Environmental determinants of acute respiratory symptoms and diarrhoea in young coloured children living in urban and peri-urban areas of South Africa

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Summary

The impact of environmental risk factors associated with housing was examined in relation to diarrhoeal disease and acute respiratory symptoms in South African coloured children. A multistage cluster sample representative of all coloured people living in the major urban and peri-urban areas of South Africa was used for the study. Interviews were conducted with respondents from 1 227 households.

Overall, 8,5% children under 5 years were reported to have had diarrhoea, while 29% had experienced coughing and breathing problems in a 2-week recall period. Individual risk factors identified using the odds ratios (ORs) for diarrhoea included not having an inside tap or a flush toilet in the homes (both yielded an OR of 3,3), not owning a refuse receptacle (OR = 2,5), not being connected to an electricity supply (OR = 2,5), low household income (OR = 1,8), more than 2 people per room (OR = 2,0) and less than Standard 5 maternal education (OR = 1,6). Absence of an inside toilet, not having a refuse receptacle and overcrowding all remained as independent risk factors after logistic regression analyses. Multiple logistic regression analyses revealed that not having a refuse receptacle and the absence of electricity for heating purposes were independently associated with respiratory symptoms.

The overall preventive potentials for respiratory symptoms were significantly less than those for diarrhoea. Improving physical access to essential environmental health services in urban areas and improvements in the educational status of women are urgently needed if childhood infections are to be prevented.

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In recent years concern has been expressed about the rapid rate of urbanisation in many African countries.[1-4] Associated with a deterioration in existing services[2,3] there has been an increase in disease and ill-health of growing peri-urban populations.[3] In rapidly urbanising areas the lack of information about vital events, disease and health service coverage, as well as about the demographic structure of the population, preclude epidemiological assessment of the effects of urban environments on health.[5] While available data suggests that in general the health status of urban populations is better than that of rural populations, few studies have systematically evaluated the impact of specific environmental factors related to housing on the health of the population.[6] At a recent WHO expert committee on environmental health in urban development (Geneva, 17 - 23 April 1990) the need for appropriate epidemiological evaluation of the impact of such factors was stressed.[4]

In this study the impact of environmental risk factors associated with housing on diarrhoeal disease and acute respiratory symptoms (ARS) in coloured children was determined. Diarrhoea and acute respiratory infections (ARI), two preventable infectious diseases, are still responsible for considerable mortality in South Africa.[7,8] Few reliable national estimates are available for morbidity from these diseases however.

The emphasis on coloureds does not imply that the authors support the racial classification of population groups. It does however reflect the legacy of Group Areas legislation, which has meant that housing has been allocated on a racial basis.

Methods

A multistage cluster sample representative of all coloured people living in the major urban and peri-urban areas of South Africa was used for the study. The Opinion Survey Centre of the Human Sciences Research Council (HSRC), in collaboration with their Institute for Statistical Research, selectd 1 500 households on a national basis proportional to urban population size. The HSRC was also responsible for the training of fieldworkers and supervision of the fieldwork operation. One of our researchers (R.B.) participated in the training of the interviewers.

Analyses of descriptive data on the availability of environmental health services, as well as rates of diarrhoea and ARS, were conducted. For both diarrhoea and ARS a 2-week recall period was used. Diarrhoea was defined as the presence of at least three loose stools in a 24-hour period. ARS included the presence of both coughing and difficulty with breathing.

To identify the relationship between risk factors for the health outcomes, multiple logistic regression models were fitted to diarrhoea and then to coughing/breathing problems. By means of a stepwise technique, the procedure selects the best variable to be added to the model in any given step. The stepwise procedure continues until all possible variables contributing significantly to the model have been selected. The procedure then computes test statistics for assessing lack of fit of the model. Owing to the small number of observations in the dependent variables categories, the following procedure was implemented: the logistic regression equation was calculated using all variables that were decided before the analysis (on the basis of available research findings) as being biologically feasible. The variable first selected by the stepwise procedure was then excluded, and the procedure was recalculated with the remaining variables. Finally, only those variables selected by each iteration were used and a stepwise logistic multiple regression model was fitted to these variables. OR were used as a relative measure of effect.[9] Owing to the exploratory nature of the study, 90% confidence intervals (CIs) were used for the ORs.

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Results

Sociodemographic data

Overall, 61% of the 1 227 respondents were female, with 6% being between 15 and 19 years old and a further 6% over the age of 65. There was an average of 5,1 people per household and 2,1 people per room for the study population. The dependency ratio (number of people under 15 years plus the number of people 65 years or above, divided by the total population) was 56%.

There were no smokers in 24% of households, one smoker in 34% of households and more than one in 42% of households.

