

EXPOSURE TO BIOMASS FUEL SMOKE AND RISK OF CHILD MORBIDITY: AN ANALYSIS ON SOUTH AND SOUTHEAST ASIAN COUNTRIES

Household air pollution (HAP) is usually measured indoors and arises from domestic activities of cooking, heating, and lighting. Around 3 billion people still cook using biomass fuels (such as firewood, agricultural wastes, charcoal, coal and cow dung) and kerosene is usually the most common fuel for inefficient stoves. Most of these people using solid fuels are from lower wealth quintiles and resides in low and middle-income countries. These cooking practices are hazardous and produce a wide range of health-damaging pollutants causing high level household air pollution; some small soot particles are produced that penetrate deep into the lungs. Indoor smoke can be 100 times higher than acceptable levels for fine particles in poorly ventilated dwellings. The women and young children who spend most of their time near the domestic hearth are comparatively more exposed to a toxic amount of HAP every day.

Household air pollution (HAP) is a severe health risk factor which is intrinsically linked to poverty. The Global Burden of Disease Study indicated that household air pollution attributed almost 3.5 million deaths worldwide in 2010. The number further increased to 3.8 million caused by the inefficient use of solid fuels and kerosene for cooking in 2015.

Solid fuel can have serious adverse consequences on health as well as on the environment, and also on economic development. Around 1.3 million children face death prematurely each year because of exposure to indoor air pollution from solid fuel concerning health. These fuels produce smoke, often used in an inefficient stove or open fire with incomplete combustion, and results in a huge amount of indoor air pollution when smoke is poorly vented. Biomass fuels (derived from plant sources) or coal combustion results in the release of products of incomplete combustion such as particulate matter (PM) and carbon monoxide. Furthermore, solid fuel is commonly used in homes with poor or absent chimney ventilation of smoke. An estimate given by the International Energy Agency (IEA 2006) indicates that the lack of new policies will increase this figure to 2.7 in 2030 due to population growth.

Data Sources

The data source used was the Demographic and Health Survey (DHS). Recent available Standard DHS-VIII data of selected eight countries of South and Southeast Asia region have been taken. DHS are nationally-representative household surveys that provide data

for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition.

Sample size

The present study considers information from currently married women aged 15-49 years of selected South and Southeast Asian countries using recent DHS data of the respective countries. The Afghanistan data set comprises 1, 25,715 women, Bangladesh 43,772 women, India 13,15,617 women Cambodia 33,290 women, Myanmar 22,989 women; Nepal 26,028 women; Philippines 1,51,703 women; and Timor Leste 28,682 women.

Child morbidity: with reference to available data from different countries on the occurrence of diseases, four categories, i.e., fever, cough, acute respiratory infections (ARI) and diarrhea were taken into consideration to compute child morbidity.

Methodology:

Differences in categorical variables were tested using Pearson's χ^2 (chi-square) statistic, i.e., to understand the association between indoor air Pollution along with other Household amenities and morbidities among children.

Since both treatment and outcome variable in our case are binomial, a simultaneous equation was used, i.e., probit regression in order to take into account the effect of Indoor air Pollution along with other household amenities. In the binary probit model, occurring of the events, here the diseases like fever, diarrhea, ARI and cough was taken as 1, and non-occurrence of the event was taken as 0.

The relationship between specific variables and the outcome probability is interpreted by means of the marginal effect, which accounts for the partial change in the probability. The marginal effect associated with continuous explanatory variables (x) on the probability P ($Y_i = 1 | X$), holding the other variables constant. The marginal effects provide insights into how the explanatory variables shift the probability of risk of morbidities. Using the command "*margins*" is state marginal effects were calculated for each variable while holding other variables constant at their sample mean values.

PREVALENCE OF DISEASE AMONG THE CHILDREN IN THE SELECTED COUNTRIES:

Table 1 shows the patterns of childhood morbidity in selected countries. Three major patterns of childhood morbidity that were experienced in the two weeks preceding

the survey were examined: diarrhea, fever, ARI and cough. These four diseases have been identified as main morbidities among children under age five.

1 Fever:

In Nepal, 4.22 percent of the fever cases in children are from the households dependent on solid fuels. The scenario of Afghanistan depicts a similar picture where children from 7.59 percent of households using solid fuel suffered from fever. Total prevalence of fever is 6.88 percent among children in Bangladesh. In Cambodia, 6.15 % of children suffered from fever where household used solid fuels. Percentage of children suffering from fever at some point in time among the solid fuel users in Myanmar, Philippines, and India is 3.55%, 4.30%, 3.37%, and 2.65% respectively.

