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The Impact of Household Indoor Socioeconomic Factors on the prescence of ARI among children in Nakuru Town, Kenya

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Abstract: *The prevalence of Acute Respiratory Infections (ARI) in children under 5 has commonly been attributed to exposure to polluted indoor air from biomass combustion. In Kenya, Acute Respiratory Infections (ARI) accounted for 67% of outpatient morbidity cases in children under 5 and 41% of outpatient morbidity cases in children under 5 in Nakuru Town. The cause that has been attributed to the high cases of respiratory infections in children living in rural areas is indoor air pollution from biomass combustion. Despite urban areas having a variation in household socioeconomic characteristics, clear studies have not been done to assess whether indoor air pollution from energy sources is an influencing factor on the presence of ARI in children under 5. The objective of this study was to determine the impact of household socioeconomic factors on the prevalence of ARI among children under 5. An observation and a cross-sectional household survey were conducted on 187 randomly selected households comprising of low-income and middle-income strata. The socioeconomic factors that had an influence on the presence of ARI in low-income households were, hours spent indoors and carpeting while none of the socioeconomic factors influenced the presence of ARI in middle-income households.*

Keywords: *Acute Respiratory Infections, Biomass, Household Socioeconomics, Indoor Air Pollution, Urban.*

I. Introduction

Acute Respiratory Infection (ARI) is a respiratory tract infection that usually begins as a viral infection in the nose, trachea (windpipe), or lungs, which inhibits normal breathing function. Acute respiratory infections can be categorized as upper respiratory infections and lower respiratory infections. Upper respiratory infections occur in the upper tract of the respiratory system causing the common cold. Lower respiratory infections affects the lung(s) area primarily causing pneumonia or further lung abscess and acute bronchitis. Acute respiratory infections are contagious implicating that they can spread from person to person [1]. Children, older adults, and people with immune system disorders are at a high risk of contracting this disease. For children from low-income homes, immunity problems will tend to be persistent due to the lack of proper nutritional contents and good healthcare accessibility. The World Health Organization (WHO) suggests that ARI kills an estimated 2.6 million children under-5 yearly worldwide [1]. In Kenya, ARI accounted for 67% of outpatient morbidity cases in children under 5. Likewise, in Nakuru Town, ARI accounted 41% of the reported outpatient morbidity cases in children under 5 [2]. According to Moturi (2010), lower respiratory tract infections in children have been linked to indoor air pollution. Other studies have reported an association between exposure to biomass fuel smoke and upper respiratory tract infections [3].

In Central Kenya, ARIs were found to be an increasing concave function of average daily exposure to PM10 above 1000-2000 ug/m^3. Public health programs were urged to focus on the reduction of exposure to below 2000 ug/m^3, which will provide substantial health benefits [4]. Globally, respiratory illnesses are the leading causes of outpatient morbidity and deaths. In India, a study was conducted to show the relationship between the use of biomass for cooking and the prevalence of active tuberculosis. In this study, persons that were living in households that mainly use biomass for cooking fuel had substantially higher prevalence of active tuberculosis than persons living in households that were using cleaner fuels. Fuel type was seen to have a large effect when the analysis was done separately for men (Odd Ratio=2.46: 95% Confidence Interval= 1.79-3.39) and women (OR=2.74: 95% CI= 1.86-4.05) and rural (OR= 2.65: 95% CI=1.74-4.03) and urban areas (OR 2.29; 95% CI=1.74-4.03). Fuel type used showed a higher prevalence of active tuberculosis in women and rural dwellers [5]. In China, through combined exposure-response function and current mortality and morbidity rates suggested that the burden of disease of China from indoor air pollution would decrease. For the burden of disease to decrease, outdoor air pollution needed to be reduced because it also served as a factor to respiratory diseases [6]. Indoor air pollution has further proven to be a major environmental health hazard for South African children. Studies done in South Africa have shown a strong and relatively consistent association between indoor air pollution and acute lower respiratory infections (ALRI) in children, regardless of the relatively small-scale nature of the epidemiological evidence. Children living in households that rely on polluting fuels such as wood fuels are more than 2 to 4 times likely to suffer from an ALRI as compared to children living in homes that rely on electricity. This consequentially results in up to 1,400 annual deaths in children under five [7].