Availabilty of key environmental health factors

In general, access to a drinking water supply appeared to be adequate, with 82% of households having an inside tap (Table I). A quarter of households did not have flush toilets inside their house; 5,5% used a bucket system. Eighty-four per cent of respondents reported being connected to the electricity supply; however, a significant proportion of households did not use an electric stove for cooking or electricity for heating. A quarter of households reported problems with flies, and a lesser proportion problems with rats.

TABLE I. AVAILABILITY OF KEY PHYSICAL ENVIRONMENTAL FACTORS TO COLOUREDS IN URBAN AND PERI-URBAN AREAS OF SOUTH AFRICA, 1989

Variable and category	No.	%
Water supply		
Tap inside	994	81,9
Tap outside	177	14,6
Communal tap	42	3,5
Toilets		
Flush inside	908	74,7
Flush outside	207	17,0
Communal flush	23	1,9
Own bucket system	60	4,9
Communal bucket system	7	0,6
Pit latrine	6	0,5
None	4	0,3
Refuse disposal		
Own receptacle	1 018	89,9
Communal heap	104	9,2
Own heap	8	0,7
None	2	0,2
Electricity supply		
Yes	1 026	84,4
No	190	15,6
Cooking fuel		
Electric stove	887	72,9
Gas	147	12,1
Paraffin	92	7,6
Coal	26	2,1
Wood	64	5,3
Heating fuel		
Electricity	666	54,9
Gas	43	3,5
Paraffin	61	5,0
Coal	53	4,4
Wood	85	7,0
None	306	25,2
Chimney in dwelling		
Yes	420	34,5
No	796	65,5
Problems with flies		
Yes	309	25,4
No	909	74,6
Problems with rats		
Yes	94	7,7
No	1 124	92,3

Diarrhoea disease rates and determinants

Overall, 8,5% of children under 5 years were reported to have had diarrhoea during the 2-week recall period. The rates

TABLE II. DIARRHOEA AND ARS RATES (%) BY AGE IN URBAN AND PERI-URBAN COLOURED CHILDREN

Age (mo.)	Diarrhoea rate†*	ARS rate‡**
< 6	5,9	33,8
6 - 11	13,3	39,6
12 - 23	16,1	29,9
24 - 59	6,0	27,6
Overall	8,5	29,2

† Percentage of children reported to have ⩾ 3 loose stools in 24-hour period over last 2 weeks.
‡ Percentage of children reported to have coughing and breathing difficulties over last 2 weeks.
* $\chi^2 = 12,2$; 3 df; $P = 0,007$.
** $\chi^2 = 3,3$; 3 df; $P = 0,334$.

TABLE III. RISK FACTORS FOR DIARRHOEA IN 1 227 CHILDREN UNDER 5 YEARS OLD USING A 2-WEEK RECALL PERIOD (ALL VARIABLES INCLUDED IN LOGISTIC REGRESSION)

Variable category	No. of cases	OR (90% CI)
Water supply		
Tap inside	26	1,0 (reference)
Other	273	3,3 (1,7 - 5,0)
Toilets		
Flush inside	19	1,0 (reference)
Other	345	3,3 (2,5 - 5,0)
Own refuse receptacle		
Yes	32	1,0 (reference)
Other	384	2,5 (1,3 - 5,0)
Electricity		
Yes	30	1,0 (reference)
No	392	2,5 (1,4 - 5,0)
Child's age (yrs)		
< 2	29	2,3 (1,4 - 4,0)
2 - 5	196	1,0 (reference)
People per room		
⩽ 2	13	1,0 (reference)
> 2	226	2,0 (1,3 - 3,3)
Monthly income per household		
< R400	15	1,8 (1,0 - 3,2)
⩾ R400	112	1,0 (reference)
Refrigerator		
Yes	23	1,0 (reference)
No	320	2,5 (1,7 - 5,0)
Maternal education		
< Std 5	14	1,6 (0,9 - 2,9)
⩾ Std 5	103	1,0 (reference)
Flies a problem		
Yes	15	1,2 (0,7 - 2,1)
No	137	1,0 (reference)

varied with age, the highest rates being reported in the 12 -23-month category (Table II). A number of risk factors for diarrhoea were identified in the cross-sectional analysis (Table III). These included not having an inside tap, not having a flush toilet inside the house, not owning a refuse receptacle, not being connected to an electricity supply, more than two people per room, low monthly income per household, absence of a refrigerator, and low maternal education. As has already been mentioned, age was an important determinant as well.

Since many of the individual risk factors were strongly interrelated, logistic regression was used to try and identify the most important independent variables of interest. Table IV gives the ORs for diarrhoea in children aged under 5 years, after adjustment in the logistic regression model. Absence of a flush toilet in the household increased risks of diarrhoea threefold compared with a 2,5-fold increase associated with not having one's own refuse receptacle and an 11% increased risk for diarrhoea associated with having more than two people per room.

