Journal of Air Pollution and Health (Autumn 2022); 7(4): 399-408

Original Article

Available online at http://japh.tums.ac.ir

Association between household air pollution and pneumonia among children under five years old admitted at the Indira Gandhi children's hospital in Kabul, Afghanistan

*Helah Safi, Padma Venkat, Muthuperumal Prakash**

Department of Epidemiology and Biostatistics, School of Public Health, SRM Institute of Science and Technology, Chennai, Tamilnadu, India

ARTICLE INFORMATION

Article Chronology:
Receive 09 April 2022
Revised 22 November 2022
Accepted 02 December 2022
Published 30 December 2022

Keywords:
Household air pollution; Pneumonia; Under-five mortality

CORRESPONDING AUTHOR:

prakashm6@srmist.edu.in
Tel: (044) 2745 3433
Fax: (044) 2745 3433

ABSTRACT

Introduction: Pneumonia is the single largest cause of death of children under the age of five (U5) globally, and nearly half of these (0.6 million/year) occur because of Household Air Pollution (HAP). Combustion of wood and fossil fuels, inefficient stoves, and poor ventilation exacerbate HAP. Almost one in five deaths among U5 children in Afghanistan is due to pneumonia. The current case-control study is to find the association between pneumonia admissions of U5 children at the Children's Hospital and HAP in Afghanistan.

Materials and methods: A hospital-based case-control study was done with caregivers of 70 confirmed pneumonia cases and 127 patients of control group from other departments in the hospital who were interviewed through a structured questionnaire.

Results: Cases and controls were found to be same on all demographic characteristics except number of children under 1 year of age. Chi-square analysis showed that those without ventilation systems in the house to remove smoke (p=0.036) and those using traditional stoves (p=0.002) were more likely to be higher among patients with pneumonia than control group. There was also a close association between U5 pneumonia and the use of room fresheners at home (p=0.027) and smoke from room heaters (0.002). Household air pollution showed a significant association with pneumonia (p=0.000).

Conclusion: The incidence of respiratory diseases is higher among children and women in the family who are more likely to be exposed to HAP. Household air pollution is related to pneumonia in U5 children in Afghanistan. Creating awareness among the caregivers about the factors contributing to pneumonia and providing alternatives can help reduce the mortality of children.

Introduction

Pneumonia is the single leading cause of death among children under the age of five (U5). Every 39 sec a U5 child dies of pneumonia worldwide. In spite of the exceptional decrease

Please cite this article as: Safi H, Venkat P, Prakash M. Association between household air pollution and pneumonia among children under five years old admitted at the Indira Gandhi children's hospital in Kabul, Afghanistan. Journal of Air Pollution and Health. 2022;7(4): 399-408.

of 51% pneumonia deaths between (2000 to 2018) from 1755000 to 802000 deaths, there is a long way to go to reduce the preventable and treatable deaths due to U5 pneumonia. Afghanistan is one among the top 5 countries with the highest level of childhood deaths from pneumonia, still there is a lack of research studies about the risk factors of pneumonia [1]. Despite some improvement, Afghanistan still has a substantial burden of pneumonia-causing 17% of U5 mortality [2].

The most common cause of U5 children pneumonia infection is Streptococcus pneumoniae, an opportunistic pathogen that takes advantage of crowded and polluted living environments and compromised immunity in vulnerable populations [3]. There are many preventable risk factors for pneumonia, Poverty-associated determinants including undernutrition, lack of safe water, Household Air Pollution (HAP), and not having access to proper health facilities are strongly associated with U5 children mortality due to pneumonia[4]. Risk of children contracting pneumonia in households using polluting fuels was double that of children from households using clean fuels in Nepal [5] . sources that generate HAP differ from place to place, like cooking associated household air pollution, smoking, temperature control devices, insecticides, fragrances, deodorants, cleaning agents, construction elements, etc., with inadequate ventilation adding to the problem [6]. With widespread use of solid fuels around the world, low-income countries were burdened with high rates of pneumonia [7]. Across the world, close to 3 billion people use low-efficiency stoves and open fires fueled by wood, animal dung, and coal for cooking which contributes to HAP. Pollution caused by insufficient fuel burning in inefficient stoves for cooking, space heating, and lighting has a direct health impact [8].

