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INFLUENCE OF HOUSEHOLD SOCIOECONOMIC CHARACTERISTICS ON THE PREVALENCE OF ACUTE RESPIRATORY INFECTIONS AMONG CHILDREN IN NAKURU TOWN, KENYA

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Citation:

Mugambi, M. M. (2015). Influence of household socioeconomic characteristics on the prevalence of acute respiratory infections among children in Nakuru town, Kenya. Isutsa, D. K. (Ed.). *Proceedings of the First International Research Conference held from 29th to 31st October, 2014 in Chuka University, Chuka, Kenya*, 407-411 pp.

ABSTRACT

Prevalence of Acute Respiratory Infections (ARI) in children under 5 years has been attributed to exposure to polluted indoor air from biomass combustion. In Kenya, ARI accounted for 67% of outpatient morbidity cases in children under 5 years, while in Nakuru Town, it accounted for 41%. The cause has been attributed to indoor air pollution from biomass use. Clear studies have not been done in urban areas to show if indoor air pollution from energy sources is an influential factor. In urban areas, household socioeconomic characteristics such as education level, income level, number of household members, sources of energy and the indoor structural characteristics such as ventilation vary. This study determined the influence of energy sources and household socioeconomic characteristics on prevalence of ARI among children. An observation, cross-sectional survey was conducted on 187 randomly selected households, comprising low-income and middle-income strata. In low-income homes, education ($p=0.028$), presence of carpet (no carpet) ($p=0.007$), hours spent indoor ($p=0.004$) and outdoor ($p=0.006$) had a significant impact on ARI in children. In middle-income homes, neither energy sources nor indoor socioeconomic characteristics influenced ARI presence in children. Exposure to outdoor and indoor environment, education level of caretakers and lack of carpet in low-income areas in urban centers were influential factors on the prevalence of respiratory illnesses affecting children under 5 years.

Key words: *Respiratory Infections, Indoor Air Pollution, Urban, Children.*

INTRODUCTION

Acute Respiratory Infection (ARI) is a respiratory tract infection that inhibits normal breathing function. It usually begins as a viral infection in the nose, trachea (windpipe), or lungs. 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 meaning that they can spread from person to person (DiMaria and Solano, 2012) and (WHO, n.d.). Children, older adults, and people with immune system disorders are at a high risk of contracting this disease. For persons and 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 acute respiratory infections kill an estimated 2.6 million children under-5 yearly worldwide (DiMaria and Solan, 2012). In Kenya, Acute Respiratory Infections (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.

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 (GoK, 2006), 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 (GoK, 2006).

In urban areas 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 (GoK, 2006). Crowding in the households will be inevitable for the urban poor unlike the urban non-poor due to their socio-economic standing. Around the world respiratory illnesses are also leading in lower income countries. In India, Mishra et al (1999) studied the relationship between the use of biomass cooking fuels 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 (Mishra et al., 1999). In China, Mestl et al (2007) 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 (Mestl et al., 2007). In Central Kenya, Ezzati and Kammen, 2001 found that ARIs were increasing concave functions of average daily exposure to PM₁₀ above 1000-2000 ug/m³. They suggested that public health programs should focus on reduction of exposure to below 2000 ug/m³, which will provide substantial health benefits (Ezzati and Kammen, 2001). Indoor air pollution has 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 (Barnes et al., 2009).

MATERIALS AND METHOD

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. (Nyasani, 2009). 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.

$$n = n'N / N-1+n' \text{ Where:}$$

n = sample size

N= accessible population

n'= sample size for simple random sampling with replacement

$$\text{But, } n' = Z\alpha/2/d2 \times P (1-P)$$

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%).

Stratum 1: Low Income Areas			
Location	Households	Proportion (%)	Sample Size
Kaptembwo	23, 200	85	104
Kiratina	4,239	15	18
Total	27,439	100	122
Stratum 2: Middle Income Areas			
Shaabab (Githima)	5,182	35	23
Langa Langa	9,674	65	42
Total	14,856	100	65

Source: GoK, 2009 and Nyasani 2009

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. For ventilation analysis a likert scale was used, ranging from strongly disagree to strongly agree. The definition for the scale was done after the pretesting of the questionnaire where ventilation characteristics were surveyed as follows:

1. No chimney. No hood. One door. One window- strongly disagree.
2. No chimney. No hood. One door. One window- disagree.
3. No chimney. No hood. One door. Two or more windows- neither agree or disagree.
4. No chimney. No hood. Two or more doors. Two or more windows- agree.
5. Chimney or hood. Two or more doors. Two or more windows- strongly agree.