Energy is an important commodity to all urban dwellers in Kenya because it is the main source of lighting and cooking. Most urban dwellers live below the national poverty line of KSH 2,913 per month per person [8], thus energy accessibility for cooking is limited to charcoal and paraffin. As for lighting, electricity grids are available, but due to high costs some urban dwellers are left to cope without. The urban poor in Kenya spent on an average 42% of their monthly income on paraffin for lighting and spent another 51% on charcoal for cooking purposes. Electricity usage for the urban poor remained at 7.7% because it was not a priority for them due to its unavailability or it being expensive. The urban non-poor households will spend 39.4% of their monthly income on charcoal, 37% will be spent on paraffin and Gas will cost about 9.6% of the monthly income. Electricity will consume 14.5% of the urban non-poor household income [8].

In urban areas in Kenya such as Nairobi, Mombasa, Kisumu, and Nakuru, the number of household members varies between the urban poor and the urban non-poor. The urban poor will tend to have more people in their homes as opposed to the urban non-poor. About 46% of urban poor will have 4-6 members living in one home while another 24% will have 7+ members. On the contrary 54% of urban non-poor will have between 1-3 members while 36% of other urban non-poor may have 4-6 members [8]. Crowding in the households will be inevitable for the urban poor unlike the urban non-poor due to their socio-economic standing.

Research that has been undertaken pertaining to household energy use and respiratory illnesses in children under 5, has primarily been done in the rural areas. The studies have indicated an association between energy use, indoor pollution and respiratory illnesses in rural areas in Kenya where wood fuel is the prevalent source of energy. In urban areas in Kenya there has not been sufficient research done on household energy use and respiratory illnesses in children under 5. Unlike rural areas, urban areas have different income groups, variation in energy sources used, and a diversity of housing structures. Thus urban areas provide a various amount of factors that make it unique for studying.

II. Materials and methods

The study was conducted in four areas of Nakuru Town, Kaptembwo, Kiratina, Shaabab and Langa-Langa. Nakuru as a Town is located 160 kilometers northwest of Nairobi, 0.2833° South and 36.0667° East along the Kenya-Uganda highway, at an altitude of 1800 meters [9]. This research was an observation and cross-sectional household survey where a comparative analysis of urban households was conducted. The sample of households cut across different socioeconomic categories of urban homes. The target population consisted of children under the age of 5 and their mothers or primary caretakers. A multi-staged sample design with a non-random first stage followed by a random second stage was used. Stage one consisted of non-random selection of low-income and middle-income areas for studying. Stage two consisted of random selection of households for studying. Purposive sampling was used across transect lines and selection of study candidates was done using the snowballing method.

The 187 homes sample size was obtained from the following formula.

$$n = n'N / N-1+n' \text{(equation 1)}$$

Where:
n = sample size
N= accessible population
n'= sample size for simple random sampling with replacement
But, $n'=Z\alpha/2/d2 \times P (1-P)$
$Z \alpha/2$ = degree of confidence taken as 1.96 at 95%
d = level of statistical significance taken as 0.05
P = proportion of the target population estimated to have the characteristic being measured ARI (taken as 0.4 at 40%).

The low-income areas of the study were Kaptembwo and Kiratina, which had a sample size consisting of 122 homes while middle-income areas of the study consisted of Shabaab (Githima) and Langa Langa, which had a sample size of 65 homes. Data was collected by the means of a questionnaire and an observational schedule. The Questionnaire was used to collect data on the socioeconomic aspects of the household such as education level, household size, income level, energy source and the child's health status. The observation schedule was used to collect data on the physical characteristics of the home such as housing type, flooring type, roofing type and ventilation.