Globally, ~4 million people die every year due to diseases related to HAP. Exposure to HAP multiples the chance of U5 children contracting pneumonia, and 45% of all pneumonia mortality among U5 children is due to HAP [8]. U5 children are susceptible to the toxic effects of pollution and are exposed to the highest concentration in their home environments [9]

Afghanistan is one of the countries with the most polluted cities like Kabul, but no epidemiological studies have been done on the impact of pollution on public health, there are news articles about air pollution in Kabul and its impact on people's lives, May-June 2005 A public opinion survey conducted showed that 46% of people in Kabul stated they had breathing problems, others reported skin problems and as well as irritation of the eyes, nose, and throat [10]

Most studies around the world have focused on the impact of HAP on respiratory tract infections than on pneumonia per se. There is hardly any research study published in Afghanistan on HAP and pneumonia in U5 children. The study some researchers, highlighted that there was a strong association between U5 children's pneumonia in Ethiopia and the lack of awareness among the parents about HAP and how to control them [11]. This study was undertaken to determine the influence of HAP factors on U5 children's pneumonia in Afghanistan.

Materials and methods

Study design

A comparative case-control study was employed to investigate the association between HAP and pneumonia among U5 children in Indira Gandhi Children's Hospital (IGCH), Kabul, Afghanistan.

Setting

The study was carried out among U5 children

admitted to Indira Gandhi Children's hospital (IGCH, Sehat Tafel) in Kabul city, Afghanistan. IGCH, established in 1966 with the assistance of Indian Government, is the central designated hospital and the biggest children's hospital in Kabul. The hospital has around 350 functioning beds for patients. Majority of the patient admissions are for acute respiratory infections and diarrhea. Other areas of visits and admissions are for accidents, orthopedics, malnutrition, skin ailments, musculoskeletal conditions etc. IGCH is one of the most reputed children's hospitals in Afghanistan and patients come from all corners of the country, to seek treatment at the hospital for the children.

Participants

The study population comprised of U5 children admitted to IGCH between June and July 2019. The caregivers were interviewed through a well-structured questionnaire for demographic information, house hold details, cooking, temperature control, smoking, and chemicals-related risk factors. The questionnaire was validated with 10% of the sample. The questionnaire, had good internal consistency reliability (Cronbach $\alpha = 0.83$). The education group demonstrated significantly ($P<0.001$) higher mean percentage of correct answers compared with the no education group.

Eligibility criteria for case group

All U5 Children (0-5 years) who were admitted to the hospital due to pneumonia during the study period were included as cases and Children above the age of five admitted to the hospital without pneumonia were excluded from the case group.

Eligibility criteria for the control group

U5 children who were admitted to the hospital due to fractures, road accidents, musculoskeletal, burns, general surgery, and other injuries were included and children above the age of five admitted to the hospital with any respiratory diseases, ENT (Ear, Nose, and Throat) problems, children with cough, wheeze, and fever sweating, nausea, vomiting or diarrhea and who were ready to provide consent to participate in the study by the caregiver were excluded from the control group.

Sample size

Since there were no specific studies on household air pollution and pneumonia in children under five years of age in Afghanistan, the odds ratio of (2.7) from the meta-analysis and systematic reviews of other studies was used for calculating the sample size [12]

Accordingly, after considering 10% of non-responses rate, the final sample size of 63 cases and 126 controls was arrived.

The average number of all U5 children admitted to IGCH in 2018 was 2,310. Based on the mentioned control selection criteria, 127 controls were randomly selected from different wards during the study. Fractures, burns, road accidents, musculoskeletal, general surgery, and other injuries until we cover the number of controls required.

Data Sources

The primary data of this study comes from face-to-face interviews with caregivers (parents/ guardians) of U5 children.

