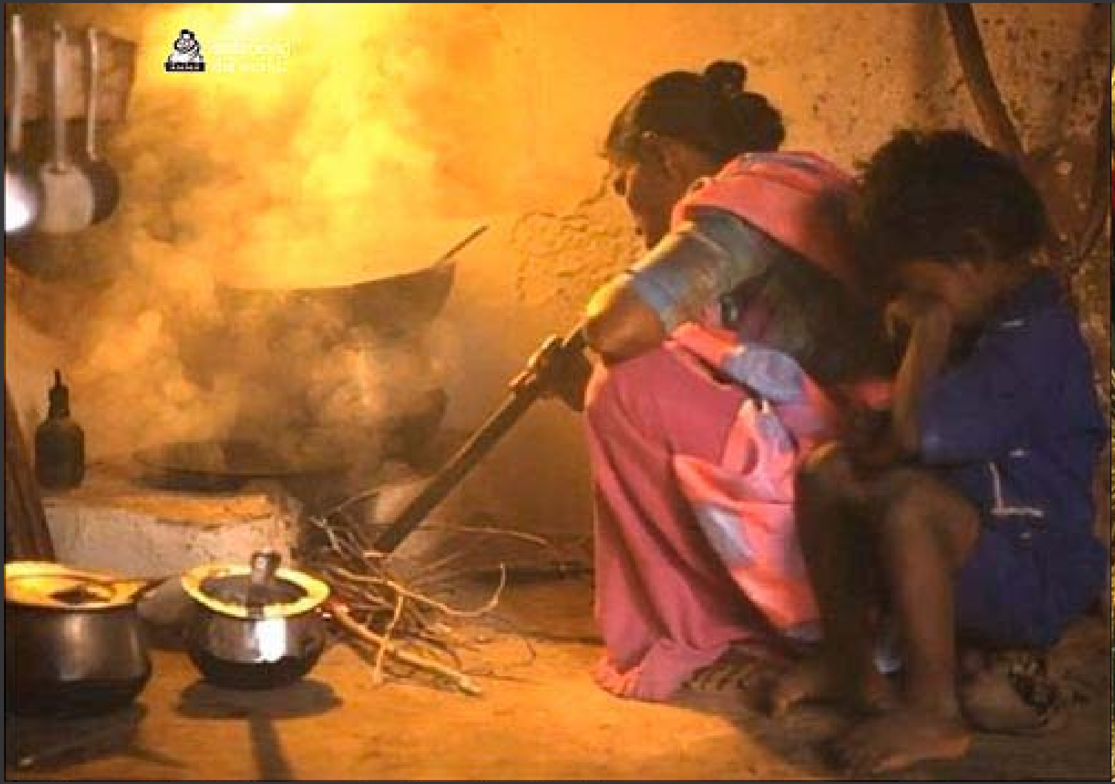
Impact of Indoor Air Pollution from Cooking with Solid fuels on Children’s Respiratory Health: Evidence from Pakistan



