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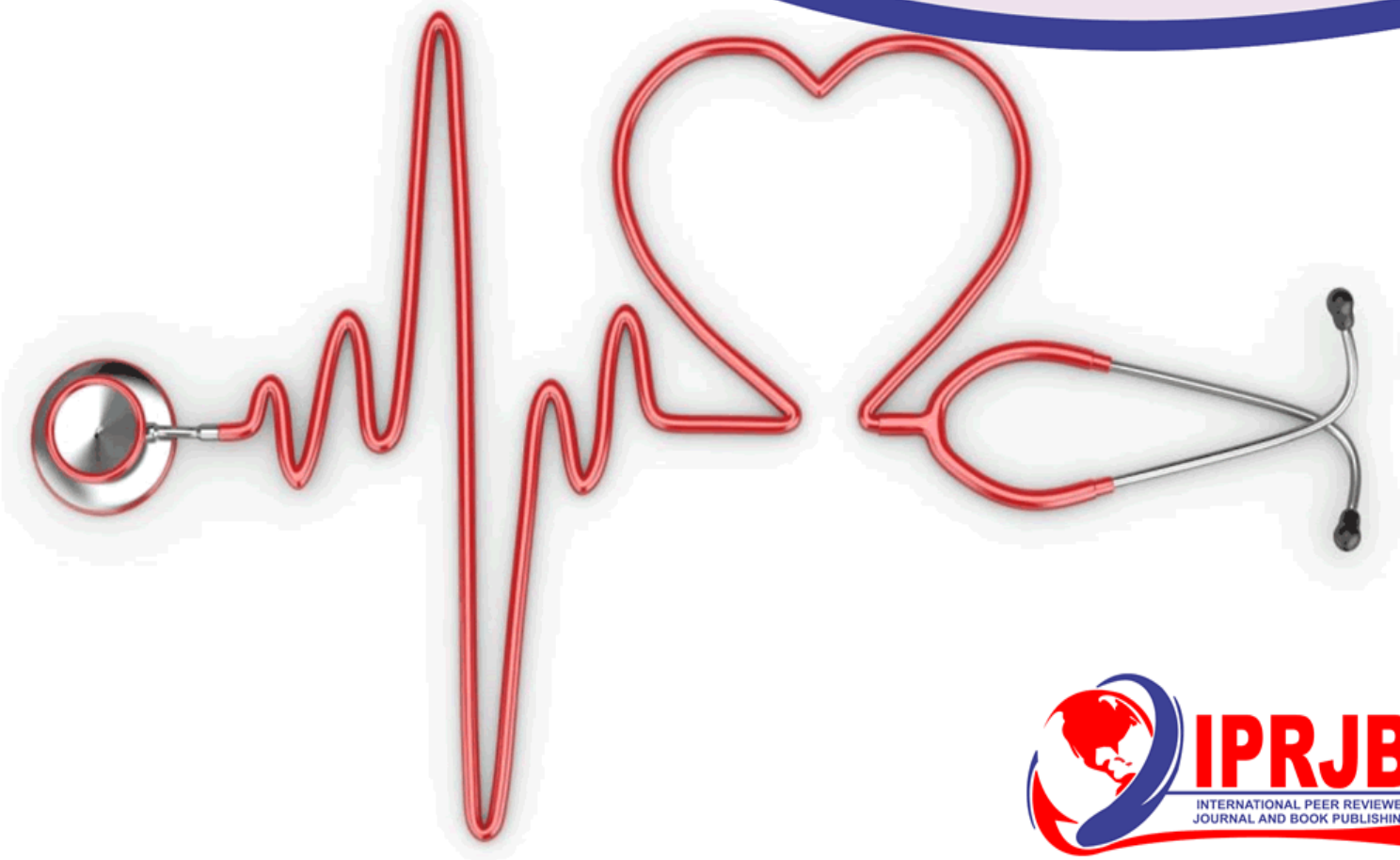

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CAREGIVERS' LEVEL OF KNOWLEDGE ON INDOOR AIR POLLUTION AND ACUTE RESPIRATORY INFECTIONS AMONG UNDER-FIVES IN INFORMAL SETTLEMENT: MAKADARA, NAIROBI COUNTY

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Abstract

Purpose: The aim of this study was to determine the caregivers' level of knowledge on indoor air pollution and risk of ARIs among 393 children below five years who live at Makadara Sub-County, Nairobi City County.

