THE EXTENT OF EXPOSURE AND HEALTH EFFECTS OF HOUSEHOLD COAL BURNING IN URBAN RESIDENTIAL AREAS IN SOUTH AFRICA

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ABSTRACT

Household coal burning is one of the major sources of total suspended particulate matter (TSP) in African urban residential areas in South Africa. The coal stoves used are usually poorly vented or unvented, consequently resulting in high levels of indoor air pollution. The effects of household fuels used in two Townships in the Vaal Triangle (central South Africa) on the health of 8-12 year old children living in these households, were investigated. Personal exposures of 45 children to TSP, resulting from mainly coal burning, determined over 12 hour periods during the summer and winter of 1991 and 1992, indicated extremely high exposures. The health questionnaire data indicated that 59.9% of the population uses coal for space heating and cooking purposes. Most of the population perceived coal burning as the major source of air pollution in their area. The respiratory illness prevalence rates for the populations living respectively in three exposure areas: a coal burning area, a partially electrified area and an electrified area, were relative low with no statistical significantly difference in prevalence rates for the different exposure areas. However, children living in an area where only coal was burned had a respectively 170% and 120% higher risk of developing Upper Respiratory Tract Illnesses (URI) than children living in a partially electrified and a totally electrified area. The health data were collected during the summer period which is the period of lowest exposure to air pollution. Crowding and environmental tobacco smoking (ETS) did not have a marked effect on the risk to develop URI and LRI. Exposure measurements taken during the winter period indicated higher levels of TSP than during the summer period. It is expected that the prevalence rate of respiratory symptoms will be significantly higher during the winter period.

INTRODUCTION

More than 40% of the total population in South Africa uses coal for cooking and heating purposes, making it one of the major sources of TSP in African urban and peri-urban residential areas. Indoor air pollution in developing countries is often the result of biomass fuel and coal burned under inefficient ventilation conditions. The stoves used are usually poorly vented or unvented. The high emission and incomplete combustion properties of coal also contribute to unacceptably high levels of human exposure to TSP and other pollutants of coal(1).

Inefficient information exist on personal exposure to and health effects of domestic coal burning exposure in South African populations. A longitudinal air pollution health study in South Africa, known as the Vaal Triangle Air Pollution Health Study (VAPS), subsequently undertook a two-part project to collect information on exposure and health effects of coal burning in urban residential areas(2).

METHODS

Households in two African urban residential areas in central South Africa (Sebokeng and Evaton) participated in an air pollution health survey. Clinic nurses and health educators (highly regarded members of the specific community) acted as interviewers. The health questionnaire was distributed to them prior to the study. On their recommendation, certain revisions were made to suit the specific characteristics of the population. The questionnaire was field tested after which final revisions were made. The interviewers then engaged in an intensive training programme.

The interviewers conducted person-to-person interviews with the mothers of 8-12 year old children to collect data on type of household fuel use, socio-economic status and respiratory health status of the child. The questions were translated by the field worker into the respondent's mother language.

The population were randomly selected from three different air pollution exposure areas: an electrified area, a partially electrified area (electricity is mainly used for lighting and coal for cooking and heating) and a coal burning area.

The seasonal TSP exposures of 45 children living in the electrified and coal burning areas respectively, were determined. The methodology is described in Terblanche et al(3).

RESULTS

A total of 543 households in two urban Townships in central South Africa participated in the air pollution health survey. The results of the questionnaire data indicated that the majority of the population uses coal for heating and cooking purposes: 59.9% uses coal for space heating and 45.3% use either wood or coal for household cooking purposes. More than 70% of the population considers coal burning as the major source of air pollution in their area. Most of the population (55.1%) still uses candles for lighting.

The extensive use of coal was reflected in the results of the personal TSP exposure

measurements: 99% of the 72 12-hour monitoring sessions were above the 24h TSP health standard. Exposure measurements taken during the winter school day indicated higher TSP exposure than during the summer school day (3).

An important additional source of indoor air pollution in this population is tobacco smoke. More than 40% of the population reported that there are "currently persons that smoke on a daily basis in the home where the child lives". More than 10 cigarettes per day are smoked in 20.6% of the households, 17.2% of the households reported that more than 5 cigars per day are smoked in the home and 9.3% of the households reported that a pipe is smoked five or more times per day in the home where the child lives. In an additional 18,4% households hand rolled cigarettes, chewing tobacco or snuff was used on a daily basis. More than 47% of the population consequently considered environmental tobacco smoke as one of the major sources of air pollution in their area.

Nighttime crowding in the households has been determined by dividing the number of persons living in the households by the number of bedrooms. The results indicated an average of 3.8 persons per bedroom.

The prevalences of respiratory diseases and symptoms of children living in the coal burning, partially electrified and electrified areas are summarized in Table 1.

Table 1 Prevalence of respiratory disease and symptoms in the study population

Respiratory illness	Electrified area % (N)	Unelectrified area % (N)	Partial electrified area % (N)	P - Value
Chest illness that kept him/her at home for 3 or more days	2,0% (N=144)	2,8% (N=211)	3,3% (N=146)	0,84
Currently asthma	0,7% (N=144)	0,5% (N=211)	0% (N=146)	0,71
Phlegm, with and without colds	0,4% (N=145)	0% (N=221)	0,6% (N=147)	-
During the past 2 months:				
Bronchitis	4,1% (N=141)	3,1% (N=220)	0,6% (N=150)	0,14
Pneumonia	1,4% (N=145)	0% (N=226)	0,6% (N=151)	0,11
Runny nose	2,0% (N=144)	4,0% (N=218)	2,0% (N=149)	0,50
Earache	2,0% (N=145)	4,9% (N=216)	3,3% (N=147)	0,36
Hay fever	0% (N=148)	1,8% (N=223)	0% (N=152)	0,09
Sinusitis	1,4% (N=146)	2,2% (N=222)	1,3% (N=149)	0,84

The respective prevalences for URI (defined as the presence of either runny nose, hay fever, earache or sinusitis during "the past two months") and LRI (defined as the presence of either bronchitis, pneumonia, asthma, phlegm, coughing or chest wheezing during "the past two months") for children living in the exposure areas, are documented in Table 2 and 3.