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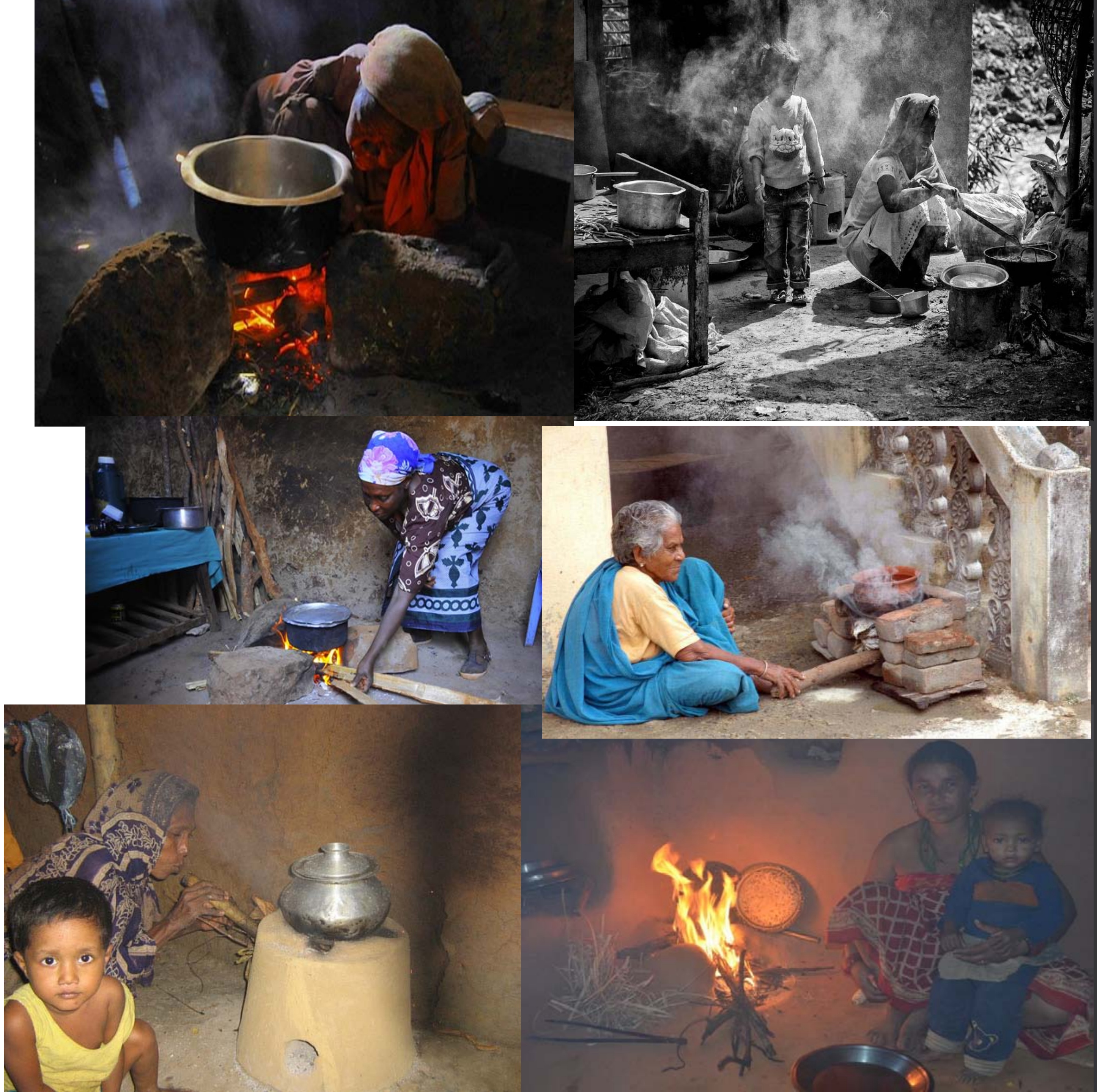
