Risk factors for indoor air pollution in rural households in Mauche division, Molo district, Kenya

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Abstract

Background: Exposure to indoor air pollution may be responsible for nearly 2 million per year deaths in developing countries. In Kenya, it is among the factors linked to high morbidity, especially in children aged below five years.

Objectives: The survey was conducted in 2005 in 350 rural households to identify household factors that are likely to enhance indoor air pollution.

Methods: Questionnaire, continuous and spot observations were used to collect data on household characteristics, type of primary building in homestead, number of rooms, type of ventilation present and type of fuel used by the household.

Results: State of housing and type of fuel used were found to be likely risk factors for indoor air pollution. Fifty two point six percent of those interviewed live in mud walled houses with iron sheet roofs. Ninety one percent live in either single or two roomed houses. Ventilation is provided both by small windows and a space left in between the wall and roof. Thirty seven percent of observed houses have no windows. In all households, fuel wood is used for cooking.

Conclusion: State of housing and fuel used in sampled households encourage indoor air pollution, which has been associated with various diseases.

Key words: biomass fuel, children, indoor pollution, respiratory infections, ventilation.

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Introduction

The World Health Organization (WHO) has assessed the contribution of a range of risk factors to the burden of disease and revealed indoor air pollution as the 8th most important risk factor and responsible for 2.7% of the global burden of disease . Globally, indoor air pollution is responsible for 1.6 million deaths due to pneumonia, chronic respiratory disease and lung cancer, with the overall disease burden (in Disability-Adjusted Life Years or DALYs, a measure combining years of life lost due to disability and death) exceeding the burden from outdoor air pollution five fold. In high-mortality developing countries, indoor smoke is responsible for an estimated 3.7% of the overall disease burden[1]. Evidence exists of associations with low birth weight, increased infant and perinatal mortality, pulmonary tuberculosis, nasopharyngeal and laryngeal cancer and cataract[2]. Exposure to indoor air pollution may be responsible for nearly 2 million more deaths in developing countries and for some 4% of the global burden of disease[3].

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Among the major contributors of indoor air pollution is burning of biomass fuels. Approximately half the world's population and up to 90% of rural households in developing countries still rely on unprocessed biomass fuels in the form of wood, dung and crop residues[4]. These are typically burnt indoors in open fires or poorly functioning stoves. As a result there are high levels of air pollution, to which women, especially those responsible for cooking, and their young children, are most heavily exposed.

Despite the magnitude of this growing problem, the health impacts of exposure to indoor air pollution have yet to become a central focus of research, development aid and policy-making[1]. In Kenya, efforts currently in place towards improving environmental health, especially for children, are concentrated at institutional level, targeting mainly schools and public institutions. This leaves out the home environment, a setting in which the most vulnerable children, aged under five years are found. The aim of this survey was to investigate factors associated with increased risk of indoor air pollution in rural households, a situation that has been linked to high morbidity, especially in children aged below five years in Kenya by the Ministry of Health [5]. Tackling indoor air pollution is linked to achieving the Millennium Development Goals, in particular to reducing child mortality (Goal 4), to promoting gender equality and empowering women (Goal 3), to opening up opportunities for income generation and eradicating extreme poverty (Goal 1), and to ensuring environmental sustainability (Goal 7).

Methods

The survey was conducted between May and September 2005 in 350 rural households in Mauche Division. With help from village elders, the sampling frame was determined. This consisted of households with at least one child aged between one and four years old. Strategies to enhance children's Environmental Health in Kenya favour school going children. In addition, children in this age bracket are not considered in the bracket of those undergoing ante- natal care because they have completed the immunization schedules offered in public clinics, so any early signs to detect ill health can not be detected in good time. Random sampling was then used to select the 350 households. A questionnaire survey as well as continuous and spot observations were used to collect data.

Questionnaire was administered to the primary females in households to collect information on household characteristics. Continuous and spot observations were carried out concurrently. At least five visits were made to each study household. These helped collect data on type of primary building (building in which the family lives and sleeps in) in homestead, number of buildings in homestead (excluding latrine), number of rooms in the primary building, type of ventilation present in the primary building and type of fuel used by the household. For standardization, observations were made at friends and relatives' homes and the results compared and discussed. Pilot testing of the tools was carried out in similar households of River Molo watershed. The research assistants were supervised weekly. Coding of questionnaire and observation schedules was done immediately after collection in order to detect any anomalies that arose. Descriptive statistics was used to organize and analyze the data.