Methodology: Descriptive, cross-sectional study design was employed in this study. Semi-Structured questionnaires were used to collect data from the caregivers of children suffering from ARIs. The questionnaires contained both closed and open-ended questions, which helped participants to provide explanations about the infection, and the perceived risk factors. Closed ended questions were utilized to gather data such as income levels, age ranges, and religion. Quantitative data was cleaned, coded and analysed using the SSPS version 22. Descriptive statistics was used to describe the caregivers' socio-economic and demographic characteristics, knowledge and practices. Chi-square and ordered logistic regression was used to determine relationships and associations between the dependent variable (ARIs) and independent variables (socio-economic and demographic factors, knowledge level, and IAP).

Findings: The findings of the study will be used in the improvement of the caregivers' level of knowledge on IAP and the risk of ARIs among children below five years. There was significant statistical differences between ARIs among children below five years and cigarette smoke exposure (P=0.005), use of charcoal in cooking (P=0.002), room occupancy P=0.013), lack of ventilation (P=0.001). The mean for particulate matter in the households was 50.1556 while the S.D for those who use charcoal was 13.372, kerosene, 16.860 and gas was 10.388. The mean knowledge level was 5.39, 95% CI; 5.07-5.72. Therefore, a mean of 5.39 out of 14 represent lower knowledge level on IAP and the risk of ARIs. There was significant statistical difference between availability of windows in the house and caregivers' level of knowledge on risk factors of IAP, χ^2 (2) = 11.09, P= 0.004.

Unique contribution to theory, practice and policy: The study recommended that there is need to ensure implementation and compliance of the existing government policies on environmental pollution especially on indoor air pollution that can lead to reduction of risk factors of acute respiratory infections. This can be achieved through regular awareness creation through trainings and counselling of caregivers on the sources of indoor air pollution and risk factors associated with acute respiratory infections among children below five years.

Keywords: *Air Pollution, Respiratory Infections, Risk Factors.*

1.0 INTRODUCTION

Acute respiratory infections (ARIs) are the major cause of morbidity among children across the globe contributing to nearly two million deaths per year (Mehta et al., 2013). In 2012, WHO reported that indoor air pollution (IAP) accounted for 4.3 million lives across the world which comprised 531,190 deaths among children below five years due to acute respiratory infections (WHO, 2013; WHO, 2018). The largest problem is witnessed in low-income countries such as Kenya (Bruce et al., 2015) in which upper respiratory infections (URIs) contributes to thirty percent (30%) of all deaths while lower respiratory infections (LRIs) account for serious illnesses such as viral infections, pneumonia, and influenza that are the main sources of mortality among children. Bruce et al., (2015) noted that upper respiratory infections are the most prevalent sources of medical visits with a wide range of symptoms such as lethargy, breathing challenges, cough, sore throat, and runny nose. The lower respiratory tract infections include infections like acute bronchitis, lung abscesses, and pneumonia. Signs and symptoms include fatigue, coughing, high fever, weakness, and shortness of breath (Lakey et al., 2016).

Acute Respiratory Infection (ARI) is one of the leading causes of diseases and deaths among children below five years around the world. Annually, more than four million people die from ARIs worldwide in which about two million are children aged below five years. In the developing countries including Kenya the problem is rampant due to high rates of indoor air pollution coupled with poor housing, overcrowding in the houses, and lack of ventilation. Young children, particularly those below five years are susceptible to respiratory pathogens and also to air pollution due to their weak immunity and underdeveloped respiratory system. There is strong evidence that indoor air pollution, such as second-hand smoke and the use of biomass fuels such as charcoal and wood, is a risk factor for respiratory infections in children. The knowledge status of caregivers on indoor air pollution (IAP) and the risk factors of ARIs determine the severity and management of ARIs as well as reducing the risk factors associated with the diseases (Lakey et al., 2016).