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 energy sources and household indoor socioeconomic characteristics on respiratory illnesses in children under 5.

RESULTS

In low-income homes key variables such as the main source of cooking fuels ($p=0.927$), source of lighting ($p=0.115$), and poor ventilation ($p=0.958$) showed no significant impact on the presence of respiratory illnesses in the children. The significant regression equation model was as follows at 95% confidence level:

$ARI = 3.02 - 0.105 \text{ education} - 0.169 \text{ hours spent indoors} - 0.0778 \text{ hours spent outdoors} - 0.0473 \text{ carpeting}$, Where:
 $y_i = ARI$

$X_{1j} = -0.105 \text{ education level}$

$X_{2j} = -0.169 \text{ hours spent indoors}$

$X_{3j} = -0.0778 \text{ hours spent outdoors}$

$X_{4j} = -0.0473 \text{ carpeting}$

An increase in the level of education reduces the chance of getting ARI by 0.105. Increasing the hours spent indoor decreases the prevalence of ARI by 0.169 and decreasing the hours spent indoor increases the prevalence of ARI by 0.169. An increase in the hours spent outdoor decreases the prevalence of ARI by 0.0778 and decreasing the hours spent outdoor increases the prevalence of ARI by 0.0778. An increase in the presence of carpeting decreases the prevalence of ARI by 0.0473 while a decrease in the presence of carpeting increases the prevalence of ARI by 0.0473. Table 1 shows the ANOVA output for low-income areas.

Table 1: ANOVA (low income)

Source	DF	SS	MS	F	P
Regression	14	2.41261	0.17233	1.99	0.025
Residual error	106	9.19070	0.08670		
Total	120	11.60331			

S = 0.294457 , R-Sq = 20.8%, R-Sq(adj) = 10.3%.

In middle-income homes, key variables such as cooking fuels (p=0.750), source of lighting (p=0.065) and ventilation status (p=0.338) showed no significant impact toward ARI. The p-values were at 95% confidence level. The regression equation was reduced to the following non-significant model: $ARI = - 1.84 + 0.778 \text{ home classification}$, Where: $y_i = ARI$, and $X_{ij} = +0.778 \text{ home classification}$

Home classification was based on whether the home had a foundation or had no foundation. In middle income homes 91% (n=59 homes) of the homes had permanent foundation. The equation model suggests that a decrease in the type of home classification by a unit, then you increase the prevalence of ARI.

Table 2: ANOVA (middle income)

Source	DF	SS	MS	F	P
Regression	14	2.9851	0.2132	1.42	0.181
Residual error	49	7.3743	0.1505		
Total	63	10.3594			

S = 0.387938, R-Sq = 28.8%, R-Sq(adj) = 8.5%.

DISCUSSION

The results show that the model was significant at p=0.025 implying that the independent variables in the regression model significantly contributed to the dependent variable (ARI). The R-Square implies that the model was erroneous by 20.8%. The significant impact of education on ARI suggests that low income home caretakers are unaware of the environmental hazards that their children are exposed to inside and outside the home. According to Habitat for Humanity Australia, Dampness affects some countries more than others due to prevailing climate conditions. 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, wheezing, aches and pains, diarrhea, nausea and headaches. This explains the high rates of respiratory illnesses in children from homes without carpeting on the floor.

In Low income areas, 62% of children spent 8 or more hours outdoors in a day while 41% spent 13-16 hours outdoors a day. The increase in hours spent outdoors by low-income children decreases the presence of ARI, which suggest that a reduction in ARI prevalence will be due to the children being in a controlled environment where their exposure to indoor environmental pollutants is limited. Like wise, an increase in hours spent indoors will reduce the prevalence of ARI because the children will be away from the hazardous environmental conditions such as rampant air pollution in low income areas associated with dust weather, roadside biomass use and vehicular emissions. Furthermore, Urban slums may be located near major roads, factories, or dumpsites, for instance, exposing residents to higher levels of air pollution or to the risks of industrial accidents (Mutunga 2004). In Nakuru town, Kaptembwo being part of the low-income study areas is located behind industrial area in Nakuru Town where emissions from the factories may be a possible cause to respiratory illnesses in children. But overall the dry and dusty weather that was prevailing in Nakuru Town contributed largely to the outdoor pollution that was an influential factor to children being sick. The poor health status of children could be explained by the continuous exposure to environmental hazards and lack of good hygiene practices as well as the absence of health services in the area (Oxfam GB, 2009). A balance in number of hours spent indoors and outdoors is key to ensuring that children reduce prevalence of ARI.

