Protecting children from indoor air pollution exposure through outdoor cooking in rural South Africa

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Introduction

Over half the global population is reliant on solid fuels such as wood, coal, crop residues and animal dung for their domestic energy requirements.[1,2] This results in high concentrations of pollutants such as particulate matter (PM) and carbon monoxide (CO) in the peoples' homes[3,4] when such fuels are burned indoors in open fires or rudimentary appliances. Amongst other health problems, indoor air pollution exposure has been associated with acute lower respiratory infections (ALRI) (such as pneumonia) amongst children younger than five years old.[5,4]

Figure 1 Outside view of segotlo (*photo: Brendon Barnes*)

By the late 1990s, there was a growing consensus of the probable links between indoor air pollution and child ALRI to call for studies to measure the effects of interventions on health.[6] Changing the way people behave has been identified as a possible strategy, particularly where people are unlikely to benefit from improved technologies in the short term. Despite this, no published studies have evaluated how changes in behaviour can relate to the way that children are exposed to indoor air pollution.[7]To address this shortage of information, this article reports on the effectiveness of promoting outdoor cooking in a poor rural South African community to reduce ill-health caused by kitchen smoke.

Figure 2 Outdoor cooking inside the segotlo (*photo: Brendon Barnes*)

The study was conducted in two poor rural villages in the Mafikeng local municipality, North West province of South Africa. Over 98% of households were reliant on a combination of wood and cow dung, collected free of charge, for their domestic energy requirements. In this region, every household had a square-shaped outdoor burning area (*segotlo*) in the homestead, which was enclosed by a wall of interwoven dried sticks approximately 1.6 m in height (Figure 1). It typically had a small entrance with a door (usually a piece of corrugated iron) that could be closed, thus creating a roofless kitchen. Inside is found a place for fuel storage (dried wood and cow dung), tables and chairs, pots, crockery and utensils (Figure 2). Outdoor cooking was widespread during summer but less so during winter when open fires are burned indoors where space heating is needed (Figure 3). At the start of the project, only one

Theme

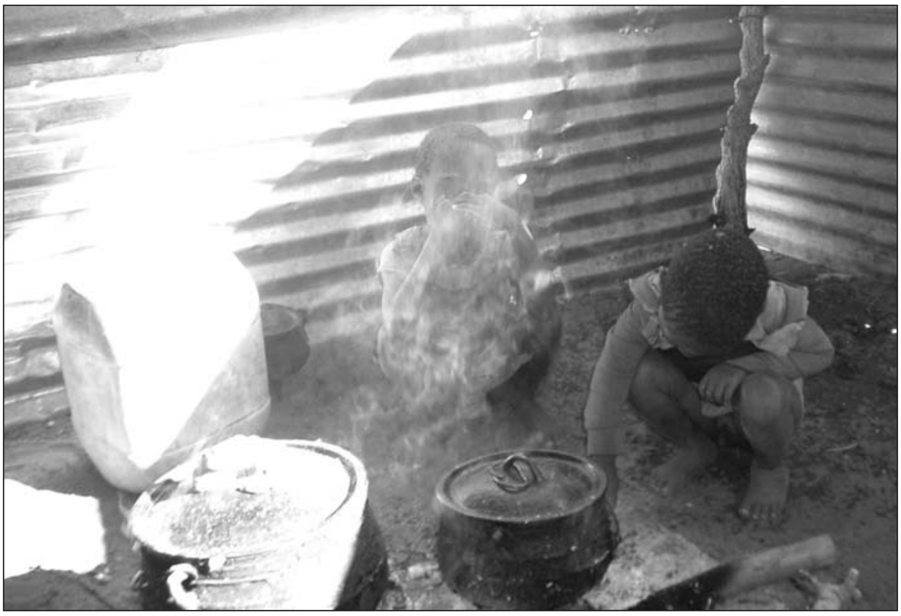

Figure 3 Children experience high levels of indoor air pollution when fires are brought indoors (*photo: Brendon Barnes*)

third of households (see below) reported using the *segotlo* for cooking during winter.

Aim and objectives of the study

The aim of the study was to evaluate the effectiveness of a low-cost '*intervention*' affecting peoples' behaviour. The *intervention* in this case involved *promoting the health benefits of outdoor cooking on the exposure of children to indoor air pollution*. Two alternative behaviours – improving ventilation and keeping children away from fires – were promoted amongst people who found it difficult to burn outdoors. However, this paper focuses mainly on outdoor burning. The objectives were to determine the impact of:

- Using the fire out-of-doors
- Exposure of children to carbon monoxide (CO)

Methods

The study involved monitoring households before and after the intervention, amongst an 'intervention group' in one village, and comparing these households to a 'control group' (in a village some 40 km distant) that did not receive the intervention.

In the intervention village, a member of the project field staff provided information about the health effects of breathing in smoke with the person responsible for childcare in the household (the 'caregiver'). This was followed by a discussion of how that person currently dealt with household energy and possible ways in which she (or he) could change her behaviour to reduce the dangers of smoke. Each household was visited one week later to determine how household members were coping with the agreed changes in behaviour, and encouraging them to continue.