TABLE IV. OR FOR DIARRHOEA IN 507 CHILDREN UNDER 5 YEARS OLD AFTER ADJUSTMENT IN A LOGISTIC REGRESSION MODEL

	Coefficient	Adjusted OR (90% CI)
Toilets		
Flush, inside	−1,249	**1,0 (reference)**
Other		**3,3 (1,3 - 5,0)**
Refuse disposal		
Own receptacle	−0,998	**1,0 (reference)**
Other		**2,5 (1,2 -5,0)**
People per room		
⩽ 2	−0,159	**1,0 (reference)**
> 2		**1,1 (1,0 - 1,3)**

Acute respiratory symptom rates and determinants

Overall, 29% of children were reported to have experienced coughing and breathing problems during the 2-week recall period. Acute respiratory symptom rates did not vary significantly by age (Table II), although there was a slightly higher rate in the 6 - 11-month age group. Several individual risk factors were associated with ARS (Table V). These included having adults in the house who smoke, failure to use electricity for cooking and heating, not owning a refuse receptacle, total income, number of people per room and maternal education. After logistic regression, two factors emerged as being important (Table VI). Absence of electricity for heating purposes was associated with a 30% increase in risk for ARS, while not having one's own refuse receptacle was associated with a doubling in the risk.

Relationship between diarrhoea and ARS

Significant associations were found between diarrhoea and ARS. In children under 2 years, the OR for diarrhoea among those with ARS was 3,7 (95% CI 1,8 - 7,6) compared with those without ARS. In children aged 2 - 5 years, the comparable OR was 3,5 (95% CI 1,3 - 9,0). Further, for children under 2 years, the OR for ARS among those with diarrhoea was 4,6 (95% CI 2,0 - 10,5) compared with those without diarrhoea. In children aged 2 - 5 years, the comparable OR was 3,8 (95% CI 1,4 - 10,7).

TABLE V. RISK FACTORS FOR COUGHING AND BREATHING PROBLEMS IN 507 CHILDREN UNDER 5 YEARS OLD USING A 2-WEEK RECALL PERIOD

Variable category	No. of cases	OR (90% CI)
No. of adults who smoke ⩾ 1 cigarette/day		
0	**20**	**1,0 (reference)**
⩾ 1	**82**	**2,0 (1,3 - 3,3)**
Electricity		
Yes	**119**	**1,0 (reference)**
No	**308**	**1,7 (1,1 - 2,5)**
Cooking fuel		
Electricity	**98**	**1,0 (reference)**
Gas, paraffin, coal, wood	**275**	**1,7 (1,3 - 2,5)**
Heating fuel		
Electricity	**58**	**1,0 (reference)**
All other	**207**	**2,0 (1,7 - 3,3)**
Refuse receptacle		
Own	**133**	**1,0 (reference)**
Other	**9**	**2,4 (1,1 - 5,0)**
Chimney		
Yes	**64**	**1,0 (reference)**
No	**104**	**1,8 (1,3 - 2,5)**
Child's age (yrs)		
< 2	**76**	**1,3 (1,0 - 1,8)**
2 - 5	**151**	**1,0 (reference)**
People per room		
< 2	**66**	**1,0 (reference)**
⩾ 2	**175**	**1,3 (0,9 - 1,7)**
Total income per household per month		
< R400	**45**	**1,5 (1,1 - 2,2)**
⩾ R400	**81**	**1,0 (reference)**
Maternal education		
< Std 5	**45**	**1,7 (1,2 - 2,4)**
⩾ Std 5	**73**	**1,0 (reference)**

TABLE VI. OR FOR COUGHING AND BREATHING PROBLEMS IN 507 CHILDREN UNDER 5 YEARS OLD AFTER ADJUSTMENT IN A LOGISTIC REGRESSION MODEL

	Coefficient	Adjusted OR (90% CI)
Heating fuel		
Electricity	−0,176	**1,0 (reference)**
Other		**1,3 (1,2 - 1,4)**
Refuse disposal		
Own receptacle	−0,753	**1,0 (reference)**
Other		**2,1 (1,1 - 4,0)**

Relationship between maternal education and selected physical environmental factors

As has been indicated, many of the factors that were significantly associated with diarrhoea and/or ARS were strongly interrelated. This is illustrated in Table VII, where the relationship between maternal education and selected environmental factors is shown. In particular, the number of people per room, the presence of an inside flush toilet and the availability of electricity were strongly related to maternal education. Further, associations were found between maternal education and income as well as many proxies of income including availability of a car and fridge in working order.

