Household Fuel Use and Prevalence of Reported Allergic Rhinitis in Rural Areas of Mpumalanga, South Africa

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***Abstract*—**

Household air pollution (HAP) exposure caused by burning of solid fuels during cooking and heating is associated with adverse health impacts. Such effects include respiratory allergic reactions and asthma. Most households in South Africa use mainly firewood and animal biomass for cooking. The use of traditional fuel for cooking and heating has been associated with allergic rhinitis especially in rural areas of South Africa. A cross-sectional study was conducted were 167 households were randomly selected after different locations were stratified. A questionnaire with both closed and open-ended questions adopted from International Study of Asthma and Allergies in Childhood (ISAAC) was used. Data was analysed using SPSS logistic regression analysis. The prevalence of household reported allergic rhinitis in the different locations were Bhubhane (64%), Mahlabatsini (53%), Masakeni (50%), Babrook (48%), KaJohn (34%) and KaDukies (23%). Allergic rhinitis was significantly associated with the use of coal, wood and kerosene. We did not find any association between allergic rhinitis and the use of charcoal and animal dung. The study showed a high prevalence of household-reported allergic rhinitis amongst children in rural areas. The findings indicate the role of particulate matter from burning traditional fuel indoors as a risk factor to allergic rhinitis.

Keywords—allergic rhinitis, biomass indoor air pollution, rural areas, solid fuels and traditional fuels.

I. INTRODUCTION

The greatest health impacts from air indoor pollution worldwide occur among the poorest and most vulnerable populations [1], [2]. Rural communities in poor countries still rely heavily on biomass fuels such as wood, charcoal, leaves and animal dung for cooking and space heating purposes [3]–[5]. South Africa is a middle-income country burdened by poverty and inequality where many South Africans are exposed to biomass fuels used for cooking and heating [6]. According to WHO, around 3.8 million people a year die from exposure to household air pollution as a result of exposure to smoke from dirty cook stoves and fuels [7]. Smoke from biomass combustion produces a large number of health-damaging air pollutants such as respirable particulate matter (PM), carbon monoxide (CO), nitrogen oxides, formaldehyde, benzene, polycyclic aromatic hydrocarbons and many other toxic organic compounds [8]. These pollutants are responsible for causing adverse health impacts such as respiratory tract infections including asthma and allergic rhinitis, rhino conjunctivitis, chronic obstructive pulmonary disease, lung cancer, cardiovascular disease and cataracts [9], [10]. Household air pollution (HAP) from the use of biomass for cooking is increasingly being recognized as a risk factor for asthma and other respiratory symptoms, especially in low- and middle-income countries [11]. Epidemiological studies have consistently shown that asthma and rhinitis often co-exist in same patients. In epidemiological studies, over 70 % of people with asthma have rhinitis [12]. Allergic rhinitis, also known as "hay fever," are associated with symptoms that are similar to the common cold including sneezing, congestion, coughing, sinus pressure, itchy watery eyes, itchy nose, mouth, and throat, and in some cases, the symptoms of hay fever can be severe that a person can't sleep or concentrate, and may feel tired or unwell [13]–[16]. It is often viewed, as a trivial disease but can significantly affect the quality of life [17]. Evidence from a limited number of studies in children suggests that the use of biomass fuels may be associated with respiratory symptoms such as allergic rhinitis compared with other fuels, but confounding by other factors associated with a traditional life-style cannot be ruled out [3], [18]. The relationship between gas and other modern fuels and the effects on women and children are well established [18], [19], however, studies of the effects from other refined fossil fuels such as kerosene on asthma and allergic disease is less well understood [3], [17], [20]. This study focused on the prevalence of household-reported allergic rhinitis caused by household fuel usage amongst children in the rural areas of Mpumalanga. A study of this nature has not been carried out before in South Africa and it is a first step towards providing baseline information for future studies.

II. METHODOLOGY

A. Study Area

Data was collected in the Mpumalanga Province which is situated in the north eastern part of South Africa. The study was conducted in 5 different locations of Louiville (Bhubhane, Mahlabatsini, Masakeni, Babrook, KaJohn and KaDukies), a rural settlement found in the town of Barberton which falls under the jurisdiction of the Ehlanzeni District Municipality. Louiville, situated next to coal and gold mines and agricultural farms where majority of the community members are employed. The prominent language of the area includes SiSwati, isiZulu, Xitsonga and isiNdebele. Most residents who have relocated to the area comes from the neighboring country (eSwatini). Houses in the area comprises of both formal and informal structures.