Baseline data were collected in August 2003 (late winter) in both the intervention and control group. The household visits were implemented immediately thereafter in the 'intervention group' only with no further contact with the two groups until 12 months later when post-intervention data were collected from both groups in August 2004.

Participants

The study obtained baseline and follow-up information from 219 households (98 households in the intervention group and 121 households in the control group). Baseline and follow-up data on child exposure to CO was obtained from a random sample of 74 (36 in the intervention and 38 in the control group respectively) study children. Measurements were made on the following:

- Location of the fire (indoors versus outdoors).
- Child CO exposure.
- Child age and sex.
- Caregiver age and formal education
- Household characteristics: monthly income, number of people, dwelling type (traditional versus formal) and dwelling size.
- Ambient temperature.

Process

Caregivers were interviewed (using a questionnaire) to find out the location of the fire, information on the household, and characteristics of both caregiver and child. Researchers carried out the interview in the local language, and filled out the appropriate responses in the questionnaire. Exposure of the child to carbon monoxide (CO) was measured using tubes that change colour with exposure to CO (Dräger passive diffusion tubes). The carbon monoxide (expressed as parts per million) was measured over a 24-hour period. The CO tubes were attached to the clothing of the youngest child or close to where the child was sleeping, being bathed or changed. Ambient temperatures were obtained from the South African Weather Bureau, measured at a weather station near to the villages.

Results

Comparisons of the background information between baseline and follow-up showed that only household income and ambient temperature changed significantly in both intervention and control groups. *Despite colder winter temperatures at follow-up, both the intervention and control groups showed an increase in the number of households burning fires out of doors.* In the intervention group, the number of households that burned outdoors was increased from 24.5% at baseline to 45.9% at follow-up. Similarly, in the control group, the number of households burning outdoors increased from 25.6% at baseline to 42.2% at follow-up. Table 1 summarizes the location of the fire for the intervention group and control group.

In terms of child exposure (Table 2), children living in outdoor-burning homes showed significantly lower (88%–90%) levels of exposure to CO

Table 1 Number of households that burned outdoors

	Group	
	Intervention (n=98)	Control (n=121)
Baseline	24 (24.5%)	31 (25.6%)
Follow-up	45 (45.9%)	51 (42.2%)

Table 2 Mean child exposure to CO by burning location

	Burning location	
	Indoor burning	Outdoor burning
Baseline	4.2 ppm hrs (n=56)	0.5 ppm hrs (n=18)
Follow-up	3 ppm hrs (n=40)	0.3 ppm hrs (n=34)

compared to indoor-burning homes at both assessments. Interestingly, amongst those that brought a fire indoors at both assessments (i.e. those that found it too difficult to burn outdoors), child CO was reduced by 26% in the intervention group but increased by 15% amongst the control group (discussed in more detail elsewhere).

Discussion and conclusion

This study provides support for outdoor burning as a strategy to reduce air pollution exposure to children in poor rural areas during winter in this specific context. However, the fact that the control group also improved suggests that exposure to the intervention, and by implication the way that caregivers think about the *health* effects of indoor air pollution, was not the *only* reason for a shift to outdoor burning. Other factors emerged from qualitative interviews that may have influenced caregivers' decision to burn outdoors or remain indoors during the study period.

While health concern was the main reason for outdoor burning in the intervention group, amongst the control group a small group of participants mentioned that they tried to create a good impression to the study team with the expectation that they would get services such as electricity sooner (called a 'Hawthorne effect'[9]), while others perceived outdoor burning to be a symbol of higher social standing (there was often stigma attached to the dirt/soot and smell generated by burning inside homes) and this is why they chose to burn outdoors. In relation to warmth, participants who burned outdoors said that they dressed more warmly and heated themselves next to fires outdoors. After dark, participants used candles to provide light indoors. They mentioned that children do not care where fires are located as they usually play outdoors and only heat themselves for at intervals for a very short time.[10]

Amongst those who found it too difficult to burn outdoors and burned indoors, the space heating benefits of indoor burning often outweighed any other motivations. In addition, amongst certain participants (particularly in the control group) the belief that indoor smoke was not harmful to health was a major barrier to change. For example, some participants said that smoke was an acceptable part of rural life, that their parents and grandparents inhaled wood smoke with no health effects and questioned why they should be concerned about it. Certain female participants also mentioned that even if they wanted to burn outdoors, their male partners would often not allow it.

Changes in behaviour are not intended to replace technical interventions in poor rural households, but to provide an alternative until such interventions are feasible. The fact that having the fire out of doors, which reduced child exposure substantially even after 12 months, suggests that it may be an effective and sustainable option for between 42–46% of the rural households in this study. A proportion of those cooking out of doors were possibly doing so as a result of participation in the study. In addition, many of the non-health factors identified in the study are very difficult to change e.g. the need for indoor space heating, and the status of women in the family. Nonetheless, the study highlighted the potential role of behavioural change in reducing exposure of children to indoor air pollution in a poor rural context. Further studies are needed to explore behavioural change in more detail. There is a need for bigger studies to explore the impact of all kinds of interventions (not just changes in behaviour) on child ALRI and other health problems. It is equally important for large-scale efforts to continue to promote improved technologies, and to address the poverty-related issues that are the underlying causes of excessive levels of indoor air pollution in developing countries.

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