Children are more prone to the health effects of air pollution due to their high rates of breathing, narrower airways, under-developed lungs and low immune systems, (WHO, 2013). In Africa, Sub-Saharan region is dis-proportionately affected by the ARIs among the under five children and these infections are aggravated by low socio-economic status of the people in the region. In Kenya, the ARIs contribute to nineteen percent (19%) of the total outpatient which represents twenty percent (20%) of entire hospital admissions (Matu et al., 2014).

Acute respiratory infections include both lower and upper respiratory infections. (Bruce et al., 2015) noted that upper respiratory infections (URIs) are the most prevalent sources of medical visits with various symptoms such as lethargy, breathing challenges, cough, sore throat, and runny nose and it contributes to thirty percent (30%) mortality rate. Lower respiratory infections (LRIs) account for serious infections such acute bronchitis, lung abscesses, and pneumonia. Main signs and symptoms include fatigue, coughing, high fever, weakness, and shortness of breath (Lakey et al., 2016). Bruce et al., (2015) noted that upper respiratory infections (URIs) are the most prevalent sources of medical visits with a wide range of symptoms such as lethargy, breathing challenges, cough, sore throat, and runny nose.

Notably, the predictors of ARIs include low socio-economic factors, indoor pollution, incomplete immunization, malnutrition, inadequate breast-feeding, illiteracy and poverty (Matu, 2015). Smoke from household solid and liquid cooking fuels is a complex mixture of

chemical and physical particle, (Smith et al., 1999). These indoor air pollutants can increase the risk of ARIs among young children. Other pollutants such as cigarette and charcoal smoke can adversely affect the defence mechanisms of the respiratory tract against infectious microorganisms. Further, exposure to indoor air pollutants such as kerosene and diesel fumes can be associated with severe inflammation of the respiratory tract, pulmonary fibrosis, and compromised pulmonary function. This can increase the severity, morbidity and mortality rate of the lower respiratory tract infections among children below five years, (Health Effects Institute, 1995).

The significant health effects from IAP across the globe takes place from the poorest communities and the most susceptible persons (Jackson et al., 2013). Nearly seventy six percent (76%) of total particulate matter leading to air pollution worldwide takes place indoors especially in the third world nations. Indoor air pollution is a major cause of non-communicable diseases like stroke, chronic obstructive pulmonary disease, pneumonia and lung cancer. Almost half of deaths due to pneumonia among children below five years are due to indoor air pollution (WHO, 2018). Biomass fuels from animal and plant materials, and smoking are the greatest contributors of indoor air pollution (Sonego et al., 2015). Incomplete combustion from cooking fuels produces emissions, which in the combination of poor housing, overcrowding and poor ventilation, generate very high amount of indoor pollution. In most cases, the indoor concentrations of pollutant particles surpass the recommended levels. The approved concentration level of indoor pollutants is PM_{10} 300-3000 µg/m3 but the concentration may rise to 30, 000 µg/m^3 particularly during lighting or cooking (Gurley et al., 2013). Exposure to indoor air pollutants might cause severe inflammation, thus making the infections more severe as the infecting organisms further damage already inflamed airways, (Thomas et al., 1999).

The study is anchored on Behavioural Change Theory and Theory of Change. Behavioural Change Theory (Kreuter et al., 2004; Alim et al., 2013) premises on how interventions to perceptions and behaviours to indoor air pollution can positively affect the health of people. Reduced indoor air pollution may be achieved though health education, which is sufficient to elicit behavioural change. This can be achieved through awareness creation, health education programs and caregivers' education, to reduce indoor air pollution exposure at the household level thus reducing the risk of contracting acute respiratory infections among children below five years (Armstrong et al., 1991; Egondi et al., 2013).

This study focused on caregiver's level of knowledge on indoor air pollution and the risk of acute respiratory infections on children below five years. The study was conducted at Makadara Sub-County, Nairobi City County. The Sub-County has low socio-economic status and high levels of air pollution. In addition, the Sub-County has high cases of respiratory infections among children below five years (DHIS, 2018). Little data had been documented on the caregiver's level of knowledge on indoor air pollution and the risk of acute respiratory infections among children below five years thus informed the need for this research.