Ethical approvals

Before conducting the study, approvals were obtained from the Institutional Review Board of the School of Public Health, SRM Institute of Science and Technology, the Ministry of Public Health of the Islamic Republic of Afghanistan and the Public Health Research and Clinical Research Bureau, Afghanistan.

Verbal informed consent was obtained from the care givers of the children, before starting the interview.

Statistical method and data processing

All data were checked, coded, and entered in software for analysis (SPSS version 22). The association between HAP and U5 pneumonia was investigated using Chi-Square analysis. $P < 0.05$ was considered statistically significant with 95% of confidence interval. A e chi squared analysis of pneumonia was done with multiple factors like the number of people in the home, the number of rooms in the household, separate kitchen, parents' occupation, literacy levels of parents, Household characteristics and source of smoke from household.

Results and discussion

The study included a total of 197 participants, including all pneumonia cases (n=70) admitted to IGCH during the study period and 127 non-pneumonia cases as the control group. The control group included 66 burn patients, 19 fracture patients, 18 general surgical operations, 17 musculoskeletal patients, 3 road traffic accidents, and 4 other injuries

Socio-demographic characteristics: The average age of children participating in the study was 22 months of which 78% of controls and 22% of cases were less than 12 months. Of all U5 children included in the study, 44.3% of cases and 44.9% of controls were female. In this study, 60% of the cases and 78.7% of the controls had 1-4 rooms in the house without a kitchen, the average number of rooms per family was 3, and average size of the family was found to be 12 people. [Table 1].

Almost 71% of the mothers in the case group and 66.9% of the control mothers and 51.4% of the fathers in the case group and 42.5% in the control group were uneducated. 11.4% of cases and 9.4% of control fathers completed university studies, respectively.

In both the group most mothers were housewives 98.6% and 98.4%. Regarding the fathers in this study, 34.3% of cases and 38.6% of control were self-employed, with their own small businesses and shops. Almost 41.4% of fathers in this group were workers; most of them were engaged in the construction industry, plumbers, and farmers. While about 11.80% of the fathers in the control group were unemployed. Most of them live in a joint-family, and other family members are responsible for their main needs. Both cases and control group were found similar with respect to many demographic variables using Z proportion test.

Almost cases and control group are same with basic demographic characteristics except the age of the children, as the percentage of children less than a year is higher among cases than control group.

Most cases (92.9%) and control (97.6%) were living in a yard (a small, often walled and paved area, open to the sky and adjacent to buildings) and 67.1% of cases and 78.0% of control were living in houses made up of mudbrick. Around 68.6% of cases and 70.9% of control house floors were made of Mud. Almost 92.2% of cases and 95.3% of control had toilets in their house. Around 65.7% of cases and 59.8% of control had a separate kitchen in the house from which 41.4% in cases and 33.1% in control were adjacent to the living room. 55.7% of kitchens in the case group and 44.9% in the control group had a kitchen window. In winter, almost 85% of the rooms in both cases and controls were ventilated daily as shown in [Table 2].

Table 1. Socio-demographic characteristics of the respondents

Characteristics	Case (n=70) %	Control (n=127) %
Child age <12 months	15 (21.4)	99 (78.0)
Female child	31 (44.3)	57 (44.9)
Less than 4 rooms (except Kitchen)	42 (60.0)	100 (78.7)
Illiterate mothers	50 (71.4)	85 (66.9)
Illiterate father	36 (51.4)	54 (42.5)
Housewife mother	69 (98.6)	125 (98.4)
Self-employed (father)	24 (34.3)	49 (38.6)
White collar job (father)	9 (12.9)	15 (11.8)

Table 2. Housing and Environmental characteristics of respondents with child U5

Characteristics	Case (n=70) %	Control (n=127) %
Type of the house (Yard)	65 (92.9)	124 (97.6)
Composition of the house (Mudbrick)	47 (67.1)	99 (78.0)
Road near to house	41 (58.6)	59 (46.5)
Type of Road near the house (Cement)	24 (34.3)	36 (28.3)
Toilet in the house	65 (92.2)	121 (95.3)
Pit latrines	52 (74.3)	103 (81.1)
Type of floor (Mud)	48 (68.6)	90 (70.9)
No separate kitchen in house	24 (34.3)	51 (40.2)
Kitchen adjacent to Living room	29 (41.4)	42 (33.1)
Kitchen without a Window	7 (10.0)	19 (15.0)
Rooms without Window	5 (7.1)	9 (7.1)
Traditional open fire for cooking	27 (38.6)	54 (42.5)