Multiple Linear Regression analysis was used to explain the relationship between the explanatory variable (ARI) and response variables (energy sources and household indoor socioeconomic characteristics). This was to show if there was a significant impact of household indoor socioeconomic factors on respiratory illnesses in children under 5.

III. Tables

The following series of tables represent the multiple linear regression and ANOVA results for Low And Middle income household in Nakuru Town. The study sought to determine whether there was a relationship between household indoor socioeconomics and the presence of ARI among children in low and middle-income households in Nakuru Town. A multiple regression analysis was carried out at 95% confidence level (ᾱ=0.05.).

Table 1: ANOVA Low Income

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.316	13	.178	2.069	.022[b]
	Residual	9.299	108	.086		
	Total	11.615	121			

a. Dependent Variable: presence of respiratory disease.

b. Predictors: (Constant), is the house properly ventilated, level of education attained by caretaker, type of roofing, type of floor used in the house, main source of light, source of cooking fuels, any form of carpet, material used to build a house, average income of family, number of members living in the house, number of rooms, hours child spend indoor per day.

Table 2: Low Income Predictor Variables

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.617	.867		1.866	.065
	level of education attained by caretaker	-.075	.050	-.148	-1.484	.141
	number of members living in the house	.079	.055	.151	1.427	.156
	average income of family	.067	.034	.198	1.984	.050
	source of cooking fuels	-.015	.045	-.033	-.335	.738
	main source of light	.064	.040	.155	1.612	.110
	hours child spend indoor per day	-.126	.056	-.342	-2.260	.026
	material used to build a house	-.024	.020	-.117	-1.177	.242
	number of rooms	-.046	.059	-.096	-.769	.443
	type of floor used in the house	.197	.324	.057	.607	.545
	any form of carpet	-.053	.018	-.306	-3.025	.003
	type of roofing	-.047	.157	-.028	-.301	.764
	is the house properly ventilated	-.005	.069	-.009	-.079	.937

a. Dependent Variable: presence of respiratory disease

Table 3: ANOVA Middle Income

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.712	13	.132	.807	.650[b]
	Residual	8.002	49	.163		
	Total	9.714	62			

a. Dependent Variable: presence of respiratory disease

b. Predictors: (Constant), is the house properly ventilated, level of education attained by caretaker, number of members living in the house, type of roofing, type of floor used in the house, main source of light, source of cooking fuels, material used to build a house, any form of carpet, average income of family , hours child spend indoor per day, number of rooms.

Table 4: Middle Income Predictor Variables.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.947	.810		2.404	.020
	level of education attained by caretaker	-.019	.066	-.043	-.293	.771
	number of members living in the house	-.111	.076	-.206	-1.464	.150
	average income of family	-.011	.060	-.031	-.184	.855
	source of cooking fuels	-.005	.065	-.012	-.075	.940
	main source of light	.104	.168	.098	.618	.539
	hours child spend indoor per day	-.123	.128	-.258	-.963	.340
	material used to build a house	.014	.081	.029	.168	.867
	number of rooms	.024	.098	.070	.239	.812
	type of floor used in the house	.060	.125	.068	.478	.635
	any form of carpet	-.049	.039	-.207	-1.252	.217
	type of roofing	.100	.061	.231	1.645	.106
	is the house properly ventilated	-.076	.095	-.224	-.800	.427

a. Dependent Variable: presence of respiratory disease

IV. Discussion

The above TABLE 1 represents the ANOVA of regression model for low-income households. From the ANOVA, we can observe the p- value = 0.022 is less than the 0.05 significant levels. The regression analysis of low-income households represented in TABLE 2 indicated that carpeting (p=0.003) and time spent indoors (p=0.026) were the only statistically significant variables in the relationship with the prevalence of ARI among children in Low Income households. Since the p- values are less than the 0.05 significant levels, we conclude that there is a relationship between carpeting and ARI and that there is also a relationship between hours spent indoors and ARI..