B. Study design, population and sample selection

A cross-sectional epidemiological study was conducted in August 2018, where interviews served as a data collection tool. The study was conducted in a rural setting identified by the local Environmental Health Services (EHS) Unit. A list of areas that formed part of the study where identified and allocated by the EHS manager. All relevant authorities and organisations where contacted for permission to conduct the study prior to its's commencement, this included the local chief who was also briefed about the study objectives and time lines. A convenient sampling method was used were a total of 177 households, were approached to participate. Only adults above the age of 18 were interviewed. The selection criteria included households with children younger than seven years old were parents answered questions on their behalf. The interviews were conducted by research assistants. Research assistants used semi-structured questionnaires to collect data from participants. The questionnaire consisted of demographic information, health outcomes (based on the ISAAC) and questions on household fuel usage. Interviews were conducted in siSwati or isiZulu however there were few households that preferred to be interviewed in Xitsonga. Ten households were excluded from the study due to bad weather conditions and insufficiency of space in some homes (these were excluded due to privacy reasons).

C. Health Outcome

A During the study, the following type of questions pertaining to the signs and symptoms of allergic rhinitis were asked:

- Has your child ever had a problem with sneezing or runny or blocked nose, when he/she DID NOT have a cold or flu? (**Yes/No**),
- In the past 12 months, has your child had a problem with sneezing or a runny or blocked nose, when they DID NOT have a cold or the flu? (**Yes/No**),
- In the past 12 months, has this nose problem been accompanied by itchy watery eyes? (**Yes/No**),
- In which of the past 12 months, has this nose problem been accompanied by itchy-watery eyes? (**Month names listed**),
- In the past 12 months, how much did this nose problem interfere with his/her daily activities including schooling? (**Not at all, a little, a moderate amount, a lot**),
- Has your child ever had hayfever? (**Yes/No**).

D. Household fuel use

Household-reported household fuel use and related questions included:

TABLE I. SELF-REPORTED HOUSEHOLD FUEL USE

Questions
What type of fuel is mostly used in your household?
Which fuel do yo you use for heating
What type of fuel do you use for cooking
Which fuel do you use for heating
Do you cook inside or ourside
Do you cook in the presence of children?

E. Data Analysis

A After data collection, the data was stored, cleaned and captured (double entry) on SSPS by research assistants under the supervision of principal investigators (who checked for missing data, duplication, etc.). The data was thereafter sent to a biostatistician in the University of Johannesburg for statistical analysis. To calculate the prevalence of health outcomes, a portion of the household energy used, was divided the number of participants who participated in the study. Feedback on the study findings were given to all who participated in this study during community meetings and municipal events. Descriptive data analysis was mostly used to display the results and odds ratio to determine statistical association amongst variables. Inferential analysis was kept to a bare minimum.

F. Ethical Consideration

The study received ethical clearance from the Research Ethics Committee of the Faculty of Health Sciences, University of Johannesburg (REC241112-035). Permission was also granted by the Ehlanzeni District Municipality and the local Chief of the area. All participants were given information sheets and signed a consent form if they agreed to participate in the study. Rules and procedures were explained to participants who could not read and write. All ethical considerations was taken into perspective during and after the study.

III. RESULTS

A. Demographic Results

Approximately 167 households participated in this study of which 82 % were female and 18% males. Demographical information revealed that 64% of the sampled population are unemployed or rely on a government grant / pension to survive. The highest education level for 64% of the sampled population ended at primary school. Houses in the community were constructed with different types of building materials such bricks, mud and corrugated iron whilst most of them were built with a combination of the above. There were 87 (52%) households that reported to have a smoker/s. Furthermore, more than 80% of these smokers smoked indoors and in the presence of other family members especially children.

B. Fuel Usage

Wood was the most predominantly used fuels in households. 75% of the participants used wood for cooking and 69 % of them used wood for heating purposes. The second highest usage of fuel is coal 15% for cooking and 14% for heating. Kerosene usage has not been popular in households i.e. only 9% used kerosene for cooking, 5 % of them used it for heating and 4 % for lighting purposes. The least popular fuel usage was animal dung were only 1% used it for cooking and 4 % for heating. Most participants have resorted to using electricity (88%) and candles 7% for lighting purposes.

