

Comparison of Respiratory Symptoms among Under Five Children Living in Households Using Biomass Fuel and Fossil Fuel in An Urban Area of Bangladesh

*Jahan N¹, Shahrin T², Oishee IA³, Tamal SS⁴, Khalequzzaman M⁵

Abstract

A cross-sectional study was conducted at Uttarkhan Thana under Dhaka City Corporation, Bangladesh, between January and December of 2018, to compare respiratory symptoms in under five children living in households using biomass fuels and fossil fuels. The study community comprised of three areas named Vatulia, Munda and Pulartek of Ward No. 4 of Uttarkhan Thana. Total number of households were 1329. Population size in total was 5114, where 2548 were male and 2566 were female. Among them 200 households were chosen by simple random sampling technique – selected households had under five children and met the inclusion criteria (i.e., mother or caregiver of children under five years of age wanted to participate voluntarily). However, we excluded children having congenital anomalies and households using electricity for cooking purpose. A semi-structured questionnaire was used as data collection instrument. Questionnaire included socio-demographic characteristics such as age, sex, educational status, marital status, occupation, number of family members. Cooking related information, e.g., frequency of cooking, duration of cooking, type of fuel used, presence of children during cooking, sleeping in the kitchen and respiratory symptoms in children, e.g., nasal discharge, cough, breathing problems, chest tightness, wheezing, and sore throat were included in the data sheet. Besides, it contained information regarding location of the kitchen, area of the kitchen and presence of any ventilation facility and chimney. Nasal discharge (79.7% vs. 71.6%), cough (69.9% vs. 64.2%), and sore throat (9% vs. 6%) were more common in biomass fuel users' children. In contrast, shortness of breath (22.4% vs. 18.8%) and wheezing (31.3% vs. 24.1%) were more common among fossil fuel users' children. However, none of those differences were statistically significant ($P>0.05$).

CBMJ 2023 July: vol. 12 no. 02 P: 164-170

Keywords: Respiratory symptoms, children, biomass fuel, fossil fuel

Introduction

According to a recent report from the World Health Organization (WHO), indoor air pollution remains a global health burden and it is estimated that near about 3 billion people of the world still depends on solid fuel which include biomass fuels to meet up their daily energy requirements.¹ Another WHO report stated that household air pollution was responsible for an estimated 3.2 million deaths per year in 2020, including over 237,000 deaths of children under the age of 5.² Evidence suggests that 4.3 million deaths occur every year in low- and middle-

1. *Dr. Nusrat Jahan, Research Fellow, International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Mohakhali, Dhaka-1212.
2. Dr. Tunazzina Shahrin, Deputy Manager, Save the Children, Bangladesh Country Office, Gulshan-2, Dhaka-1212.
3. Dr. Irtifa Aziz Oishee, Deputy Manager, Save the Children, Bangladesh Country Office, Gulshan-2, Dhaka-1212.
4. Dr. Syed Shafiq Tamal, Medical Officer, Human Resource Management Department, Directorate General of Health Services (DGHS), Mohakhali, Dhaka-1212.
5. Dr. Md. Khalequzzaman, Associate Professor, Department of Public Health and Informatics, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka- 1000.

Address of Correspondence:

Email: nusratrakhi0@gmail.com

income countries who are affected by indoor air pollution.³ In a developing country like Bangladesh, about one fifth of all deaths of under five children are caused by acute respiratory infection or pneumonia, which is mostly related with household environment.⁴ Children, especially infants are more prone to develop acute lower respiratory tract infections (ALRI), who are exposed to particulate matter less than or equal to 2.5 μ m in diameter.⁵ People daily exposed to toxic substances due to the use of solid fuels which means biomass fuel (derived from plant sources) or combustion of coal and incomplete combustion of these fuel causes release of toxic products such as particulate matter and carbon monoxide.⁶ Fossil fuel (e.g., coal, oil, gasoline, diesel and natural gas) combustion is also responsible for environmental pollution and climate change which led to many developmental impairments as well as disproportionate burden of disease to the poor and children.^{6,7}

