2)

Where, A_{ij} is the proportion of exposed persons experiencing i days of the lost normal activity of each illness (j), D is the income per workday (in BDT)

We know,

$$C= L+M\ldots\ldots\ldots\ldots..(3)$$

Where, L= Lost income per illness (BDT), M= Medical cost (BDT), C= Total cost per illness (BDT)

3. Result and Discussion

Households usually undertake treatment when exposed to pollution. They visit doctors or take various medicines due to the disease related to indoor air pollution. In the sample, the cost of treatment is zero for several households. In that case, loss of income is considered as the opportunity of of illneness. So, for the truncated nature of the dependent variable, the author uses the Tobit regression for estimation of the treatment cost. A Tobit regression analysis is used here to determine the factors that affect the treatment cost, taking treatment cost as the dependent variable. Factors that influence the cost of treatment are explained in Table 2.

The model depicts that the treatment cost increases by BDT 205.729 for urban households than the rural households that uses traditional stove, which is statistically significant at 1 percent level.

Table 2: Estimation of Treatment Cost

Table 2: Estimation of Treatment Cost

Tobit Model				
		Model 1[a]	Model 2[b]	Model 3[c]
A	B	C	D	E
Explanatory Variable	**Unit of Measurement**	**Coefficient**	**Coefficient**	**Coefficient**
Age	Years	2.656	2.409	0.686
Income	BDT/Month	-0.002	-	0.000
Smoke	Yes = 1, No = 0	403.960**	336.403***	-0.362
Ventilation	Yes = 1, No = 0	-48.752	16.381	-38.231
Fire wood Consumption	Kg/Month	0.0283	0.043	-38.231
Frequency of Illness	Times	164.056***	29.627	48.967
Total hours of cooking	Hours	45.843	-8.912	10.667
Size of Family	Member	-78.767	36.676	-4.891
Traditional Chula	Yes = 1, No = 0	68.284	35.799	205.729***
Illness	Yes = 1, No = 0	-	-	445.056***
Location	Urban =1, Rural=0	-	-	139.493
Constant		-602.143	-208.836	-549.068
Sigma		456.224	217.348	358.436
LR chi^2 (10)		23.790	29.770	90.00
Prob > chi^2		0.0082	0.0009	0.000
Log likelihood		-519.749	-448.520	-926.349
Pseudo R^2		0.0224	0.032	0.046
Number of observation		80	80	160

N.B.: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Dependent Variable: Treatment Cost (BDT/Person). [a] Model 1= Regression for Urban Area, [b] Model 2= Regression for Rural Area, [c] Model 3= Combined Regression for both urban and rural area.

Source: Author's Compilation based on Field Survey, 2021

Therefore, if households' members in the urban area fall sick, the treatment cost is higher by BDT 445.056 compared to the rural area, which is statistically significant at 1 percent level. Frequency of illness is higher in rural areas compared to urban areas, which is 1 percent significant. The variables like smoke is one of the significant factor to increase the treatment cost in both urban and rural areas.Use of traditional cooking system also positively influence the dependent variable at significant level.

Calculation of Total Cost of Illness

To estimate the health cost of pollution exposure, the estimation for each type of illness occurrence is multiplied by their respective estimates of the episodes of illness for the exposed household. The loss days for the households are 1, 2 and 3. Loss days of activity are found from each type of illness in the field survey. The loss of income is estimated from the proportion of loss days multiplied by the income per workday. Then, the medical visit per illness is found from the proportion of people who are sick and their visit for medical treatment. Now the medical cost per illness is estimated by multiplying the proportion of medical visit/illness to medical cost per visit. Finally, the total cost of illness is found from the summation of effective daily income and medical cost/disease. Then total cost of illness is estimated in two different areas; urban and rural which would be helpful for area wise effecting decision making.

Cost of Illness for Rural Area

By following the cost of illness method by (Dwight et al., 2004) , the total cost of illness for the surveyed villages is BDT 24,811.30.Table 3 calculates the total loss income in a rural area. The proportion value of illness is multiplied by the effective daily income of the individual. The proportion of medical visit is similarly multiplied by the medical cost per visit. Then, the total cost of illness is found by summing the value of total loss income and medical cost /visit, which is BDT 24,811.30.

