ARI And Indoor Air Pollution: Its Burden And Correlation

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Citation

S Kumar, S Mehra. *ARI And Indoor Air Pollution: Its Burden And Correlation*. The Internet Journal of Pulmonary Medicine. 2006 Volume 8 Number 2.

Abstract

Most of the disease burden in India is due to the respiratory disorders namely acute respiratory infections (ARI), asthma, chronic obstructive pulmonary disease (COPD), tuberculosis (TB) and lung cancer. These diseases are mainly attributed with exposure to indoor pollution, solid-cooking fuels, smoking, poor housing and malnutrition.

NATIONAL BURDEN OF DISEASE (NBD)

Those disease categories that cause at least 1% of the NBD or at least 1% of all deaths constitute the national burden. Although commonly used, number of deaths is not a very informative indicator of ill health. Better is some measure of the loss of healthy life such as the disability adjusted life year (DALY), which basically indicates the amount of healthy life expectancy lost because of a disease, including both mortality and morbidity. It can be seen that it is the children less than five years, who bear the largest overall ill-health burden of any age group with the major contribution made by ARI. Respiratory diseases such as ARI,TB, COPD and Cancer all contribute to atleast 1% of DALYs and Deaths[1]. ARI is the largest contributor to the NBD with 12% DALYs and 13% deaths[1].

INDOOR AIR POLLUTION

Four components of indoor pollution are combustion products, chemicals, radon, and biologic agents. Out of the four components, combustion-generated pollutants, principally those from solid-fuel (wood, charcoal, crop residues, dung, and coal) cooking and heating stoves, have been the major culprit. Thus the major source of indoor air pollution is exposure to biomass fuel cooking[2]It is considered positive if the individual gives the history of regularly cooking at home.

STATUS OF HOUSEHOLD FUEL USE IN INDIA

The types of cooking fuels used at home included liquefied petroleum gas (LPG), kerosene, or the solid fuels i.e. coal, dried wood, dung and other products of animal or plant origin (biomass fuels). Degree of pollution strongly depends on type of fuel used. .

Solid fuels are substantially more polluting per meal than the liquid and gaseous fuels further up on the ‘‘energy ladder.’‘ The amount of important health-damaging pollutants (e.g., PM10, CO, PAH, HCHO, VOC) breathed by a cook during a typical meal is about 2 orders of magnitude lower when burning bottled gas than burning wood or crop residues. Thus, as a first approximation, the use of unprocessed solid fuels in the household is an indicator of the potential for excessive air pollution exposures. In this way, access to clean fuels is parallel to the often-cited statistic on access to clean water as an indicator of disease risk.

MAGNITUDE OF PROBLEM

Air pollution has become a major concern in India in recent years both because it is now clear that large parts of the Indian urban population are exposed to some of the highest pollutant levels in the world. Annual concentrations reported at urban monitors in India for PM_{10}, particles less than 10 microns in diameter, is of range 90–600 µg/m3, with a population mean of about 200 µg/m3.

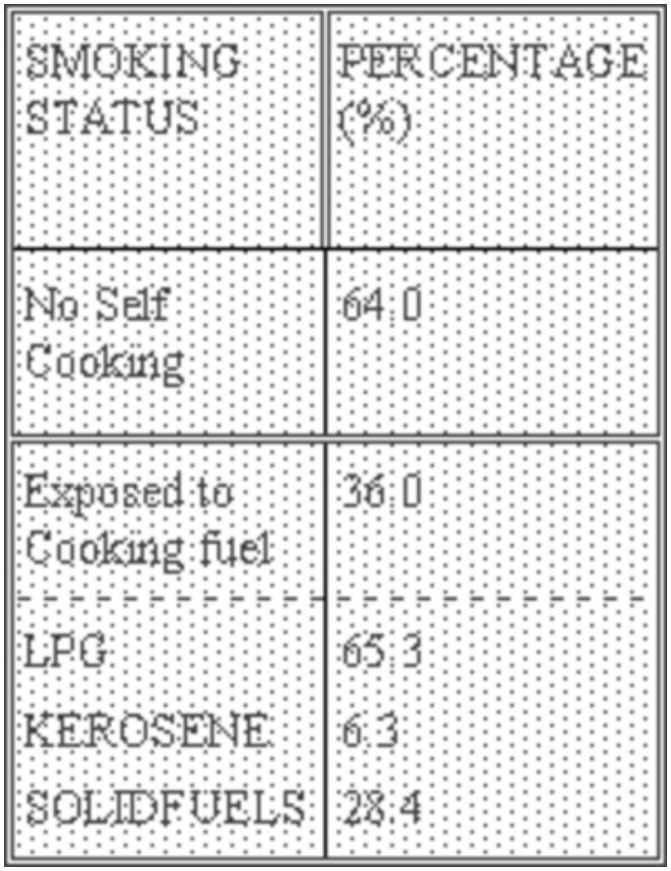
The 1991 National Census included for the first time a question about the primary household fuel used and reflected that about 95% of the rural population still relied primarily on biomass fuels (dung, crop residues, and wood). A small fraction uses coal, which means about 97% of households relied principally on these unprocessed solid fuels. Nationwide, some 81% of all households relied on these fuels; 3% used coal and 78% used biomass. However recent data as revealed by NFHS-3[3]found that 71 percent of India's households use solid fuels for their cooking and that 91 percent of rural households do so.