Association between the risk factors and pneumonia were analyzed using chi squared analysis. The current study found an association between the traditional room heaters using charcoal and pneumonia in U5 children. The living environment of children, using wood for cooking stove, wood as the main heating sources, coal, animal dung, and biomass are more prone to pneumonia (p=0.002). In U5 children, pneumonia was also influenced by the number of rooms in the household.

In U5 children, the use of room air freshener also showed an association with pneumonia, with a p-value of 0.027. However, the current study did not find any evidence to prove the correlation between passive cigarette smoke and pneumonia in U5 children (p=0.157). [Table 3].

Table 3. Association between household air pollution with pneumonia among children under-five

Source of Smoke from household	P-value	df
Cooking smoke	0.058	3
Smoke from room heaters	0.002	1
Cigarette smoke	0.157	1
Using regular air freshener	0.027	1
Ventilation system to remove smoke in the house	0.036	1
Traditional open fire for room heater	0.002	1
Separate kitchen in house	0.256	1
Household air pollution (using traditional open fire for room, water & household heating, and Tandoor room heating)	0.000	3

Table 4. Association between household characteristics with pneumonia among children under-five

Characteristics	X^2(P value)	df
Type of the house (Yard)	2.6472 (0.103)	1
Composition of the House (Mudbrick)	2.7485 (0.097)	1
Road Near to House	2.6499 (0.103)	1
Type of Road near the house (Cement)	0.7516 (0.385)	1
Toilet in the house	0.5007 (0.479)	1
Pit latrines	1.2501(0.26354)	1
Type of floor (Mud)	0.1133(0.736)	1
No Separate Kitchen in House	0.6599 (0.416)	1
Kitchen Adjacent to Living room	1.3675 (0.2422)	1
Kitchen without a Window	0.9693 (0.324)	1
Rooms without Window	0.0002(0.988)	1
Traditional open fire for cooking	0.2906 (.589)	1

None of the household characteristics shows significant relationship with pneumonia among under 5 children [Table 4].

The purpose of this study was to find out the association between HAP indicators and U5 pneumonia, including cooking stoves, room heaters, smoking, perfume, cleaning agents, and deodorants. The findings indicate a statistically significant association between traditional stoves used to heat the houses and U5 children's pneumonia.

The findings of the current study are consistent with the study conducted by researchers, which reported that most people in South Asian countries use solid fuel for heating and cooking. Pollution caused using solid fuel is one of the strongest risk factors for pneumonia and acute respiratory infections [13]. Similarly, a cross-sectional study based on de-identified data from Afghanistan's first standardized Demographic and Health Survey (DHS) in 2015 conducted by other researchers which reported 70.2% of households in Afghanistan used solid fuels and had a prevalence of acute respiratory infections of 6%. The prevalence of acute respiratory infection was higher in households using solid fuels ((adjusted prevalence rate (aPR) = 1.10; 95% CI: (0.98, 1.23)) [14]

Contrary to the findings of the study, environmental tobacco smoking exposure was associated with an increased risk of hospital admissions for pneumonia in U5 children in Vietnam [15]. A case-control study on the exposure to second-hand smoke and burden of the lower respiratory health among Thai children found that that number of smoke per day were significantly high among cases and they were more exposed to second-hand smoke in the household [16]. Whereas the current study did not find a significant association between cigarette smoke and pneumonia.

The current study found an association between

U5 children's pneumonia and cooking smoke. Most people in the study used wood, animal waste, coal, and biomass as heating and cooking sources. This result is similar to a meta-analysis of indoor air pollution and respiratory health in children in developing countries. The study reported that the main reason for HAP is the solid fuel used for cooking and heating. The probability of pneumonia is three times higher among those who are exposed to the smoke [13]. The results a study confirm this, which indicates that cooking with unprocessed solid fuel is one of the most important variables found to be associated with pneumonia in children [17].