Table 3: Cost of Illness for Rural Area

Explanatory Variable	Unit of Measurement	Exp. Sign	Reference
Age	Years	+	Author's Compilation
Income	BDT/Year	+	(Thakuri, 2009)
Smoke	1= Yes, 0=Otherwise	+	(Thakuri, 2009)
Chronic illness	1= Yes, 0= Otherwise	?	(Thakuri, 2009)
Distance to hospital	Km	+	(Thakuri, 2009)
Size of family	No.	?	Author's Compilation
Frequency of illness	Frequency/Year	+	(Thakuri, 2009)
Fuel consumption	Kg/month		Author's Compilation
Hours of cooking	Hours/Day	+	(Thakuri, 2009)

N.B.: Dependent Variable: Treatment Cost (BDT/person).
Source: Author's Compilation, 2021

Table 2: Estimation of Treatment Cost

Tobit Model				
		Model 1[a]	Model 2[b]	Model 3[c]
A	B	C	D	E
Explanatory Variable	Unit of Measurement	Coefficient	Coefficient	Coefficient
Age	Years	2.656	2.409	0.686
Income	BDT/Month	-0.002	-	0.000
Smoke	Yes = 1, No = 0	403.960**	336.403***	-0.362
Ventilation	Yes = 1, No = 0	-48.752	16.381	-38.231
Fire wood Consumption	Kg/Month	0.0283	0.043	-38.231
Frequency of Illness	Times	164.056***	29.627	48.967
Total hours of cooking	Hours	45.843	-8.912	10.667
Size of Family	Member	-78.767	36.676	-4.891
Traditional Chula	Yes = 1, No = 0	68.284	35.799	205.729***
Illness	Yes = 1, No = 0	-	-	445.056***
Location	Urban =1, Rural=0	-	-	139.493
Constant		-602.143	-208.836	-549.068
Sigma		456.224	217.348	358.436
LR chi^2 (10)		23.790	29.770	90.00
Prob > chi^2		0.0082	0.0009	0.000
Log likelihood		-519.749	-448.520	-926.349
Pseudo R^2		0.0224	0.032	0.046
Number of observation		80	80	160

N.B.: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Dependent Variable: Treatment Cost (BDT/Person). [a] Model 1= Regression for Urban Area, [b] Model 2= Regression for Rural Area, [c] Model 3= Combined Regression for both urban and rural area.
Source: Author's Compilation based on Field Survey, 2021

Cost of Illness for Urban Area

The cost per illness is calculated using the cost of illness model. Table 4 calculates the total loss income in a particular area. The proportion value of illness is multiplied by the effective daily income of the individual. The proportion of medical visit is similarly multiplied by the medical cost per visit. Then, the total cost of illness is found by summing the value of total loss income and medical cost per visit, which is BDT 32,692.39. Here it has been seen that cost of illness is higher in urban area compared to rural area (table:3).

Table 4: Cost of Illness for Urban Area

Tobit Model

		Model 1[a]	**Model 2[b]**	**Model 3[c]**
A	**B**	**C**	**D**	**E**
Explanatory Variable	**Unit of Measurement**	**Coefficient**	**Coefficient**	**Coefficient**
Age	Years	2.656	2.409	0.686
Income	BDT/Month	-0.002	-	0.000
Smoke	Yes = 1, No = 0	403.960**	336.403***	-0.362
Ventilation	Yes = 1, No = 0	-48.752	16.381	-38.231
Fire wood Consumption	Kg/Month	0.0283	0.043	-38.231
Frequency of Illness	Times	164.056***	29.627	48.967
Total hours of cooking	Hours	45.843	-8.912	10.667
Size of Family	Member	-78.767	36.676	-4.891
Traditional Chula	Yes = 1, No = 0	68.284	35.799	205.729***
Illness	Yes = 1, No = 0	-	-	445.056***
Location	Urban =1, Rural=0	-	-	139.493
Constant		-602.143	-208.836	-549.068
Sigma		456.224	217.348	358.436
LR chi^2 (10)		23.790	29.770	90.00
Prob > chi^2		0.0082	0.0009	0.000
Log likelihood		-519.749	-448.520	-926.349
Pseudo R^2		0.0224	0.032	0.046
Number of observation		80	80	160

N.B.: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Dependent Variable: Treatment Cost (BDT/Person). [a] Model 1= Regression for Urban Area, [b] Model 2= Regression for Rural Area, [c] Model 3= Combined Regression for both urban and rural area.

Source: Author's Compilation based on Field Survey, 2021

4. Conclusion

The households cooking behaviour varies from households to households. Some spend more hours in the kitchen and others less depending on the activities. According to the survey findings, about forty-one percent of the households with traditional stove spend more hours in the kitchen than other types of the stove like gas, kerosene and electric. The mean hours spent is 4.5 hours per day.

This paper finds that the major health problem faced by households in the study area is eye irritation, headache, cough, asthma, skin disease. This study finds that average sick days as a result of indoor air pollution are 0.711 days /episode.