2 Diarrhea:

1.49 % of children from solid fuel using household in Nepal suffered Diarrhea; in Afghanistan, it is 7.40 %. In Bangladesh, the total prevalence of children having diarrhea is 1.0 % who belongs to the household using solid fuel for cooking. Cambodia showed 2.84 % of diarrhea cases among children from the solid fuel using household. In Myanmar, the calculated percentage of diarrhea suffering children from solid fuel using houses were as high as 2.42%. Philippines and Timor-Leste and India also showed a very high prevalence of diarrhea among children in the solid fuel using households

3 Acute respiratory infections (ARI):

Indoor air pollution has a significant effect on ARIs; the evidence was found in Nepal where 0.59 % of children having ARIs were from solid fuel. 3.66% of children born in a household using solid-fuel suffered ARI in Afghanistan which is highest in all countries in this study. Bangladesh had 1.01% of children suffering from ARI in the solid-fuel using household. 1.21% of children in Cambodia suffered ARI in the solid-fuel using household. In Myanmar, Philippines, Timor-Leste, and India the percentage of children having ARI are 0.71 %, 0.42 % and 0.47% and 0.58%, respectively.

4 Cough:

The highest prevalence of cough is found in Afghanistan which is around 6 percent while minimum prevalence is seen in India with 2.13 percent. 4.25% of children in Nepal from household using solid fuel had a cough at some point in time. In Afghanistan, 6.32% of children suffered ARI who belonged to the household using solid-fuel. In Bangladesh and Cambodia, the percentage was as high as 5.98% and 4.75% respectively. The percentage of children from solid-fuel using household who had a cough in Myanmar, Philippines and Timor-Leste and India was 3.40%, 5.27% and 3.92 % and 2.24% respectively.

Results of marginal effect from Probit regression analysis:

Fever:

Table 2 shows the result of marginal probabilities from the probit regression of fever with respect to its related covariates. Since the Coefficients of a probit regression model is not directly interpretable, the marginal probabilities are calculated to see the effect of various categories of independent variables on the outcome variable. When we see the probabilities across different countries, the variations can clearly be seen. For the type of fuel used for cooking in the household, non-solid fuel, among 8 selected countries, Afghanistan showed the highest probability of occurrence of fever in non-solid fuel user with a probability value of 0.065 and least probability of occurrence was seen in India (0.024). Among solid-fuel using households' highest probability of occurrence of fever was seen in Afghanistan (0.067) and India occupied the extreme bottom with a probability of 0.026. Even after consuming safe drinking water probability of occurrence of fever was seen to be highest in Afghanistan and Bangladesh with a probability 0.66. In unsafe drinking water, the probability was highest in Bangladesh (0.075), and least probability was seen in India (0.023). Where there was no toilet facility highest probability of occurrence of fever was seen in Afghanistan (0.079). In all the three categories (no toilet, flush toilet, and pit & others) India occupied the bottom with probabilities of occurrence 0.027, 0.024 and 0.024 respectively. The results remain unchanged when interaction effect of fuel use and source of drinking water was seen Afghanistan and Nepal occupied the top position in terms of probabilities of occurrence of fever, and lowest probability was seen in India.

Diarrhea:

In table 3 Afghanistan showed the highest probability of 0.071 for the occurrence of Diarrhea whereas Nepal shows the lowest with a probability of 0.012. Now, when we see the scenario for solid fuel, Afghanistan again topped the list with a probability of 0.072 whereas Bangladesh shows the least (0.008). The Scenario for the people who use safe drinking water, Afghanistan topped the list with the highest probability of getting diarrhea as compared to other 7 counterparts, whereas Bangladesh is the least one. For, unsafe use of drinking water, again Afghanistan topped the list with a probability of 0.072 whereas Nepal stands at the bottom. It can clearly see that the probabilities for all the countries come out to be highly significant. When we see the probabilities of occurrence of diarrhea for no facility of the toilet, again Afghanistan topped the list with a very high probability of 0.088 with is way high as compared to other countries and Bangladesh at the bottom with 0.012. Having with the Flush facility Toilet and for pit and others user, the probability of occurrence of diarrhea in again high in Afghanistan (0.063 & 0.07) and lowest in Bangladesh (.009 & 0.008). People who cook food outside the home, Afghanistan, and Bangladesh are the extremes with a probability of 0.065 and 0.007 respectively, and the same scenario can be seen for the people who cook inside the home. When we compare the probabilities for the different types of wall materials used in the home, for kachcha materials, Afghanistan stays at the top with a probability of 0.069 whereas Bangladesh at the bottom with 0.004 probability. For semi-pucca and pucca also, Afghanistan topped, and Bangladesh remains at the bottom. For kachcha floor material, Afghanistan is having the highest probability followed by Myanmar whereas Nepal is the least. With 0.072 and 0.008 probability, Afghanistan and Bangladesh topped and stayed at the bottom in the list of semi-pucca floor material. Same Probabilities can be seen for pucca floor also. For the scenario of Roof materials for kachcha, semi-pucca and pucca, Afghanistan topped in all three cases, whereas Bangladesh stays at the bottom. For the Education level of mothers, the above scenario can be seen here also. In all 4 sub-categories of education, namely illiterate, primary, secondary and higher, Afghanistan remained with a top probability of occurrence of diarrhea followed by Myanmar whereas Bangladesh is having the smallest chance of diarrhea in the all 8 countries selected for the study. For poor, middle and rich wealth quintile population, Afghanistan