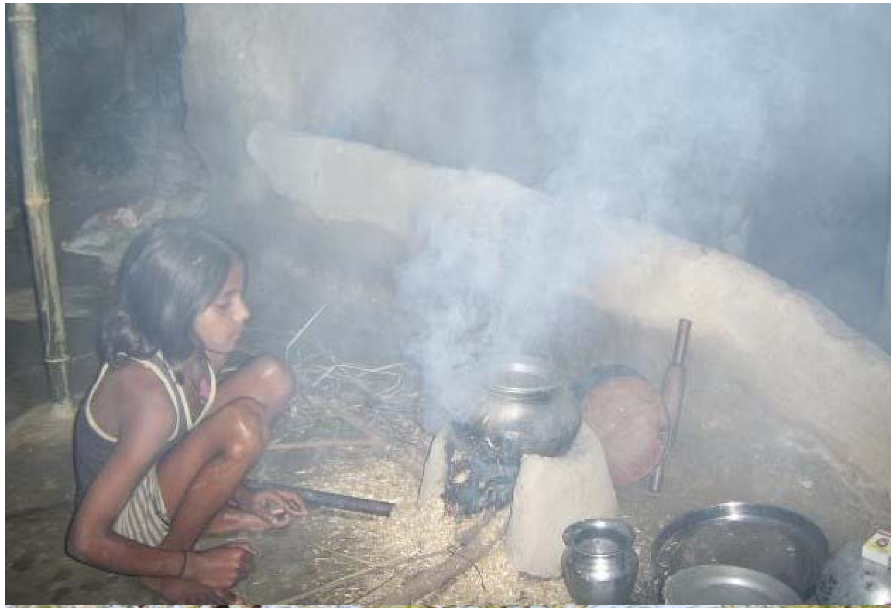
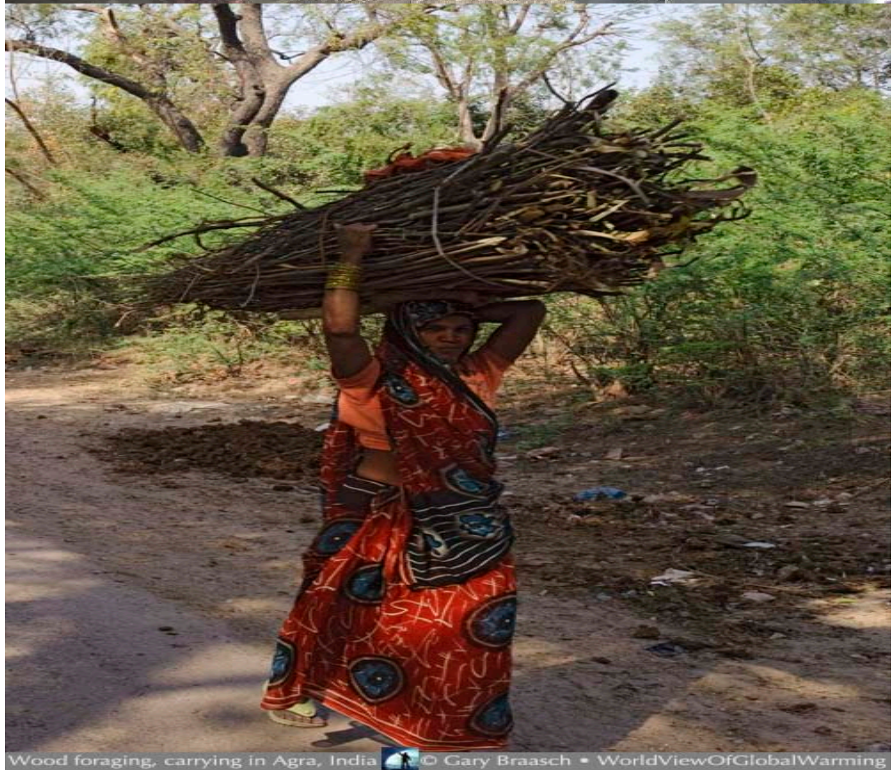