This study focuses on the generation of HAP through household's cooking behaviour and also the plausible health symptoms of HAP. The sets of essential factors responsible for the health cost of IAP are presented in this paper. The analysis shows that smoke and extensive use of traditional stove are responsible factors for the health damages of households. Moreover, the surveyed area is highly dependent on solid biomass fuel as it is readily available and cheap. For the higher cost of adopting cleaner energy, the households stick to the traditional way of cooking, although this type of fuel gives off corrosive fumes which is harmful to health. This fuel is not only creating health cost but also creating environmental cost by deforestation. As with the other basic needs as food, clothing, shelter and health the supply of household energy is also crucial. Therefore, it is a crying need to ensure a sustainable and alternative supply of energy for the household sector through planned policy. Different interventions from the part of government can help to reduce the HAP. In this regard, the NGOs and INGOs can play a participatory role to create awareness among the households about the negative externalities of air pollution at household level. By providing financial support to adopt user friendly cooking system to the households, cost of illnesd due to HAP can be reduced.

5. Acknowledgement

The author is grateful to all field enumerator for conducting the survey, during the pandemic and also thankful to the co-author for technical assistance and research publication department of Rajaratra University of Sri Lanka.

6. References

Almond, 2006. Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population. *Journal of Political Economy*. 114(4), 672-712.

Atreya, 2007. Presticide Use in Nepal: Understanding Health Costs from Short-Term Exposure. South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu, Nepal.

BBS, 2011. District Statistics Khulna. Bangladesh Bureau of Statistics. Statistics and Informatic Division, Planning Ministry, Government of Bangladesh.

Bonjour, S., Adair-Rohani, H., Wolf, J., Bruce, N.G., Mehta, S., et al. 2013. Solid fuel use for household cooking: Country and regional estimates for 1980-2010. *Environmental Health Perspectives*, 121(7): 784-90.

Bruce, N.L., Rehfuess, E., Mehta, S., Hutton, G. and Smith, K.R., 2006. Indoor Air Pollution in Disease Control Priorities in Developing Countries. Washinton, DC; Oxford University Press.

Chandramohan, B.P., Villalan, T. and Karthikeyan, S. 2010. The conomic Cost of Health Problems due to Indoor Air Pollution at Household Level in Tamil Nadu. Himalayan Research Paper Archive.

Dasgupta, S., Haq, M., Khalikuzzaman, M., Pandey, L. and Wheeler, D. 2004. Indoor Air Quality for Poor Families: New Evidence from Bangladesh, Working Paper, 3393, Developemnt Reaserch Group, Washinton, DC: The World Bank.

Dasgupta, S., Haq, M., Khalikuzzaman, M., Pandey, L. and Wheeler, D. 2004a. Indoor Air Quality for Poor Families: New Evidence from Bangladesh, Working Paper, 3393, World Bank Policy Research, Dhaka.

Duflo, E., Greenstone, M. and Hanna, R. 2008. Indoor Air Pollution Health and Economic Wellbeing, Surveys and Perspective Integrating Environment and Society (SAPIE).

Dwight, 2005. Estimating the Economic Burden from Illness Associated with Recreational Coastal Water Pollution- A Case Study in Orange Country. Journal of Environmental Management, 76(3), 93-103.

Ezzati, M. and Kammen, D.M. 2002. Household Energy, Indoor Air Pollution and Public Health in Developing Countries. Resources for the Future, Issues Brief. Washinton, DC: USA.

Freeman, A.M., 1993. The measurement of Environmental and Resource Value: Theory and Methods, *Resource for the Future*, Washinton, DC.

Larsen, B. 2016. Benefits and Costs of Household Cooking Options for Air Pollution Control: Bangladesh Priorities. Copenhagen Consensus Center and BRAC Research and Evaluation Department.

Lim, S.S., Vos, T., Flaxman, A.D., Danaei, G., et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet, 380: 2224-60.

NIPORT, Mitra Assoc., and ICF Int. 2013. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA

Schrinding, Y.V., Bruce, N., Smith, K.R., Tremmer, G.B. and Ezzati, M. 2000. Addresing the Impact of Household Energy and Indoor Air Pollution on the Health of the Poor; Implication for Policy Action and Intervention measures. *Global Consultation on the Health Impact of Indoor Air Pollution and Household Energy in Developing Countries*. Washinton, DC, 3-4, May.

Smith, K.R. 1987. Biofuels, Air Pollution and Health: A Global Review. *United Nations Human Settlement Programme (UNHSP)*, Nairobi.

Smith, K.R. 2000. National Burdan of Disease in India from Indoor Air Pollution. *National Academy of Science of the United States of America (NAS)*, 13286-13293.

Smith, K.R., Apte, M.G., Yoqing, M., Wongsekiarttirat, W. and Kulkarni, A. 1994. Air Pollution and the Energy Ladder in Asian Cities Energy, 19(5), 587-600.

Smith, K.R., Mehta, S. and Feuz, M.M. 2004. Indoor Air Pollution from Household Use of Solid Fuels, in, *Comperative Quantification of Health Risk: Global and Regional Burden of Disease Attribute to Selected Major Risk Factors*. 1453-1493.

Thakuri, M.B.M., 2009. Revisiting the Need of Improved Stoves: Estimating Health, Time and Carbon Benefits. Working Paper, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu, Nepal.