Results

The study area lies within the Upper River Njoro Watershed. The climate in this region is bimodal. Rainfall ranges between 760-1270mm per annum. The long rains start in March and last until June. The short rains start in August up to October. The area is newly settled and most families live as squatters (Unpublished data from area administrator's office). The average household size for the 350 households that were sampled is 6 (range 2 -15). Average number of children per household is 4 (range1-13). Average number of children per household aged below five is 2 (range 1-4). Most (91.7%) households are male headed. All households have the primary female living with the rest of the family. Of those headed by females, 86.2% are single mothers and the remaining 13.8% have fathers who live away from the rest of the family for most part of the year. No household reported having a father as a single parent.

Table 1 shows the type of housing for the sampled households. More than half (52.6%) of those interviewed live in mud walled houses with iron sheet roofs. Only one household lives in a stonewalled house. Some buildings such as those shown in figure 1 may let in the elements of weather. It has no ventilation windows.

Table 1: House type

House type	n	Percent
Stone walled	1	0.3
Timber walled with iron sheets	54	15.4
Mud walled with iron sheets	184	52.6
Iron walls with iron roof	5	1.4
Mud walled with thatch roof	76	21.7
Timber walled with thatch roof	1	0.3
Timber walled, bark of tree roof	4	1.1
Mud walled, polythene paper roof	19	5.4
Timber walled, polythene paper roof	5	1.4
Mud/timber walled, iron roof	1	0.3
Total	350	100.0

Figure 1: Mud/wooden walled house with polythene roof belonging to one of the study households

About 43% of households live in single-roomed houses; 48% in two-roomed houses and 7% in three-roomed houses. Only 2% live in four-roomed houses. The average household size is 6 for 1-2 roomed houses, and 7 for 3-4 roomed houses. Table 2 shows the number of buildings in relation to the number of rooms in primary building. Of all households, 39.1% live in single roomed houses with no other building in the homestead. This is where they carry out their activities, including cooking and sleeping. In the night, they heap the household belongings in a corner and spread their beddings on the floor. Figure 2 shows the interior of one such house, with the fire place just to the right of the table.

Where there are two buildings in the homestead, the second building was used for storing maize and other food crops after harvesting in 98.2% (n=165) of households. Where there is a third building, it was used as the kitchen/sleeping quarters for older children in 82.3% (n=14) of households. This means that 88% (n=308) of households cook in the primary building. In all the households sampled, wood fuel is used for cooking. Since the study area is next to a forest, fuel wood is readily available to all households.

Table 2: Number of buildings in homesteads in relation to number of rooms in primary building

	No. of rooms in main house			
No. of buildings in homestead	1 (n=150)	2 (n=168)	3 (n=24)	4 (n=8)
1 (n=140)	137 (39.1%)	1 (0.3%)	1 (0.3%)	1 (0.3%)
2 (n=193)	13 (3.7%)	156 (44.6)	20 (5.7%)	4 (1.1%)
3 (n=17)	0 (0.0%)	11 (3.1%)	3 (0.9%)	3 (0.9%)

Figure 2: Interior of a one roomed house occupied by one of the study households

The types of ventilation present in the primary buildings in the study homesteads include windows and a space left in between the wall and roof. Except for the single stone walled house observed in the study homesteads, all houses had a space in between the wall and roof of approximately 15cm wide, as shown in figure 3. Table 3 shows the number of windows in the primary buildings in the study households. The windows are about 30cm^2 and are made of timber. A total of 130 (37%) houses have no windows at all. During daytime, the door of such buildings is usually left open to allow light to illuminate the interior. The open door offers ventilation. However during the night when the door has to be closed, smoke from the open fire that is used for cooking, warming and in some cases, lighting fills the house since the only outlet is through the narrow ventilation between the wall and roof.