INTRODUCTION

<u>Do people today still use fuels like wood, charcoal and grass for cooking?</u>

- **3 billion** people in the world use solid fuels and biomass fuels for cooking and heating purposes. (WHO,2016)
- **4.3 million** people die prematurely globally by indoor air pollution from solid fuels. (WHO,2012)
- Household air pollution is the leading risk factor for the disease burden in **South Asia** and the 4th largest risk factor for global burden of disease. (Lim et al, 2010).
- Among various respiratory illnesses caused by indoor air pollution, ARI is the most dominant cause of death among children. (WHO,2014)

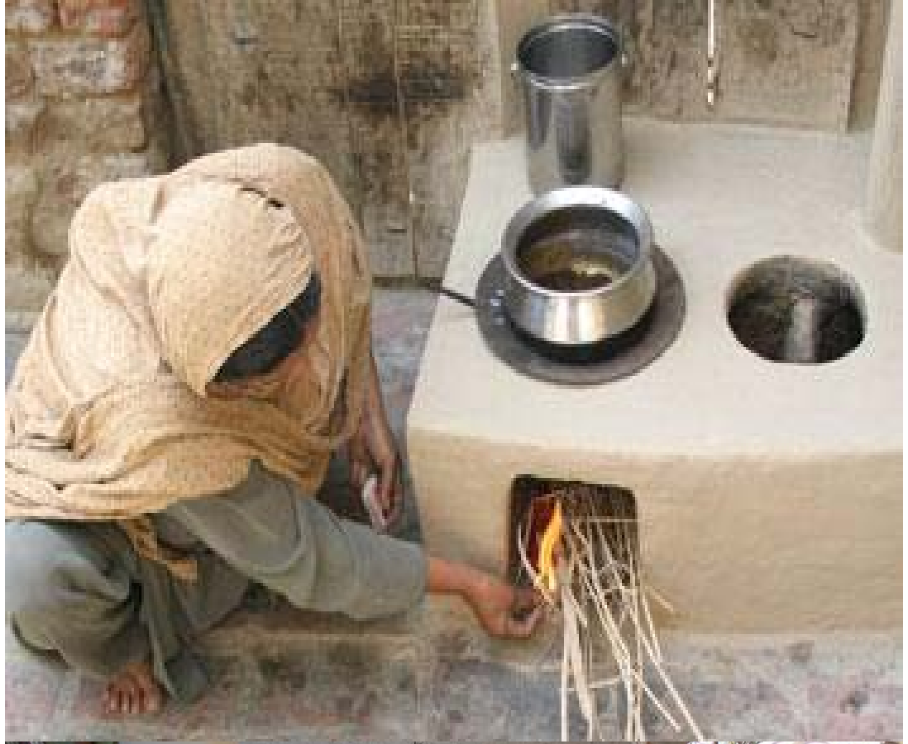


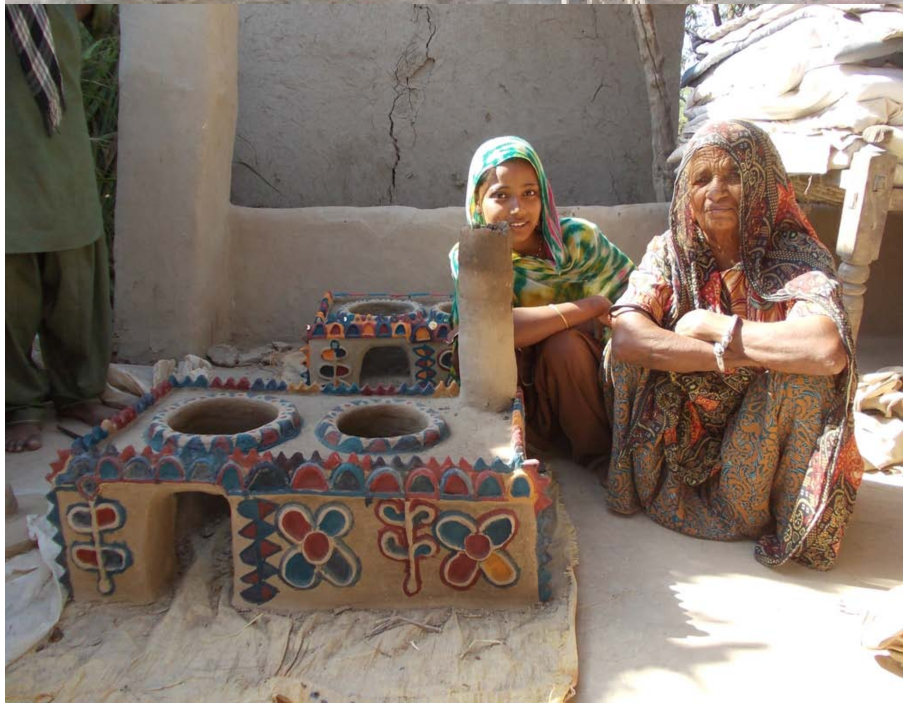


INTRODUCTION

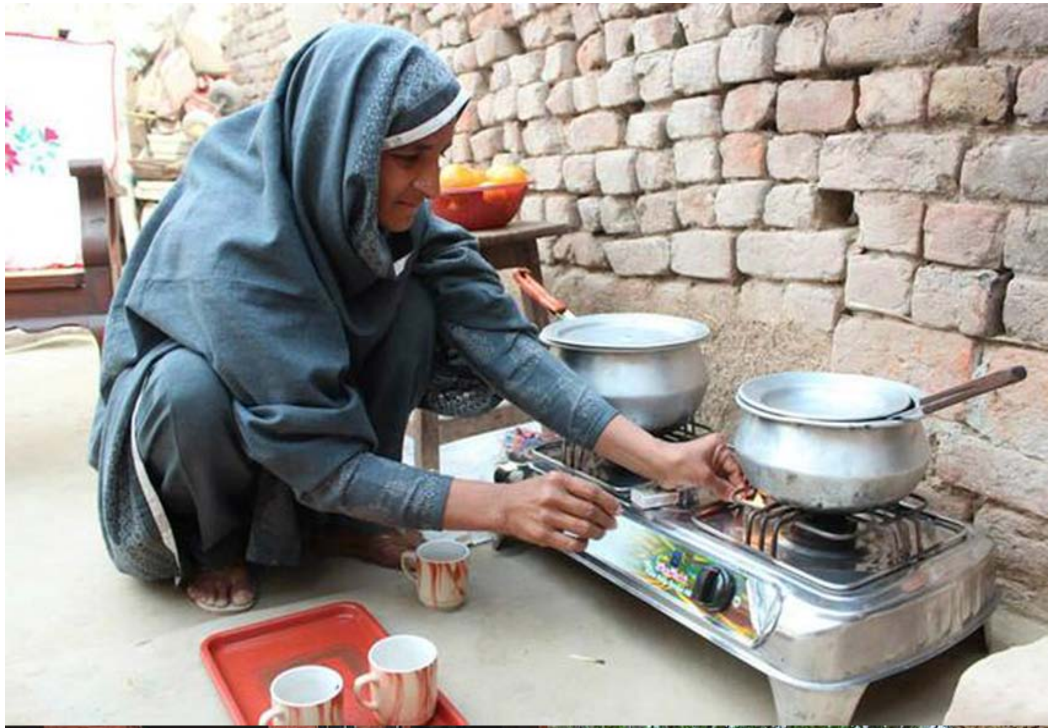
<u>What has been done to tackle this in Pakistan?</u>

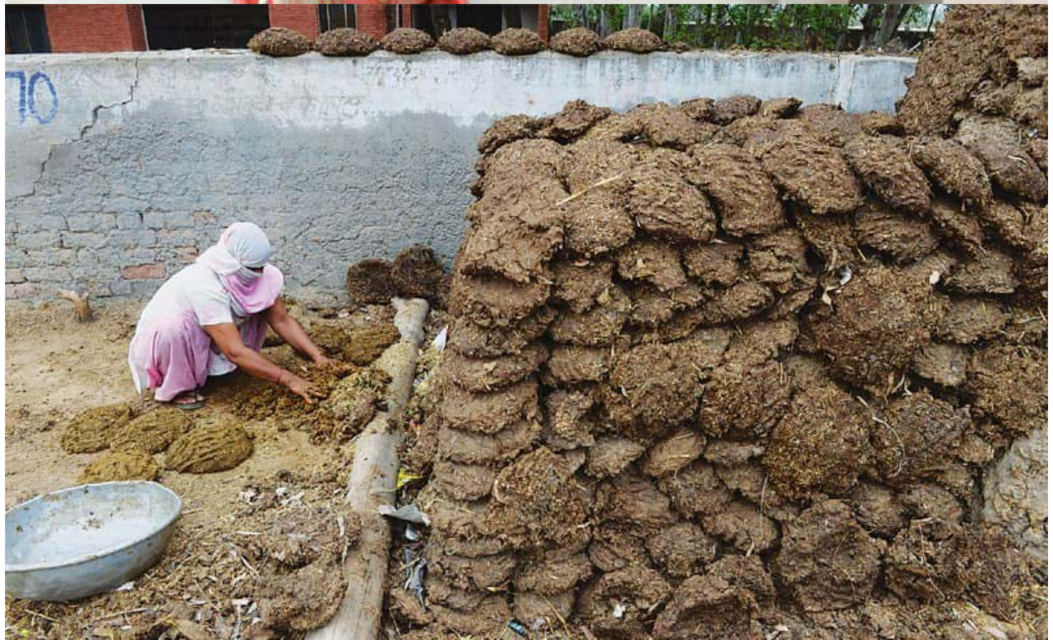
- Improved cook stove programs launched in the 1970's.
- Pakistan Rural Support Program (1991) launched Pakistan Domestic Biogas Programme.
- Contribution by Aga Khan Planning and Building Services (AKPBSP), Pakistan Design Institute (PDI), Escorts Foundation, Association for Humanitarian Development (AHD) and others in various programs.
- Awareness campaigns by NGO's on how to use improved cook stoves.
- IAP is **not** a recognized environmental hazard at policy level in Pakistan. (WHO)





INTRODUCTION





<u>So, what’s the current situation in Pakistan?</u>

- 62% of all households use solid fuels for cooking purpose. (PDHS, 2013).
- Wood users have much higher exposure to carbon monoxide than natural gas users (Siddiqui et al, 2005a).
- Women and children are more exposed to pollutants as opposed to men.
- 90% of rural households and 50% of urban households depend upon biomass and solid fuels for their energy needs (Fatimi, Kadir, Ahmed, & Kazi, 2005)

INTRODUCTION

<u>Why do this research?</u>

- Health budget is less than 2% of GDP.
- Scarce literature.
- Morbidity oriented disease.
- De-forestation rate (-2.1%) is highest amongst the region in Pakistan. (UNFAO).