The higher number of people living in the household are more likely to be associated with pneumonia in under-five children, supporting this, a study reported that children live in a crowded household were 60 % more likely get pneumonia [18]. Crowded spaces without proper ventilation systems contribute to pneumococcal disease [19]. Similarly, a community-based cross-sectional study reported that household air pollution and crowded spaces are some risk factors for pneumonia. Overcrowding and insufficient ventilation paved the way for various viruses and bacteria that cause pneumonia [20].

Using air fresheners, cleaning agents and spray is one of the causes of HAP [21]. Air fresheners may be one of many sources that release volatile organic compounds into indoor environments. Usually used in the home; air fresheners had a huge impact on the respiratory system and lung function [22].

Cleaner cooking fuels and non-emission stoves will decrease the impact of HAP on individuals in the family [23]. Handling HAP requires a multi-sectoral approach and is a priority to achieve the Sustainable Development Goals (SDGs) [24]. This study clearly helps people to understand that HAP is related to pneumonia in children U5, but the results are not consistent with prior findings on all HAP indicators, which may be due to the small sample size.

Conclusion

HAP is one of the major risks for mortality and morbidity due to respiratory diseases worldwide, especially in developing countries. In most cases, children and women in the family are more likely to be exposed to HAP, among whom the incidence of respiratory diseases is higher. Since Afghanistan is one of the developing countries, and recently Kabul has become one of the most polluted cities in the world [25], the mortality rate of children under five due to pneumonia is higher. This study finds that crowded families and lack of modern facilities for cooking and heating are significant risk factors for U5 children's pneumonia. Despite these results, more research is still needed to find this association and suggest a better way to reduce HAP exposure. The study was conducted in short time frame and the sample was not selected at randomly because the study was done in the summer season where case load is less. This study can be further expanded by taking random sample from community rather than a single hospital.

Financial supports

No external funding was received or used for this research study.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Helah Safi (HS) contributed significantly from conceptualization to writing first draft, except validation of the questionnaire and PV contributed for conceptualization, supervision and final review , PM contributes for Conceptualization , validation , analysis and finalizing the draft manuscript.

Acknowledgements

Mohanasundari, David Gift, Mais, Thennavan,

Silvy, Dean and faculty of School of Public Health, SRM Institute of Science and Technology. We would also like to thank all the participants who volunteered in our study.

References

1. Zabihullah R, Dhoubhadel BG, Rauf FA, Shafiq SA, Suzuki M, Watanabe K, Yoshida LM, Yasunami M, Zabihullah S, Parry CM, Mirwais R. Risk for death among children with pneumonia, Afghanistan. Emerging infectious diseases. 2017 Aug;23(8):1404.

2. Pneumonia in Children Statistics [Internet]. UNICEF DATA. [cited 2022 Aug 28]. Available from:https://data.unicef.org/topic/child-health/pneumonia/

3. Gilani Z, Kwong YD, Levine OS, Deloria-Knoll M, Scott JAG, O'Brien KL, et al. A Literature Review and Survey of Childhood Pneumonia Etiology Studies: 2000–2010. Clin Infect Dis. 2012 Apr 1;54(suppl_2):S102–8.

4. Causes of Pneumonia | CDC [Internet]. 2021 [cited 2022 Aug 28]. Available from: https://www.cdc.gov/pneumonia/causes.html

5. Budhathoki SS, Tinkari BS, Bhandari A, Dhimal M, Zhou H, Ghimire A, et al. The Association of Childhood Pneumonia with Household Air Pollution in Nepal: Evidence from Nepal Demographic Health Surveys. Matern Child Health J. 2020 Feb;24(Suppl 1):48–56.