Table 3: Number of windows in primary buildings in study homesteads in relation to number of rooms

	No. of households whose houses have following no. of windows				
No. of rooms in building	**0**	**1**	**2**	**3**	**>3**
1 (n=150)	87 (24.9%)	56 (16.0%)	7 (2.0%)	0 (0.0%)	0 (0.0%)
2 (n=168)	43 (12.3%)	77 (22.0%)	48 (13.7%)	0 (0.0%)	0 (0.0%)
3 (n=24)	0.0 (0.0%)	0 (0.0%)	7 (2.0%)	17 (4.9%)	0 (0.0%)
4 (n=8)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.9%)	5 (1.4%)

Figure 3: Ventilation in between wall and roof in one of the study homesteads

Discussion

Many (43%) sampled households live in single roomed houses. These houses are likely to be crowded, given an average of six people per household in the study area. These households have an average of two children aged between 1-4 years, who in most cases stay around the home environment, since they are not of school age. They stay indoors at mealtimes during daytime and at night when open fires have to be lit for warming, cooking and lighting. During the wet and cold seasons, they also spend their time indoors. This increases their exposure to indoor air pollutants. UNICEF[6] reported a greater prevalence of Acute Respiratory Infections (ARIs) in crowded households where large families inhabit small living spaces in Central province of Kenya, and especially during cold conditions.

Using firewood for cooking in a single room that is not well aerated as observed in the study is a documented health risk[3, 7, 8]. Particulate matter, chemicals and infectious agents volatilize from open fires and ravage the respiratory systems of all the household members, especially children[9]. In poorly ventilated dwellings, such as those encountered in this study, indoor smoke can exceed acceptable levels for small particles in outdoor air 100-fold[1]. The most important substances that may damage health include particles, carbon monoxide, nitrous oxides, formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[a]pyrene[7]. Particles with diameters below 10 microns, and particularly those less than 2.5 microns in diameter, can penetrate deeply into the lungs and appear to have the greatest potential for damaging health[10].

Research by Kammen and Ezzati[11] in the Laikipia district of Kenya demonstrated a relationship between higher particulate levels and higher rates of respiratory illnesses. Lower respiratory tract infections in children have been linked to indoor air pollution by various authors[12,13,14]. Other studies have reported an association between exposure to biomass fuel smoke and upper respiratory tract infections[15,16]. Among children under five years of age, three to five million deaths annually have been attributed to ARI, of which 75% are from pneumonia[17]. In Kenya, ARI are among the leading cause of mortality, contributing to over 70% of the deaths in children under five[5]. In terms of lost healthy life years (measured as disability adjusted life years, DALYs), ARI is the chief cause of global ill health today because its biggest impact is in young children[18]. Estimates indicate that it is responsible for just under 4% of the disability-adjusted life years lost, meaning that its consequences are comparable with those of tobacco use and that they are only exceeded by those of malnutrition (16%), unsafe water and sanitation (9%)[19]. This is because of their high incidence and mortality rates among young children[20].

Studies on biomass smoke in relation to asthma in children have yielded mixed findings. Studies in Turkey[21] and Jordan[22] found no relationship between wood burning and asthma incidences. However a study in Kenya found increased exposure to wood smoke in asthmatics[23]. Pollution attributable to the use of biomass fuel causes eye irritation[13] and may cause cataract. Animal studies have shown that wood smoke condensates, like cigarette smoke, damage the lens in rats, producing discoloration, opacities and particles of debris. The mechanism is thought to involve absorption and accumulation of toxins that lead to oxidation[3].

Exposure to wood smoke has also been associated with reduced resistance to lung infection[24]. Smoke interferes with the mucociliary defences of the lungs and decreases several antibacterial properties of lung macrophages[25]. This has been given as a possible explanation for 59% of rural cases and 23% of urban cases of tuberculosis in India[3]. Such exposure may be an additional factor in the relationship between poverty and tuberculosis, hitherto explained by malnutrition, overcrowding and inadequate access to health care. Given the underdeveloped immunity in children, exposure to wood smoke is therefore a serious public health challenge in a developing country like Kenya.

Conclusion

The state of housing and type of fuel used in households encourage indoor air pollution, which in many studies has been associated with disease occurrence. Just like other countries in sub-Saharan Africa, the reliance on biomass fuels by these households and other similar ones in Kenya, will continue to grow as a result of unavailability of, or increases in the price of, alternatives such as electricity, kerosene and liquid petroleum gas. Poor rural households often do not have the resources to obtain cleaner, more efficient fuels and appliances. Therefore they should be encouraged to construct fireplaces whereby smoke is diverted to the outside, without getting into the living quarters. Similarly, the house design should be such that there are bigger windows to encourage more aeration in the houses. While seeking interventions, it is necessary to keep in mind the close interrelationship between poverty and indoor air pollution, and consequently the importance of socioeconomic development, which should be at the core of efforts to achieve healthier household environments.

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