A study done by SK Jindal etal,[4] showed history of exposure

to combustion of cooking fuels in 36% of subjects but there were large variations at different centers where study was carried out. Majority of subjects at Delhi and Chandigarh used LPG whereas almost similar numbers used LPG or dried solid fuels at Bangalore and Kanpur.

Figure 1

Table 1: distribution of subjects based on history of EXPOSURE TO DOMESTIC COOKING FUEL EXPOSURE



SMOKING STATUS	PERCENTAGE (%)
No Self Cooking	64.0
Exposed to Cooking fuel	36.0
LPG	65.3
KEROSENE	6.3
SOLIDFUELS	28.4

HOW DOES IT EFFECT RESPIRATORY SYSTEM

A number of studies have been carried out to address the health effects of use of such stoves. Exposure to combustion products from solid fuels has been considered an important cause of several diseases in developing countries, including acute respiratory infections, chronic obstructive pulmonary disease, and cancer of the lung, nasopharynx, and larynx)[5,6,7,8,9]

Biomass and coal smoke contain a large number of pollutants, including particulate matter, carbon monoxide, nitrogen dioxide, sulfur oxides, formaldehyde, polycyclic organic compounds, and metals, such as arsenic[10]. Further, some coal produces substantial indoor exposure to arsenic[7]. Smoky coal has been found to be more carcinogenic than cleaner coal and wood smoke when tested on mouse skin[28]. There is growing evidence that exposure to indoor smoke can cause serious respiratory and other adverse health effects which may include ARI in children and COPD or chronic bronchitis in women. Based on data from NFHS-1[11], M,ishra et al. (1999) found that the prevalence of active tuberculosis in India could be reduced by 51 percent if everyone were to use cleaner fuels. Similar findings were observed in other studies[12].On the basis of the various existing epidemiological studies, attributable risks were calculated in reference to the demographic conditions and patterns of each disease in India. Sufficient evidence is available to estimate risks most confidently for acute respiratory infections (ARI), chronic obstructive pulmonary disease (COPD), and lung cancer while Estimates for tuberculosis (TB), asthma, and blindness are of intermediate confidence.

Figure 2

Table 2 : Estimated annual health effects of indoor air pollution in India

Disease	Deaths, thousands	YLL, millions	DALYs, millions	Sickday severity
I. Strong evidence				
ARI* (880,000)	270–400	9.2–14	9.6–14	0.28
COPD† (60,000)	20–35	0.19–0.34	0.39–0.68	0.43
Lung cancer† (6,000)	0.42–0.79	0.0046–0.0086	0.0048–0.0090	0.15
II. Moderate evidence				
Blindness† (~0)	~0	~0	0.064–0.13	0.5
TB† (250,000)	53–130	0.97–2.4	1.1–2.6	0.15
APO (560,000)	?	?	?	
Asthma (20,000)	3.6–9.0	0.046–0.12	0.27–0.68	0.15
III. Suggestive evidence				
IHD† (1,100,000)	54–200	0.49–1.8	0.55–2.1	0.32
Possible total (2,300,000)	400–780	11–18	12–20	
Range used§:	400–550	11–16	12–17	

ACUTE RESPIRATORY INFECTIONS (ARI)

ARI is a class that includes infections from a wide range of viruses and bacteria, but with similar symptoms and risk factors[13]. In every country, young children contract these diseases at similar rates, but in India and other poor countries, they often proceed to severe stages, including pneumonia and death. For example in developed countries, the common cold is no more than a passing inconvenience, trivial for most and rarely of any serious consequence to one's health. Such is not the case elsewhere in the world. There, a mere cold can and often does lead to tragic results It is generally acute lower respiratory infections (ALRI) that impose the highest burden and greatest risk of mortality. This is especially true in India, where 40 percent of infant illnesses are caused by acute respiratory infections (ARI), which can undermine a child's overall resistance, if not

actually shorten his or her life expectancy.