Urbanization process is a global trend now and Bangladesh is already in the urbanization process.⁸ For cooking purpose, different types of fuels are used in the poor urban areas such as, liquid gas or natural gas (62.5%), wood (31.1%), rice husk, dung cake (2.3%), kerosene (1.8%).⁸ In such areas, household air pollution is more due to cooking in poorly ventilated settings, generating hazardous levels of air pollutants which affect people's health especially of young children.³ To our concern, only few studies were done about respiratory symptoms in children and fuel choice in Bangladesh. Thus, there is limited data about respiratory symptoms in children and use of different fuels in households in urban areas as well as household air pollution (HAP) of the country. Therefore, we proposed this study to compare respiratory symptoms in under five

children in households using biomass fuel and fossil fuel in an urban area in Dhaka, Bangladesh.

Methods

This cross-sectional study was conducted at Uttarkhan Thana under Dhaka City Corporation, Bangladesh, between January and December of 2018. The study community comprised of three areas named Vatulia, Munda and Pulartek of Ward No. 4 of Uttarkhan Thana. Total number of households were 1329. Population size in total was 5114, where 2548 were male and 2566 were female.

A previously constructed sampling frame was used to select the sample observation from these areas. We took it as baseline ID. Among them, 200 households were chosen by simple random sampling technique. The first household was selected randomly from the baseline ID. Then every alternate household was explored. If that household had under five children and met the inclusion criteria (i.e., mother or caregiver of children under five years of age wanted to participate voluntarily), we took her/him as respondent in the study. However, we excluded children having congenital anomalies and households using electricity for cooking purpose. Thus, a total of 200 respondents were finally selected for this study. A semi-structured questionnaire was used as data collection instrument. Questionnaire included socio-demographic characteristics such as age, sex, educational status, marital status, occupation, number of family members. Cooking related information like frequency of cooking, duration of cooking, type of fuel used etc. and respiratory symptoms in children such as, nasal discharge, cough, breathing problems, chest tightness,

wheezing, sore throat pain were included in the questionnaire. It also contained information regarding the location of kitchen, area of the kitchen, presence of ventilation facility and chimney. Questionnaire was formatted in both Bangla and English languages. However, in the field site, we used Bangla version for data collection. Biomass fuels included paddy husk, bran, straw, jute sticks, bagasse, firewood, twigs, leaves, bark, roots, woody debris and cow dung, while fossil fuels included natural gas, LP gas, and kerosene.

The socio-demographic variables were analyzed by using descriptive analysis. Categorical variables were expressed as frequency and percentage, while were expressed as mean±SD. The relationship of respiratory symptoms in children and fuel use in the households was determined by using Pearson chi-square test. The level of significance was at 95% confidence interval and a P value <0.05 was considered as significant.

The study was approved by the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh (BSMMU/2018/10699).

Results

A total of 200 respondents participated in this study. Table-I shows different socio-demographic characteristics of the respondents. Majority of the respondents' age were between 18-39 years both in biomass fuel users (89.5%) and fossil fuel users (95.5%). In biomass fuel users, 94% respondents were female and in fossil fuel it was 95.5%. About 69.2% respondents of biomass fuel users had completed secondary school where 88.1% fossil fuel user had completed their secondary school. Regarding respondents'

occupation, most of them were homemaker both in biomass fuel user (85.7%) and fossil fuel user (89.5%). The mean number of family members were 5.1±1.8 and 4.7±1.5 among biomass fuel user and fossil fuel user respectively. Table-II shows kitchen related information of the respondents. Biomass fuel users' respondent's kitchen volume (0.014±0.01) was less than fossil fuel users (0.019±0.01). Chimney was absent in all the kitchens. Ventilation between wall and roof was more in biomass fuel users' (82.7%) kitchen than fossil fuel users' (79.1%).

Table-III shows cooking related information of the respondents. About 70.0% respondents of biomass fuel users cooked twice a day, whereas 68.7% fossil fuel user respondents coked twice a day. Mean duration of cooking hour was 3.0±0.9 and 3.2±1.0 hour for biomass and fossil fuel user, respectively. In biomass fuel user, 2.3% of respondents sleeping in the cooking room and it was 14.9% in fossil fuel user. Majority of the respondents of biomass fuel user took their children in the kitchen during cooking (73.7%), whereas 65.7% respondents of fossil fuel users took their children in the kitchen during cooking.