The statistical analysis of middle-income households indicated that the predictor variables were statistically insignificant in the relationship between household indoor socioeconomic characteristics and the prevalence of ARI among children in middle-Income households. TABLE 3 represents the ANOVA of the regression model for middle-income households. From the ANOVA, we can observe that the p- value =0.650 is greater than 0.05 significant level. Since the p- value is greater than the 0.05 significant levels, it means that the regression model is insignificant and cannot be used in determining the relationship between household indoor socioeconomic characteristics and ARI prevalence among middle-income children. The predictor variables for middle-income households are displayed in TABLE 4. These variables were all insignificant as their p-values were greater than 0.05, thus we conclude that in middle-income households indoor socioeconomic characteristics were not influential on ARI. Energy sources in this study were not a contributing factor in the presence of ARI in children, which was contradicting to the study.

Children who spent more time spent indoors lowered their chances of contracting ARI. This could be attributed to the fact that 41% (n=50) of children in low-income households spent 13-16 hours indoors while 25.4% (n=31) spent 17-20 hours indoors. Children who spent more time indoors were less likely to be exposed to ARI pollutants because in most low income households cooking was done outside which assisted in reducing pollution factors indoors.

Those children who spent less time indoors in low-income areas had a higher chance of contracting ARI. Urban slums residents are exposed to high levels of outdoor air pollution, which could be a deterrent for their health, as they may be located near major roads, factories, overcrowded areas or dumpsites [10]. In Nakuru town, Kaptembwo being part of the low-income study areas is located behind the industrial area in Nakuru Town where emissions from the factories may be a possible cause to respiratory infections in children. Overall the dry dusty weather and emissions from burning of solid wastes on the roadsides were likely environmental hazards that low-income children came across causing them to contract respiratory diseases.

The presence of carpeting lowered the chances of children contracting ARI. In low income households 23% (n=28) had plastic carpet while 12.3% (n=15) had woolen carpet. Households that had no presence of carpet constituted of 64.8% (n=79), suggesting that the lack of carpeting contributed to a higher chance of ARI presence. Carpeting can help against the cold and dampness found in flooring. According to Habitat for Humanity Australia, Studies have identified the association between damp homes and a higher prevalence of poor health. Damp houses have a higher incidence of dust mites and mold (spores), causing or exacerbating respiratory conditions such as asthma and wheezing. This explains the high rates of respiratory illnesses in children from homes without some form of carpeting on the floor [11]. The presence of Carpeting not only served as a guard against the cold and sometime moist concrete flooring but also was a culprit if it was not cleansed properly as it retained dust, mites, moisture and allergens that would cause ARI symptoms to develop in children.

V. Conclusion

Household indoor socioeconomic characteristics that had impacted the presence of ARI among children in low income were hours spent indoor, and carpeting. Children who spent more time indoors were less likely to be exposed to factors causing ARI. Furthermore in low income households cooking was done outside which assisted in reducing pollution factors indoors. Carpeting was less preferable in low-income households, which would cause the cold concrete flooring to be a contributing factor to ARI. Also dirty carpets that were not cleansed properly retained dust, mites, moisture and allergens that would cause ARI symptoms to develop in children. In middle-income households none of the indoor socioeconomic characteristic impacted the presence of ARI among children. Energy sources used for cooking and lighting were not influential on the presence of ARI among children from low and middle-income households even though biomass fuels like charcoal were highly prevalent. The variables that were expected to be influential to the presence of Acute Respiratory Infections such as biomass energy sources used for cooking, turned out not to have any impact whatsoever on the children's health. In these urban areas children spent much more of their time during the day outside the home, where they interacted fully with their environment while playing. So it would be safe to say that outside factors played a bigger role in the presence of ARI in children.

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