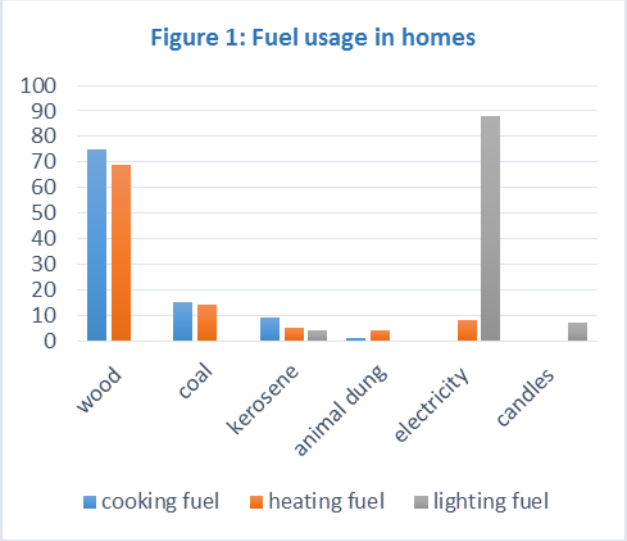

Figure 1 – shows the different types of fuel used in homes for activities such as cooking, heating and lighting.

C. Household cooking behaviour

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TABLE I. TYPE OF COOKING PRACTICES

Table 1: Cooking practices in homes			
Do you cook inside or outside		*Number*	*Percentage (%)*
	Inside	149	89
	Outside	18	11
Do you cook with children in the house	*Yes*	107	64
	No	60	36

D. Reported Health Outcome

Figure 2, shows the frequencies and percentage of household reported health outcome. The prevalence of rhinitis (ever present) was 67 %, current rhinitis 70% and current rhino conjunctivitis 69%. One hundred and thirty-five (81%) children who had experience hay fever and 90 (54%) reported to have suffered from rhinitis in the past 12 months.

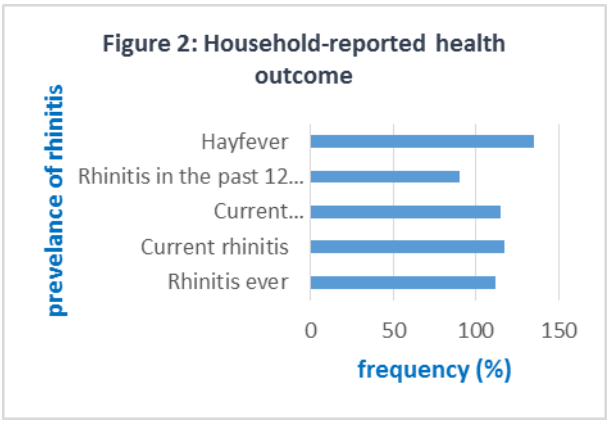

Figure 2 – Shows the prevalence of rhinitis amongst the sampled population.

Bhubhane location had a high prevalence of rhinitis ever at 63% and the lowest was KaDukies with 23 %. While the others were Mahlabatsini 53%, Babrook 48% and KaJohn 34%.

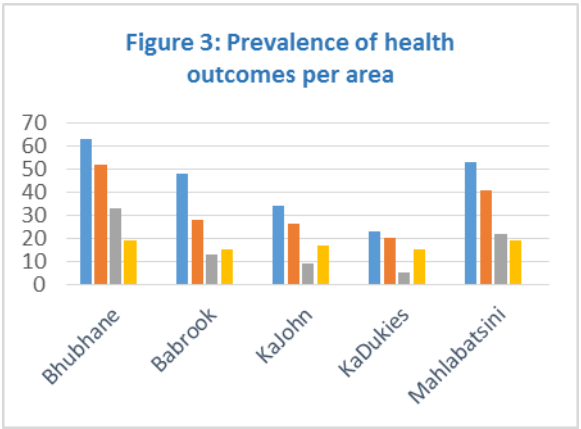

Figure 3 – Indicates the prevalence of rhinitis per location.

Table II. Relationship of household reported cooking fuel use and rhinitis ever.

Fuel used for cooking	Total	%	Crude OR (OR%-CI)	*p*	Crude OR (OR%-CI)	*p*
Wood	117	70	1.47(1.80-1.88)	0.001	1.59(1.23-2.01)	0.000
Coal	28	17	1.47(1.80-1.88)	0.000	1.47(1.80-1.88)	0.002
Paraffin	5	3	1.47(1.80-1.88)	0.001	1.47(1.80-1.88)	0.002
Electricity	17	10	1.47(1.80-1.88)	0.452	1.47(1.80-1.88)	0.691

E. Association of household fuel use and health outcomes

Children staying in household that used wood, coal and kerosene mostly were at risk of suffering from rhinitis ever (OR 1.21 95% CI: 1.05 − 1.46), current rhinitis (OR 1.26 95% CI: 1.01 − 1.40), and hay fever (OR 1.11 95% CI: 1.21 − 1.48). Cooking using wood, coal and kerosene in the presence of children increased the likelihood of the developing rhinitis (OR 1.31 95% CI: 1.04 − 1.69), hay fever (OR 1.21 95% CI: 1.07 − 1.81). Table II, shows a summary of the association between cooking fuel and rhinitis ever.