Table-IV shows the respiratory symptoms of children in last thirty days. No significant association was observed between respiratory symptoms and using different fuel ($P>0.05$); however, nasal discharge was more common in biomass fuel users' children (79.7%) than fossil fuel users' children (71.6%). Shortness of breath was more in fossil fuel users' children (22.4%). Cough was prominent in biomass fuel users' children (69.9%) than fossil fuel users' children (64.2%). Wheezing was more in fossil fuel users' children (31.3%) than biomass fuel users'

children (24.1%). Sore throat was higher in biomass fuel (9%) than fossil fuel (6%) users' children.

Table-I: Socio-demographic characteristics of the respondents (N=200)

Characteristics	Biomass fuel n (%)	Fossil fuel n (%)
Age (in years)		
18-39	119 (89.5)	64 (95.5)
40-64	14 (10.5)	3 (4.5)
Sex		
Male	08 (6.0)	03 (4.5)
Female	125 (94%)	64 (95.5)
Education		
No formal education	18 (13.5)	1 (1.5)
Primary completed	23 (17.3)	7 (10.4)
Secondary and above	92 (69.2)	59 (88.1)
Marital status		
Married	128 (96.2)	67 (100)
Other	5 (3.8)	00 (0.0)
Occupation		
Home maker	114 (85.7)	60 (89.5)
Employed	10 (7.5)	6 (9.0)
Labor	9 (6.8)	1 (1.5)
Household information		
Numbers of family members per room (mean±SD)	5.1±1.8	4.7±1.5

Table-II: Kitchen related information of the respondents (N=200)

Characteristics	Biomass fuel n (%)	Fossil fuel n (%)
Kitchen volume (m³, mean±SD)	0.014±0.01	0.019±0.01
Presence of chimney		
Yes	-	-
No	133 (100)	67 (100)
Presence of ventilation between wall and roof		
Yes	110 (82.7)	53 (79.1)
No	23 (17.3)	14 (20.9)

Table-III: Cooking related information among respondents (N=200)

Factors	Biomass fuel	Fossil fuel
	n (%)	n (%)
Frequency of cooking		
Once	26 (19.5)	8 (11.9)
Twice	93 (69.9)	46 (68.7)
Thrice	14 (10.5)	13 (19.4)
Duration of cooking (hours/day, mean±SD)	3.0±0.9	3.2±1
Sleeping in the cooking room		
Yes	3 (2.3)	10 (14.9)
No	130 (97.7)	57 (85.1)
Children stay beside their mother during cooking		
Yes	98 (73.7)	44 (65.7)
No	35 (26.3)	23 (34.3)

Table-IV: Respiratory symptoms among the children

Symptoms in children	Biomass fuel n (%)	Fossil fuel n (%)	P value
Nasal discharge			
Yes	106 (79.7)	48(71.6)	0.201
No	27 (20.3)	19(28.4)	
Cough			
Yes	89 (69.9)	43(64.2)	0.700
No	44 (33.1)	24(35.8)	
Shortness of breath			
Yes	25 (18.8)	15(22.4)	0.549
No	108 (81.2)	52(77.6)	
Wheezing or whistling chest			
Yes	32 (24.1)	21(31.3)	0.271
No	101 (75.9)	46(68.7)	
Sore throat			
Yes	12 (9.0)	4(6.0)	0.453
No	121 (91.0)	63(94.0)	