TABLE VII. RELATIONSHIP BETWEEN MATERNAL EDUCATION AND SELECTED ENVIRONMENTAL FACTORS

	Maternal education < Std 5 (%)	χ^2	*P*-value
People per room			
≤ 2	**18,8**	**6,7**	**0,008**
> 2	**28,7**		
Toilets			
Flush inside	**18,5**	**24,2**	**< 0,0001**
Other	**38,9**		
Refuse			
Own receptacle	**25,1**	**0,5**	**0,5**
Other	**21,2**		
Electricity			
Yes	**19,0**	**40,2**	**<0,0001**
No	**50,6**		
All mothers	**23,9**		

Discussion

With rapid urbanisation it is essential continually to assess access to environmental services and their impact (positively or negatively) on health.[10] Identification of determinants is critical to planners of urban renewal programmes.[5]

Urbanisation holds the opportunity for improving the socio-economic status of populations. Improved employment, social and health services as well as improved access to water and sanitation facilities could potentially result in dramatic declines in diarrhoeal disease and other infectious conditions. Nevertheless, several negative elements associated with housing are known to impact on health.[10] This study has provided national information on environmental health risk factors in a South African population.

Over the last few decades, coloured infant mortality rates have declined considerably in association with increasing urbanisation in South Africa. Nevertheless, studies have shown that this group experienced increases in the post-neonatal mortality rate during the late 1960s and early 1970s,[11] which were possibly associated with the effect of resettlement.

This study documents that there is still a large potential for prevention of common infectious diseases in early childhood. The absolute rates reported here should be interpreted with caution, because they are affected by the season in which the study was conducted, the recall period used and the relationship of the respondent to the child.

Adverse effects related to the unavailability of water, sanitation facilities, refuse removal, electricity and vector control, overcrowding, and low socio-economic status have been confirmed here for diarrhoea and ARS. After controlling for several socio-economic factors, certain environmental health factors remained as important risk factors for infectious conditions. Nevertheless, the modifying influence of social factors, particularly maternal education, implies that improving physical access to services independent of improvements in the general educational status of women may not result in the full benefits of such services being realised. The study therefore indicates the need for a broad intersectoral approach to urban development.

Despite the shortcomings of the cross-sectional design, similar risk factors for diarrhoea were found to those derived from an incident case-control study in metropolitan areas of Brazil.[12] Increased risk of death (not disease as in this study) from diarrhoea was associated with the absence of a flush toilet, non-availability of piped water and household overcrowding. In a previous South African study of risk factors for diarrhoea, house size was also found to be associated with diarrhoeal disease.[13] As in this study diarrhoea rates were highest in the under-1-year-olds. An additional important factor in the present study was related to solid waste disposal. Disease incidence may be reduced through improving the water supply and solid waste disposal facilities in the urban areas.

Further evidence of the impact of improved sanitation on diarrhoea rates occurring concurrently with improving maternal education was found in a recent health impact evaluation study in Lesotho.[14] The study indicated that under-5-year-olds from households with a latrine experienced 24% fewer episodes of diarrhoea than children from households without a latrine. Importantly, the impact of latrines on diarrhoea was greater in those households that used more water and practised better personal hygiene and where mothers had a higher level of education. Similar findings have been found in Malaysia,[15] the Philippines[16] and Sri Lanka.[6] Importantly, improvements in water and sanitary services can be expected not only to impact on diarrhoeal diseases but, as has been shown in a recent WHO review, to reduce morbidity from soil-transmitted nematode infections as well as nutritional diseases.[17]

Several factors associated with smoking and fuel use were found to be significantly related to respiratory symptoms and have started to receive attention in Africa recently.[18] Passive smoking and the use of fuel sources other than electricity appears to exacerbate risk. With the high rates of smoking documented among the coloured population in South Africa,[19] more research into the effects of environmental tobacco smoke is needed, as are smoking intervention programmes. Not only is passive smoking a potential risk factor for ARI but, as is well documented, smoking in pregnancy can lead to low-birth-weight babies and other complications subsequently.

As most people, particularly the very young, the old and the sick, spend the majority of their time in the home, indoor sources of air pollution may be of particular importance. Kossove[20] demonstrated that Zulu infants hospitalised for lower respiratory tract infections were more likely than controls to come from homes with cook-fire smoke. No confounding factors were investigated, however. Recent work has documented the extent of use of various fuels in urban, peri-urban and rural areas of South Africa.[21] Considering that ARI is an important cause of childhood mortality in South Africa (in some urban areas now even more important than diarrhoea),[8] there is a need for more extensive studies into the interactive effect of overcrowding and domestic air pollution.

It is concluded that improving physical access to essential environmental health services in urban areas and improvements in the educational status of women are urgently needed if childhood infections are to be prevented.

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