Heating households with kerosene, wood and coal contributes to rhinitis ever, current rhinitis and current rhino conjunctivitis (OR 0.65 95% CI: 0.53 − 0.81) and hay fever (OR 0.65 95% CI: 0.53 − 0.81). Cooking in the presence of children was significant associated with rhinitis ever and current rhinitis. We also found that those with less income had a likelihood of having a child suffering rhinitis ever, current rhinitis, and hay fever. Those staying close to the coal mine and had house close to the forest did not show any different ratio where compare to locations far away from the mines and forests. We did not find an association between the health outcome and smoking inside the house. Furthermore, there was no association identified with animal dung, charcoal and electricity.

IV. DISCUSSION

The overall aim of this study was to determine if the use of household fuel contributes to the prevalence of allergic rhinitis in children. To date, reviews on allergic rhinitis [21], [22], guidelines on the allergic rhinitis [23], [24] and studies on management and treatment of allergic rhinitis [25]–[29] in South Africa is widely available however there is no data available on the specific relationship between household fuel usage and allergic rhinitis. In this study, we provided baseline data for self-reported prevalence of allergic rhinitis in children. This data is important for South Africa, a developing country and many people do not have access to electricity. Still, resort to biomass fuel usage due to highly priced electricity. While, the people who have access to electricity use biomass fuels to supplement their energy usage i.e. for example use electricity for lighting but wood and coal for cooking and heating so that their electricity account is not so high. We have identified associations between biomass fuel usage in homes and the prevalence of allergic rhinitis in children. This study was carried out in rural settings were road traffic volumes are relatively low. Open fires are used to heat most homes in the area. Biomass fuels were burnt in poor ventilated homes with no chimneys and small or no windows. Most families cook and sleep in the same area or adjacent kitchen. This action or way of life can ultimately contribute to chronic respiratory related effects on the exposed individual. It would have been interesting if we carried out indoor and outdoor air sampling to supplement our findings and determine what type of pollutants are present in the atmosphere that can be a contributory factor of allergic rhinitis. Allergic rhinitis is known to even affect the quality of life of an individual [17]. More than 50 % of the sampled population suffers from rhinitis and have at one point in time in the twelve months had symptoms associated with rhinitis (117 children that suffers from rhinitis, 112 of the children had rhinitis in their lives and 90 children have had symptoms of rhinitis in the past twelve months). This study considered confounding factors such as smoking in the presence of children, socio economic status (SES) of households and cooking in the presence of children. Other environmental factors such as outdoor air pollution due to traffic, surrounding mines, agricultural farms and medical reasons that can cause or contribute to the development of rhinitis in children were not taken into consideration for this study. No verification of symptoms and physiological effects were made and the location of houses near mines could have contributed to the effects of allergic rhinitis as well.

The study used a small sample size and households that were included consisted of children under the age of 13 years. We relied on the information of the person that was at home during data collection. Children that suffered from rhinitis were not interviewed; therefore, we could not grasp a clear understanding of actual rhinitis symptoms from a child's perspective. The most insightful learnings from this study were noting important steps that that needs to be noted when assessing self-reported allergic rhinitis symptoms in children. Here we found that a simpler method of data collection should be followed when gathering information from children. Lastly, the data collection took place in the month of August where most of the health-related symptoms associated with allergic rhinitis is common due the dry autumn weather patterns being experienced.

V. CONCLUSION

These findings provide evidence that the use of fuels for cooking and heating increases the symptoms of respiratory related effects in particular allergic rhinitis. The results support the hypothesis that household fuel plays a role in the prevalence of allergic rhinitis symptoms in children reported in

the area. There is currently no information at the municipality or national level that describe comprehensively the association between household fuel usage and allergic rhinitis in South Africa. A database of this sort would be extremely useful to better understand household biomass fuel usage and its effects on the population in particular children. Proper homes and electricity supply should be made available in the near future to reduce the amount of air pollutants being generated by biomass fuel usage. A more comprehensive study with a larger sample size and scientific testing (validation methods) is vital to provide the evidence needed for government to channel their resources were it is most needed and come up with mitigation methods to prevent and reduce the current air pollution status of the area.

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