Discussion

In the present study, household air pollution (HAP) and its health impacts in under five children was observed by comparing between using fossil fuels and biomass fuels for cooking. It was observed that children under five years old of fossil fuel user had higher morbidities. In our study, respiratory symptoms like nasal discharge, cough, chest tightness, throat pain in children of biomass fuel user were 79.7%, 69.9%, 5.3% and 9.0%, respectively which were higher than fossil fuel users' children. Similar findings were also observed in study done in Western Sierra Leone, which reported that 63.5% of children had higher prevalence of acute respiratory infection living in a home using biomass fuel for cooking purpose.⁹ Another study conducted in Nepal reported that about 85.6% of population who used biomass fuel for cooking purpose had higher prevalence of all respiratory symptoms.¹⁰ An earlier study conducted in our country also found that 89% children had nasal discharge, 69% had cough, 34% had chest tightness, 5% had throat pain who lived in households where biomass fuel was used for cooking purpose.¹¹ A recent study done in Pakistan reported that children belonging to households using biomass fuels are around 1.5 times more likely to have ARI symptoms as compared to households using fossil fuels.¹² Another population based survey conducted in Nepal showed that children under five years old from the families used biomass fuel were more likely to had symptoms of ARI (4.9%) compared to their counterparts who used fossil fuel (3.4%).¹³ That higher prevalence of respiratory symptoms in children of biomass fuel users might be due to the higher level of pollutants emitted by burning of biomass fuel which is relatively higher than burning of fossil fuel.^{3,14} A study conducted

in the Philippines reported that the incidence of severe coughing with difficulty in breathing is lower by 2.4 times for young children in households that use LPG, natural gas than for young children in households that use biomass fuel.¹⁵

Regarding adequate ventilation, a study conducted in Rwanda found that children under five residing in households that avail indoor cooking were more likely to have symptoms of respiratory infection with cough and breathing difficulty in comparison to their counterpart living in households with ventilation holes in the cooking area.¹⁶ A recent study done in Bangladesh reported a higher prevalence of shortness of breathing (22.4% vs. 18.8%) and wheezing or whistling chest (31.3% vs. 24.1%) while comparing between children of fossil fuel users and biomass fuel users respectively.¹⁷ Similar findings were reported in another study where shortness of breath was found relatively higher in children of fossil fuel users than children of biomass fuel user (26% vs. 24%) in the summer season in Bangladesh.¹⁴ Another study observed the association between indoor air pollution, fuel choice and health effects in Bangladesh and found that indoor air pollution and use of biomass fuel were important risk factor for developing acute respiratory tract infection among the children i.e., 1.18 times and 1.19 times higher respectively.¹⁸ Ventilation in the houses causes rapid change to air quality from very dirty to reasonably clean which may be an explanation of difference between fuel choice and respiratory symptoms.^{19,20} Similar observations were reported in another study done in Bangladesh among women involved in cooking. Moreover, it is evident that populations in low- and middle-income countries (LMICs),

e.g., Bangladesh, often face multiple barriers to adoption of HAP interventions, including accessibility, affordability, lack of sustainable infrastructure and interventions not meeting cultural and social preferences.³

However, before generalizing the result, some limitations should be considered. Firstly, we could not measure the pollutant level due to budget constraint. Secondly, personal exposure of children was not determined. Thirdly, nutritional status of the children was not measured which might be an important confounder for the respiratory symptoms. Fourthly, there was a chance of recall bias and information bias during interviewing the respondents. Finally, we conducted this study with a small sample population in one urban area due to time and budget constraints.

Conclusion

Our data suggest that among under five children, various respiratory symptoms are very common in a densely populated urban area of Bangladesh. Nasal discharge, cough and sore throat are more common in biomass fuel users' children, while shortness of breath and wheezing are more common among fossil fuel users' children. Hence, interventions are needed to reduce the health consequences associated with household air pollution, which disproportionately affect young children. We recommend further studies with larger samples and in multiple sites to get clearer picture of the country.