OBJECTIVE

- Estimate the impact of indoor air pollution from cooking with solid fuels on the prevalence of ARI among children under the age of five.

LITERATURE REVIEW

Zimbabwe	Mishra (2003)	Zimbabwe Demographic and Health Survey (1999)	Type of fuel used mainly for cooking	Multiple Logistic Regression	Children 2x as likely to have ARI in households using solid fuels as compared to households using cleaner fuels.

LITERATURE REVIEW

India	Mishra et al. (2005)	National Family Health Survey (1998-1999)	Type of fuel used mainly for cooking (with ETS)	Multiple Logistic Regression	Male children more likely to have suffered ARI than female children.
Nepal	Acharya et al. (2014)	Nepal Demographic and Health Survey (2011)	Type of fuel mainly used for cooking	Multiple Logistic Regression	4.5% children had symptoms of ARI. Odds ratio of 1.79.

LITERATURE REVIEW

Indonesia	Silwal and Mckay (2015)	Indonesia Family Life Survey (IFLS) – (1997,2000 and 2007) – Panel Data	Peak Expiratory Flow – Direct Exposure Assessment	Two-Stage Least Squares Method	Households cooking with firewood had 9.4% lower lung capacity measurement compared to those cooking with cleaner fuels.

CONTRIBUTION TO LITERATURE

- Kerosene considered a polluting fuel as opposed to a clean fuel (WHO 2016).
- Endogenous nature of type of cooking fuel and averting activities not ignored.
- Estimations take into account the complex multi-stage survey design.
- Adds Pakistan to the list of countries on which ARI studies have already been done, making possible a more cohesive regional analysis.

DATA

- Pakistan Demographic and Health Survey 2012-13 by National Institute of Population Studies.
- Contains data about family planning, mortality, morbidity, fertility preferences, domestic violence, HIV/AIDS, health of children, attitude and behavior of households towards health.
- 96% response rate in the Survey. 11,040 children under the age of five years.
- Survey is nationally representative at provincial and regional level, including Urban-Rural breakdown.
- Two-Stage Stratified Cluster Sampling with weights according to sampling probabilities.
- Cross-Section Data.

THEORETICAL MODEL

- Health production model, initially contributed by Grossman (1972) and later modified by Cropper (1981) and Cropper & Freeman (1991) to include pollution as a function of health.
- Model examines how parental decision making regarding household resource allocation affects children's health.

Dose-Response function of children's health:

$$h=h(c,a)$$

Sick time of the child is shown by:

$$s = s(h, m)$$
$$s = s(c, a, m)$$

Simple utility of parents in a household looks like:

$$u=u(z,l,\mathrm{s})$$

The behavior of the utility function would be as follows:

$\partial u/\partial z$, $\partial u/\partial l>0$ and $\partial u /\partial s<0$

THEORETICAL MODEL

- The parent chooses z, l, a *and* m so as to maximize utility subject to the budget constraint of

$$I + p_w(T - l - t(s)) = z + p_a a + p_m m$$

Where

- I = non-labor income,
- p_w = the wage rate
- T = total time available
- $t(s)$ = the time lost by the parents, which depends on the time of period for which the child is sick
- p_a = price of averting activities
- p_m = price of mitigating activities

Solving the above utility-maximization problem yields the demand function for mitigating activities *(m)* and averting activities *(a)*:

ECONOMETRIC MODEL

- $$H = f\,(C(F)\,,\,A\,,\,X\,,\,\varepsilon)$$

where the response variable is defined as the presence of ARI in child (H = 1, otherwise 0);

C denotes concentration of pollution which is a function of F, which denotes the dummy variable for the type of fuel used;

X represents the set of exogenous variables explaining H;

A denotes averting activities;

ε is the error term which is assumed to independently, identically and normally distributed.