ARI AS IN WORLD

For the world as a whole, ARI is the largest category, accounting for about 8.5% of the global burden. However ARI is rare in developed countries. Since severe childhood ARI is rare in developed countries, few air pollution studies there have focused on it through lack of interest or insufficient cases for statistical significance. Ironically, when developed-country exposure-response information is applied to Less Developed Countries, ARI has often been left out.

ARI AS IN INDIA

A report by Directorate General of Health Services, Government of India indicates that ARI contributes towards about one fourth to one third of all under five deaths in India. ARI is the second most important cause of infant mortality in several developing countries, the first being diarrheal diseases. It accounts for 40 percent of the infant illnesses Slightly more than three children out of every 1000 die each year in India from complications associated with ARI.

ARI is the largest single disease category for India, accounting for about one-ninth of the national burden. Astonishingly, Indian ARI is actually the largest single disease category in the world, in the sense of being subject to attention by one government. The Indian portion of this one disease class, which affects mainly one age group, accounts for 2.5% of the entire global burden of ill health. The incidence rate for pneumonia, which is part of ARI in developing countries, may go up to 10% and is about 16%in India.[14] It accounts for 11 percent of NBD as in India and is a major contributor of illnesses in under fives. It is responsible for 13 percent of all deaths as in India[15].

FACTORS AFFECTING INCIDENCE

Factors like environmental conditions, living conditions, nutritional status and socio-economic conditions have been mentioned as associated with ARI, based on the influence observed considering each variable as separate.

Data show the incidence of ARI to be highest among India's poor. Weakened by chronic malnutrition, children living in poor areas have a difficult time overcoming infection and disease. Their resistance to infection is often undermined further by parasites. Promiscuity and the lack of adequate sanitary facilities in these areas only compound the problem. Further in a review study done on causes of respiratory burden as in rural India, it was observed that children under 5 are at highest risk for ARI including Pneumonia, It was exceptionally high in Haryana state[16]. The most frequent underlying cause of persistent pneumonia in children were post tubercular bronchitis and asthma and due to neonatal care management [16]. Children with no history of immunization for DPT (diphtheria, pertussis and tetanus) and measles vaccine are also at high risk with 2.7 times more risk of exposure[17].

A case control study done on risk factors for Pneumonia clearly marks that solid fuel use for cooking (OR 3.97) was associated with high-risk after adjusting for confounders[18]. Children under 5 years have the highest risks for the acute respiratory disease thought to be affected by air pollution and of course do not smoke. In addition, particularly in the first few years, they spend much time with their mother and thus receive higher exposures than older children, who may spend much time away from the household. The Indian portion of this one disease class, which affects mainly one age group, accounts for 2.5% of the entire global burden of ill health.

This has been documented[19] in a number of studies have been done in the developing world that give quantitative estimates of the relative risk of severe ARI for children living in biomass-burning households: South Africa[20], Zimbabwe[21], Nigeria [22], Tanzania[23], Gambia [24,25,26,27], Brazil[28] Argentina[30], and Nepal[31] This has been proved even in studies from India[29]. Although none of these studies had the resources to do the kind of sophisticated analysis commonly found in developed-country studies, as a group they make an intriguing case. A study among Native Americans (Navaho) also showed strong and significant effects or woodstove use at much lower indoor pollution levels than the levels found in developing countries[32], [33]. There are even larger groups of studies that show various childhood respiratory symptoms (coughing, wheezing, etc.) to be associated with solid-fuel smoke exposures. Smith et al.[19] carried out a review of these studies and suggested a clear relation between indoor air pollution and ARI.

DISCUSSION AND CONCLUSION

At the global level, India seems to have some 30% of all household solid-fuel stoves, although the estimates are generally much less reliable than in India where fuel use is determined in the national census. On that basis, the total world health impact on women and children would be roughly three times larger than the Indian estimates.

By themselves, epidemiological studies do not prove causality, only association. Nevertheless, when a number of studies find similar associations in different populations, places, and times; in situations of different mixes of confounders; and done by different investigators with different methods; the argument for causality starts to become stronger.