References

1. World Health Organization (WHO). *WHO guidelines for indoor air quality: household fuel combustion*. Geneva, Switzerland: WHO; 2014.
2. World Health Organization (WHO). *Household air pollution. Key facts*. (November 28, 2022). Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health> (Accessed December 16, 2022).
3. Woolley KE, Dickinson-Craig E, Lawson HL, Sheikh J, Day R, Pope FD, et al. Effectiveness of interventions to reduce household air pollution from solid biomass fuels and improve maternal and child health outcomes in low- and middle-income countries: A systematic review and meta-analysis. *Indoor Air*. 2022;32(1):e12958.
4. National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. *Bangladesh Demographic and Health Survey 2011*. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2013.
5. Gurley ES, Salje H, Homaira N, Ram PK, Haque R, Petri WA Jr, et al. Seasonal concentrations and determinants of indoor particulate matter in a low-income community in Dhaka, Bangladesh. *Environ Res*. 2013;121:11-6.
6. Gordon SB, Bruce NG, Grigg J, Hibberd PL, Kurmi OP, Lam KB, et al. Respiratory risks from household air pollution in low and middle income countries. *Lancet Respir Med*. 2014;2(10):823-60.
7. Kuhn R, Rothman DS, Turner S, Solórzano J, Hughes B. Beyond attributable burden: Estimating the avoidable burden of disease associated with household air pollution. *PLoS One*. 2016;11(3):e0149669.
8. National Institute of Population Research and Training (NIPORT), International Centre for Diarrhoeal Disease Research, Bangladesh

- (icddr,b), MEASURE Evaluation, University of North Carolina at Chapel Hill, USA. Bangladesh Urban Health Survey 2013 Final Report. Dhaka, Bangladesh and Chapel Hill, North Carolina, USA: NIPORT, icddr,b, MEASURE Evaluation; 2015.
9. Taylor ET, Nakai S. Prevalence of acute respiratory infections in women and children in Western Sierra Leone due to smoke from wood and charcoal stoves. *Int J Environ Res Public Health*. 2012;9(6):2252-65.
 10. Shrestha IL, Shrestha SL. Indoor air pollution from biomass fuels and respiratory health of the exposed population in Nepalese households. *Int J Occup Environ Health*. 2005;11(2):150-60.
 11. Khalequzzaman M, Kamijima M, Sakai K, Chowdhury NA, Hamajima N, Nakajima T. Indoor air pollution and its impact on children under five years old in Bangladesh. *Indoor Air*. 2007;17(4):297-304.
 12. Khan MSB, Lohano HD. Household air pollution from cooking fuel and respiratory health risks for children in Pakistan. *Environ Sci Pollut Res Int*. 2018;25(25):24778-86.
 13. Acharya P, Mishra SR, Berg-Beckhoff G. Solid fuel in kitchen and acute respiratory tract infection among under five children: evidence from Nepal demographic and health survey 2011. *J Community Health*. 2015;40(3):515-21.
 14. Khalequzzaman M, Kamijima M, Sakai K, Hoque BA, Nakajima T. Indoor air pollution and the health of children in biomass- and fossil-fuel users of Bangladesh: Situation in two different seasons. *Environ Health Prev Med*. 2010;15(4):236-43.
 15. Capuno JJ, Tan CAR Jr, Javier X. Cooking and coughing: Estimating the effects of clean fuel for cooking on the respiratory health of children in the Philippines. *Glob Public Health*. 2018;13(1):20-34.
 16. Das I, Pedit J, Handa S, Jagger P. Household air pollution (HAP), microenvironment and child health: Strategies for mitigating HAP exposure in urban Rwanda. *Environ Res Lett*. 2018;13(4):045011.
 17. Hasan M, Tasfina S, Haque SMR, Saif-Ur-Rahman KM, Khalequzzaman M, Bari W, et al. Association of biomass fuel smoke with respiratory symptoms among children under 5 years of age in urban areas: results from Bangladesh Urban Health Survey, 2013. *Environ Health Prev Med*. 2019;24(1):65.
 18. Khan MN, Nurs CZB, Islam MM, Islam MR, Rahman MM. Household air pollution from cooking and risk of adverse health and birth outcomes in Bangladesh: a nationwide population-based study. *Environ Health*. 2017;16(1):57.
 19. Dasgupta S, Huq M, Khaliquzzaman M, Pandey K, Wheeler D. Who suffers from indoor air pollution? Evidence from Bangladesh. *Health Policy Plan*. 2006;21(6):444-58.
 20. Alim MA, Nurunnabi ASM, Ahmad S, Khan MA, Ahmad SA. Study on respiratory problems and respiratory function amongst females exposed to biomass fuel and gas/ electricity fuel in a district of Bangladesh. *Community Based Med J*. 2014;3(1):8-12.