Table 2: Odds ratios for upper respiratory tract illnesses[1] (URI) for school children living in different areas in townships in the Vaal Triangle (central South Africa)

Categories	Prevalence of URI		OR	95% CI*		Controlled for ETS	Controlled for crowding	Controlled for both
				Lower	Upper			
Living area								
- coal area vs mixed area	9.8%	3.8%	2.7	1.1	6.8	2.7	3.4	3.3
- coal area vs electrified	10.0%	4.7%	2.2	0.9	5.3	2.2	2.5	2.6
- mixed area vs electrified	3.8%	4.7%	0.8	0.3	2.5	0.8	0.7	0.8

* If 1 is not included in the CI, then the OR is significant
Mixed area=partially electrified area

Table 3: Odds ratios for lower respiratory tract illnesses[1] (LRI) for school children living in different areas in townships in the Vaal Triangle (central South Africa)

Categories	Prevalence of URI		OR	95% CI*		Controlled for ETS	Controlled for crowding	Controlled for both
				Lower	Upper			
Living area								
- coal area vs mixed area	6.4%	5.1%	1.3	0.5	3.1	1.3	1.3	1.3
- coal area vs electrified	6.4%	7.4%	0.9	0.4	1.9	0.9	1	1.1
- mixed area vs electrified	5.1%	7.4%	0,8	0.3	1.7	0.7	0.8	0.8

* If 1 is not included in the CI, then the OR is significant
Mixed area=partially electrified area

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Controlled for crowding	Controlled for both
1.3	1.3
1	1.1
0.8	0.8

Environmental tobacco smoking (ETS), defined as persons smoking on a daily basis in the home where the child lives and crowding, defined as 5 or more persons per bedroom in the home where the child lives, did not have a marked effect on the OR's for URI and LRI for children living in different air pollution exposure areas in the Vaal Triangle (Table 2 and 3).

DISCUSSION

Coal is burned extensively in black urban residential areas in South Africa, resulting in high levels of atmospheric particulate matter. The majority of the study population uses coal for cooking and/or heating purposes.

The extensive use of coal and its effect on the quality of the surrounding air were reflected in the measurements of personal TSP exposures and the population's perception of the most important source of air pollution in their area. The results indicated that the USA 24 hour health standard for exposure to TSP was exceeded in 99% of the monitoring sessions (3). Most of the study population considered coal burning as the major source of air pollution in their area.

The coal stoves used are often poorly vented or unvented, resulting in high levels of indoor air pollution. Data on activity patterns indicated that winter is the high risk period for exposure to high levels of indoor air pollution - the population spend more time indoors during winter and burn greater amounts of fuel for house heating purposes during winter time.

Environmental tobacco smoke contributes to indoor air pollution. More than 40% of the population are exposed to tobacco smoke on a daily basis in the household. Environmental tobacco smoke was regarded as the major source of air pollution by 47% of the households.

Crowding is an important risk factor in developing acute respiratory infections. The results indicated that an average of 3,8 persons live in one bedroom.

The respective prevalences of respiratory disease and symptom for the population were relatively low with no statistically significant differences in prevalence rates for the three areas: electrified, partially electrified and coal burning (Table 1). The lack of difference between the three areas could be attributed to their close proximity to one another and the nature of the coal emissions which spreads over a wide area without proper dilution or dispersion. The ubiquitous exposure to the air pollution was confirmed by the personal exposure results where no statistically significant difference could be found between TSP exposure in the electrified area and exposure in the coal burning area (3).

However, children living in the coal burning areas had a respective 170% and 120% higher risk of developing URI than children living in the partially electrified and electrified area. There was no significant difference in risk of developing LRI between the three groups. Crowding and ETS did not have a marked effect on the above risks.

The health data were collected during the summer period which is the period of lowest exposure to air pollution. Personal exposure data and data on activity patterns indicated that winter is the period of greatest risk of exposure to high levels on indoor air pollution levels. The personal TSP exposures of children during a winter school day were significantly higher than during a summer school day (3). Children spend more time indoors during the cold

winter months in an environment where greater amounts of fuel are burned for house heating purposes than in the summer months when coal is mainly used for cooking and heating of water.

It is expected that the prevalence rates of respiratory symptoms will be significantly higher during the winter period which is the period of higher exposure to air pollution in the Townships.

ACKNOWLEDGEMENTS

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REFERENCES

1. Smith KR. Biomass cookstoves in global perspective: Energy, Health, and Global warning. Informal consultation on Epidemiological Social, and Technical Aspects of Indoor Air Pollution from Biomass fuel, Geneva, 1991.

2. Terblanche APS, Opperman L, Nel CME, Reinach SG, Tosen G, Cadman A. Preliminary results of exposure measurements and health effects of the Vaal Triangle Air Pollution Health Study. South African Medical Journal 1992; 81: 550-556.

3. Terblanche APS, Nel CME, Opperman L, Nyikos H. Exposure to air pollution from transitional household fields in a South African Population. Journal of Exposure Analysis and Environmental Epidemiology 1993; 3(in press).

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ABSTRACT

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