6. Apte K, Salvi S. Household air pollution and its effects on health. F1000Res. 2016 Oct 28;5:F1000 Faculty Rev-2593.

7. WHO. Household air pollution and health [Internet]. [cited 2022 Aug 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

8. WHO-CED-PHE-18.01-eng.pdf [Internet]. [cited 2022 Aug 28]. Available from: https://apps.who.int/iris/bitstream/handle/10665/275545/WHO-CED-PHE-18.01-eng.pdf?ua=1

9. Waseq WM. The impact of air pollution on human health and environment with mitigation measures to reduce air pollution in Kabul Afghanistan. Int J Healthc Sci. 2020;8(1):12.

10. Markos Y, Dadi AF, Demisse AG, Habitu YA, Derseh BT, Debalkie G. Determinants of under-five pneumonia at Gondar University hospital, Northwest Ethiopia: an unmatched case-control study. Journal of environmental and public health. 2019;2019.

11. Dherani M, Pope D, Mascarenhas M, Smith KR, Weber M, Bruce N. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. Bulletin of the World Health Organization. 2008;86:390-8C.

12. Ghimire M, Bhattacharya SK, Narain JP. Pneumonia in South-East Asia Region: Public health perspective. Indian J Med Res. 2012 Apr;135(4):459–68.

13. Rana J, Luna-Gutiérrez P, Haque SE, Nazif-Muñoz JI, Mitra DK, Oulhote Y. Associations between household air pollution and early child development among children aged 36–59 months in Bangladesh. J Epidemiol Community Health. 2022 Jul 1;76(7):667–76.

14. Suzuki M, Thiem VD, Yanai H, Matsubayashi T, Yoshida LM, Tho LH, et al. Association of environmental tobacco smoking exposure with an increased risk of hospital admissions for pneumonia in children under 5 years of age in Vietnam. Thorax. 2009 Jun;64(6):484–9.

15. Charoenca N, Kungskulniti N, Tipayamongkholgul M, Sujirarat D, Lohchindarat S, Mock J, Hamann SL. Determining the burden of secondhand smoke exposure on the respiratory health of Thai children. Tobacco Induced Diseases. 2013 Dec;11(1):1-6.

16. Beletew B, Bimerew M, Mengesha A, Wudu M, Azmeraw M. Prevalence of pneumonia and its associated factors among under-five

children in East Africa: a systematic review and meta-analysis. BMC Pediatr. 2020 May 27;20(1):1-3.

17. Doshi S, Silk BJ, Dutt D, Ahmed M, Cohen AL, Taylor TH, Brooks WA, Goswami D, Luby SP, Fry AM, Ram PK. Household-level risk factors for influenza among young children in Dhaka, Bangladesh: a case–control study. Tropical Medicine & International Health. 2015 Jun;20(6):719-29.

18. Hoge CW, Reichler MR, Dominguez EA, Bremer JC, Mastro TD, Hendricks KA, et al. An Epidemic of Pneumococcal Disease in an Overcrowded, Inadequately Ventilated Jail. New England Journal of Medicine. 1994 Sep 8;331(10):643-8.

19. Gothankar J, Doke P, Dhumale G, Pore P, Lalwani S, Quraishi S, et al. Reported incidence and risk factors of childhood pneumonia in India: a community-based cross-sectional study. BMC Public Health. 2018 Sep 11;18(1):1-1.

20. Steinemann A. Volatile emissions from common consumer products. Air Qual Atmos Health. 2015 Jun 1;8(3):273–81.

21. Kim S, Hong SH, Bong CK, Cho MH. Characterization of air freshener emission: the potential health effects. The Journal of toxicological sciences. 2015;40(5):535–50.

22. Bruce NG, Dherani MK, Das JK, Balakrishnan K, Adair-Rohani H, Bhutta ZA, et al. Control of household air pollution for child survival: estimates for intervention impacts. BMC Public Health. 2013 Sep;13(3):1-3.

23. Amegah AK, Jaakkola JJ. Household air pollution and the sustainable development goals. Bulletin of the World Health Organization. 2016 Mar 1;94(3):215.

24. WHO. Air quality database 2018 [Internet]. [cited 2022 Aug 28]. Available from: https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database/2018.