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References

1. Global Burden of Disease Murray, C. & Lopez, A. (1996) (Harvard Univ. Press, Cambridge, MA)
2. Prasad R ,Garg R,Biomass fuel and Lung Health(Editorial) Chest 2005;7:1-2.
3. IIPS/NFHS. National Family Health Survey Phase-III. International Institute for Population Sciences; 2007. Deonar, Mumbai-78, India.
4. Jindal SK, Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, et al. Asthma Epidemiology Study Group. A multicentric study on epidemiology of chronic obstructive pulmonary disease and its relationship with tobacco smoking and environmental tobacco smoke exposure. Indian J Chest Dis Allied Sci 2006; 48 : 23-27.
5. Chen BH, Hong CJ, Pandey MR, et al. indoor air pollution in developing countries. World Health Stat Q 1990 ; 43:127-138.
6. Dutt D, Srinivasa D, Rotti SB, et al. Effect of indoor air pollution on the respiratory system of women using different fuels for cooking in an urban slum of Pondicherry. Natl Med J India 1996; 9 : 113-17.
7. Finkelman R, Belkin H, Zheng B. Health impacts of domestic coal use in China. Proc Natl Acad Sci U S A 1999 ; 96:3427-31.
8. Gupta D, Boffetta P, Gaborieau V, et al. Risk factors of lung cancer in Chandigarh, India. Indian J Med Res 2001 ; 113:142-50.
9. Kleinerman R, Wang Z, Wang L, et al. Lung cancer and indoor exposure to coal and biomass in rural China. J Occup Environ Med 2002;44:338-44.
10. Zhang J, Smith K. Indoor air pollution: a global health concern. Br Med Bull 2003;68: 209-25.
11. IIPS/NFHS. National Family Health Survey Phase-I. International Institute for Population Sciences ; 1993. Deonar, Mumbai-78, India.
12. Prasad R,Nautial RG.Air pollution and tuberculosis Journal of IMA academy of medical specialties 2002;13:31-33.
13. Smith, K. R., Samet, J. M., Romieu, I. & Bruce, N. Thorax.2000; 55, 518-532
14. Selwyn BJ. The epidemiology of aute respiratory tract infections in yourng children. Comparison of findings from several developing coutries. Rev Infect Dis 12 (suppl 8) S870-888
15. Kirk R. Smith. National burden of disease in India from indoor air pollution Proc Natl Acad Sci U S A. 2000 ; 97: 13286-13293
16. Agnihotram V. Ramanakumar, Chattopadyay Aparajita: Respiratory Disease Burden In Rural India: A Review From Multiple Data Sources. The Internet Journal of Epidemiology. 2005; 2 : 2.
17. Deb SK. Acute respiratory disease survey in Tripura in case of children below five years of age.J India Med Assoc 1998 ; 96: 111-116.
18. Mahalannabis D, Gupta S, Paul D, Gupta A, Lahiri M, Khaled MA. Risk factors for pneumonia in infants and young children and the role of solid fuel for cooking : A case-control study. Epidemiol Infect. 2002 ; 129 : 65-71.
19. Smith, K. R., Samet, J. M., Romieu, I. & Bruce, N. Thorax 55, 518-532.
20. Kossove, D. (1982) S. Afr. Med. J. 61, 622-624.
21. Collings, D. A., Sithole, S. D. & Martin, K. S. Trop. Doct. 20, 151-155.
22. Johnson, A. W. & Aderele, W. I. Ann. Trop. Paediatr. 12, 421-432.
23. Mtango, F. D., Neuvians, D., Broome, C. V., Hightower, A. W. & Pio, A. Trop. Med. Parasitol.1992 ; 43, 229-233.
24. de Francisco, A., Morris, J., Hall, A. J., Armstrong-Schellenberg, J. R. & Greenwood, B. M. Int. J. Epidemiol.1993 ; 22, 1174-1182.
25. O'Dempsey, T., McArdle, T. F., Morris, J., Lloyd-Evans, N., Baldeh, I., Lawrence, B. E.,Secka, O. & Greenwood, B. M. Int. J. Epidemiol.1996 ; 25, 885-893.
26. Campbell, H., Armstrong, J. R. & Byass, P. Lancet 1989 ;1: 1012.
27. Armstrong, J. R. & Campbell, H. Int. J. Epidemiol. 1991 ; 20: 424-429.
28. Victora, C., Fuchs, S., Flores, J., Fonseca, W. & Kirkwood, B. (1994) Pediatrics. 1994 ; 93: 977-985.
29. Shah, N., Ramankutty, V., Premila, P. G. & Sathy, N. J. Trop. Pediatr.1994 ; 40: 201-206.
30. Cerqueiro, M. C., Murtagh, P., Halac, A., Avila, M. & Weissenbacher, M. Rev. Infect.Dis. 1990 ; 12, Suppl. 8: S1021-S1028.
31. Pandey, M. R., Boleij, J. S., Smith, K. R. & Wafula, E. M. Lancet 1989; 1: 427-429.
32. Morris, K., Morgenlander, M., Coulehan, J. L., Gahagen, S., Arena, V. C. & Morganlander,M. Am. J. Dis. Child . 1990 ; 144: 105-108.
33. Robin, L. F., Less, P. S., Winget, M., Steinhoff, M., Mouton, L. H., Santosham, M. & Correa,A. Pediatr. Infect. Dis. J .1996 ; 15: 859-865.

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