VARIABLES

High Polluting Fuels	Low Polluting Fuels
Wood	Liquefied Petroleum Gas
Coal	Natural Gas
Charcoal	Electricity
Animal Dung	Biogas
Kerosene	
Straw/Shrubs/Grass	

H (Response variable) **1 if child has ARI; 0 otherwise**	
F (Type of fuel) **1 if household uses polluting fuels; 0 otherwise**	
A (Averting activities) **1 if household has a separate kitchen; 0 otherwise**	
X (Control variables)	
Child Characteristics	Current age in months
	Birth order
	Sex of child
	Nutritional status (stunted or not)
Household Characteristics	Household crowding
Mother Characteristics	Education of Mother
	Mother smokes tobacco
	Mother’s age at child birth
Fixed effects	Dummy - 1 for Urban; 0 for Rural
	Primary Sampling Units

ESTIMATION METHOD

- Conditional Likelihood Maximization estimator is used to derive the odd ratios.
- Fixed effects over Primary Sampling Units (PSUs).
- Survey design is accounted for in the estimation by using the ‘**svy**’ prefix in STATA.

HYPOTHESES

- Type of fuel used for cooking does not affect prevalence of ARI in children under five years of age.
- Household characteristics do not affect prevalence of ARI in children under five years of age.
- Child characteristics do not affect prevalence of ARI in children under five years of age.
- Mother’s characteristics do not influence prevalence of ARI in children under five years of age.

DESCRIPTIVE STATISTICS

- Around 22% of the children have symptoms of ARI.
- 68% households consume high polluting fuels and 32% consume low polluting fuels.
- Households consuming polluting fuels have marginally lower ARI prevalence than households consuming low polluting fuels.
- Males having 1.3% more cases of ARI than females.
- Children between 13-24 months of age have highest prevalence of ARI.
- Children belonging to older mothers have 3.3% lower ARI prevalence.
- Educated mothers rely on low polluting fuels for cooking whilst uneducated mothers rely on high polluting fuels.

REGRESSION RESULTS

Characteristics	Odds Ratio
Cooking fuel	
Low polluting	1.00
High polluting	1.47**
Has separate kitchen	
No	1.00
Yes	1.19*
Child's age (months)	
0-12	1.00
13-24	1.09
25-36	0.79**
37-48	0.67***
49-59	0.58***
Sex of child	
Female	1.00
Male	1.10
Birth order	
1	1.00
2	0.92
3	1.13
4+	1.18

Characteristics	Odds Ratio
Household crowding	
No	1.00
Yes	0.93
Mother's education	
Not educated	1.00
Educated	0.88
Mother smokes tobacco	
No	1.00
Yes	1.00
Mother's age at childbirth	
14-24	1.00
25-35	0.82**
36-49	0.67**
Observations	8134
p-value	0.00
F	3.98

REGRESSION RESULTS

- Children belonging to households consuming high polluting fuels are 1.47 times more likely to have ARI than children belonging to households consuming low polluting fuels.
- Having a separate kitchen increases the likelihood of having ARI by 1.19 times.
- Likelihood of ARI decreases monotonically as age of the child increases.
- Children born to mothers between the age group of 25-35 and 36-49 are 28% and 33% less likely to have ARI than children born to mothers between the age group of 14-24 respectively.
- Female children are 1.71 times more likely to have ARI than male children, in households consuming high polluting fuels.

DISCUSSION

- The results match with studies done in Zimbabwe, India and Nepal.
- Children with malnutrition are more than twice as likely to have ARI than children who are not undernourished.
- Indirect exposure assessment can greatly hamper the causality in this study.
- Many households use multiple fuel sources for cooking; the survey only considers a single type of fuel.
- The response variable is measured through mother’s recall memory which is an undiagnosed way of measuring ARI.

CONCLUSION

- Respiratory illnesses like ARI not only reduce the health of a child but also burden the parents in terms of productive time lost and expenses for medical treatment.
- There is some evidence of ARI caused by high polluting fuels, but primary studies and randomized control trials are needed to strengthen the evidence.
- Provision of low polluting fuels such as LPG, natural gas, biogas and electricity can lower indoor air pollution and thus the risk of ARI.

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