The table 2 ANOVA shows that the regression equation model for middle incomes was insignificant (p=0.181). The R coefficient of determination (R-sq) implies that the model was erroneous by 28.8%. This insignificance of the model may show that the children are brought up in a friendlier, cleaner and controlled (gated communities) environments. Thus the variables listed in the study have no significant impact on their respiratory health. Middle-income children also spend similar amounts of times indoor and outdoors as low-income children. 53% of children spent 8 or more hours a day outdoors while 40% of children spent 13-16 hours in a day at home. External factors such as Air Bourne contraction cannot be ruled out as a cause of ARI presence in middle-income children due to social and public interactions (such as school) with children from low-income homes. The school going children from middle-income homes could in turn affect the children at home. The environment that most children in middle-income areas lived in was a controlled environment, gated community flats or gated homes where they were limited to straying off to the streets where much of the air pollution was concentrated.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, we concluded that in urban areas household energy sources are not significantly influential toward the prevalence of ARI in children. Findings of this research showed that in low-income neighborhoods, the level of education of the caretaker, the hours spent indoors, the hours spent outdoors and carpeting significantly influenced the presence of ARI in children under 5. In middle-income areas neither energy sources nor indoor socioeconomic characteristics had an impact on the presence of ARI in children under 5. This only seemed to suggest that the presence of ARI in middle-income children was as a result of possible interactions in public places away from home between middle income and low-income children.

At home, majority of middle income children played in controlled environments as they mostly lived in gated communities that restricted their movements toward roads and streets where solid and liquid wastes and pollution from dust, vehicular emissions and roadside biomass usage were present. Unfortunately low-income children roamed freely outside their plots and were exposed to extremely hazardous conditions that included exposure to solid and liquid wastes and air pollutants from roadside biomass usage, vehicular emissions and a dry dust weather. The interaction between low and middle-income children occurred in schools. The results of this study justify that Children living in urban areas are highly active outside their homes. The environment outside their homes, contain majority of the hazards that expose them to infections and illnesses. Children under 5 should therefore be restricted to playing in their homestead compounds or plots to keep them from the polluted outdoor environment outside their homes. The hours the children play outside and spend inside should be balanced such as to ensure they are not over exposed to one environment that could increase their illness prevalence. Recommendations:

1. Landlords of single unit homes should be responsible for ensuring that all the homes they build should have a secure roof hatch/latch window where tenants can open if they decide to cook in the home or just to let fresh air into the home. This will result in a much more conducive internal environment.
2. In low-income homes, charcoal was the main source of energy. Most of the homes did not have a cleaner alternative other than kerosene. Middle-income homes used cooking gas as an alternative energy source. Policy makers should discourage charcoal and promote green energy alternatives such as efficient eco-charcoal from recycled plant and animal waste. Price manipulation for electricity and gas should be dealt with for the sake of low-income families.
3. Throughout this study, a lot of caretakers in low-income homes were poorly sensitized on the environmental hazards that affect their children such as allowing their children to play roadside where a lot of dangers and pollution existed. Community based organizations (CBO) and women self-help groups in low-income areas should be briefed and sensitized on environmental hazards their children are exposed to.
4. Children living in urban areas are highly active outside their homes. The environment, which are outside their homes, contain majority of the hazards that expose them to infections and illnesses. Children under 5 should be restricted to playing in their homestead compounds or plots to keep them from the polluted outdoor environment outside their homes. The hours children play outside and spend inside should be balanced to ensure they are not over-exposed to one environment that could increase illness prevalence.
5. In this study, ARI was prevalent among low and middle-income children under 5. What seems to be the primary source of the ARI is the environmental conditions and factors that the children are exposed to outside their homes. Weather has seemed to be one of the major factors of ARI prevalence in children. Other factors are outside air pollution and airborne contamination through interactions with other children. Clinical officers in schools and clinics should be trained properly to diagnose ARI and be clear and precise on preventative measures and inquire on the child's environment.

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