taking the lead with 6.7%, 7.6% and 7.5% respectively den Myanmar, whereas Bangladesh is the least with 1.4%, 0.08%, and 0.05%. When we compare for maternal age at birth, for all the categories Afghanistan is the highest and Bangladesh is the lowest among all countries selected for the study. For Parity also, there is a significantly high probability as compared to other countries in Afghanistan which let them be at the top for chances of diarrhea. For the categories of parity and birth interval, the overall scenario does not change at all when we try to see the interaction effect of fuel and water source on diarrhea, the overall levels of remains as it is just like all other variables. In these selected countries, we can clearly put forward our conclusion that Afghanistan is having the highest chance of getting diarrhea followed by Myanmar most of the times, and Bangladesh is always stayed at the bottom indicating a better scenario that all other countries including India also.

ARI (acute respiratory infections):

Table 4 is showing the result of marginal probabilities from the probit regression of the binary outcome variable ARI (Acute Respiratory Infections) with respect to different correlated covariates. The marginal probabilities are calculated to see the effect of various categories of independent variables on the outcome variable. From the different fuel types used in household, for non-solid fuel users of Afghanistan shows the maximum probability of 0.024 who are susceptible to ARI among selected 8 countries, whereas the Philippines is the least. As far as solid fuel users also, Afghanistan tops the list with 0.03 probability, followed by Cambodia & Myanmar and least is for the Philippines. For different types of sources of water, both for safe and unsafe water users, Afghanistan people are having the highest probability of getting ARI whereas the Philippines is the lowest to the list. As far as the toilet facility, place for cooking foods, Parity are a concern, the same scenario can be seen for both the countries compared to the listed 8 selected south-Asian countries. The scenario for kachcha wall material, Afghanistan is having highest probability whereas India is having the lowest. For semi-pucca and Pucca wall material houses, Afghanistan and the Philippines are the extremes. For any types of roof materials, Afghanistan topped the list whereas India is at the bottom in terms of probability for the occurrence of ARI. When we see in terms of education of the mother, illiterate women of Afghanistan is having highest chances with 0.028 for ARI, whereas India stays in the bottom with probability 0.006. For Primary and secondary educated

women, Afghanistan is the highest, and the Philippines is the lowest. The countries for the highest and the lowest probability of ARI for higher educated women is Afghanistan and Nepal respectively. Any wealth quintiles, Afghanistan is the highest, and the Philippines is the lowest. Afghanistan and Timor-Leste are having the extremes of probabilities for the happening of ARI in terms of maternal age at birth. For birth intervals, having one year of gap & 4 and above, Afghanistan and the Philippines are the extremes; for 2-3 years of gap, Afghanistan and Nepal stays at top and bottom respectively. For, the interaction effect of fuel and sources of drinking water, the probability of occurrence of ARI for Afghanistan people in all 4 categories are the highest.

Cough:

In table 5 result of marginal effect probit regression model on cough are presented, it was observed from the analysis that Nepal showed the highest probability of cough in both non-solid and solid fuel using households with probabilities 0.049 and 0.058 respectively. India continued to remain at the least probability state. Again, Nepal occupied the top position in terms of probability of occurrence of cough in the scenario of safe water sources (0.057) and also in the unsafe water sources with a probability of 0.055. Afghanistan lies in the vicinity of the highest probability values in terms of both fuel use and drinking water sources. When interaction effect of fuel use and source of drinking water was seen the interaction effect of both safe and unsafe drinking with solid fuel showed the highest probability of occurrence of cough in Nepal and least probability was seen in India.

CONCLUSION:

It was seen from the analysis of chapter one that there is a significant effect of household air pollution caused by solid fuel use on occurrence of certain diseases among younger children. The diseases which were seen to get effected by biomass fuel smoke here were fever, cough, acute respiratory infections and diarrhea.

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