1.1 Problem Statement

Environmental pollution especially air pollution has been a menace to the well-being of the Kenyan nation for a long time. Air pollution is a major cause of acute respiratory infections in the country. Indoor environments contain many biological agents such as bacteria, viruses, insects and moulds which cause severe respiratory infections among children beolow five years (Barbes, 2014). Mehta et al., (2013) argue that though acute respiratory infections are significant causes of mortality and morbidity in children across the globe, minimum advancement has been realized in their prophylaxis and control. Acute respiratory infections

contribute nineteen percent (19%) of the total outpatient, and twenty percent (20%) of the entire hospital admissions, (Matu et al, 2014). Acute respiratory infections account for seventeen percent (17%) of under-five mortality rates.

The government of Kenya (GOK) developed guidelines and policies such as; Air Quality Regulations 2014; National Environmental Policy (NEP) 2013; and Kenya Standards Act, Cap 496 to reduce air pollution. The National Environment Policy, (2013) requires compliance with air quality standards, and promotion of alternative cooking stoves that are none polluting to the environment. Despite all these government policies in place, indoor air pollution has remained a major challenge to the Kenyan population especially children below five years. In the year 2017, 165,650 children below five years were suffering from acute respiratory infections, (KNBS, 2018).

According to Gordon et al., (2014) healthcare seeking behaviours of the caregivers such as poor disease management and late seeking of health care services leads to approximately 68% of ARIs deaths. Smith et al., (2014) argue that a big percentage of caregivers are not able to pursue prompt, appropriate medical care and early seeking behaviour of childhood illness. Most of them go for over the countermedical care services from pharmacies instead of seeking care from certified medical practitioners unless they consider the illness to be severe. Caregivers with low knowledge level on the risk factors of acute respiratory infections impact negatively on the proper management of ARIs as well as reducing the risk factors associated with the disease, (Ujunwa & Ezeonu 2014). Likewise, Bates et al., (2013) indicated that caregivers have scarce information on how unclean fuels in the houses could lead to severe lower respiratory infections.

In Nairobi City County, acute respiratory infections due to air pollution cause the highest number of deaths among children under-five years as compared to other types of diseases (Matu et al., 2014). Caregivers' level of knowledge and perception of the infections is recognized as the key contributing factors of health seeking behaviours in the health facilities (Gurley et al., 2013). Caregivers with low knowledge on the risk factors of acute respiratory infections impact negatively on the proper management of ARIs as well as increasing the risk factors associated with the infections, (Ujunwa & Ezeonu, 2014). Empirical evidence from Nairobi County has highlighted that caregivers of children below five years delay in seeking appropriate medical care, this leads to heightened risk of morbidity and mortality rates due to ARIs in the County. Therefore, this study sought to determine caregivers' level of knowledge on indoor air pollution and the risk of acute respiratory infections among underfives in informal settlements, Makadara, Nairobi City County.

Study Objectives

The main objective of the study was to determine the caregivers' level of knowledge on indoor air pollution and risk of acute respiratory infections among under-fives in informal settlement at Makadara, Nairobi County. The study was guided by the following specific objectives:

i. To establish the risk factors associated with acute respiratory infections among under-fives in informal settlement at Makadara, Nairobi County.
ii. To identify the sources of indoor air pollution in the households within Makadara, Nairobi County.
iii. To assess caregivers' level of knowledge on indoor air pollution and on the risk of acute respiratory infections among under-fives in informal settlements at Makadara, Nairobi County.

iv. To establish the the relationship between caregivers' level of knowledge on indoor air pollution and the risk of acute respiratory infections among under-fives in informal settlements at Makadara, Nairobi County.

Conceptual Framework

The framework was presented through the conceptual model (Figure 1) which has three key variables including; independent variable (indoor air pollution), intermediate variable (caregivers' level of knowledge) and risk factors of acute respiratory infections as the dependent variable. Based on the discussions derived from the previous sections of this review, hypotheses were drawn from the model.

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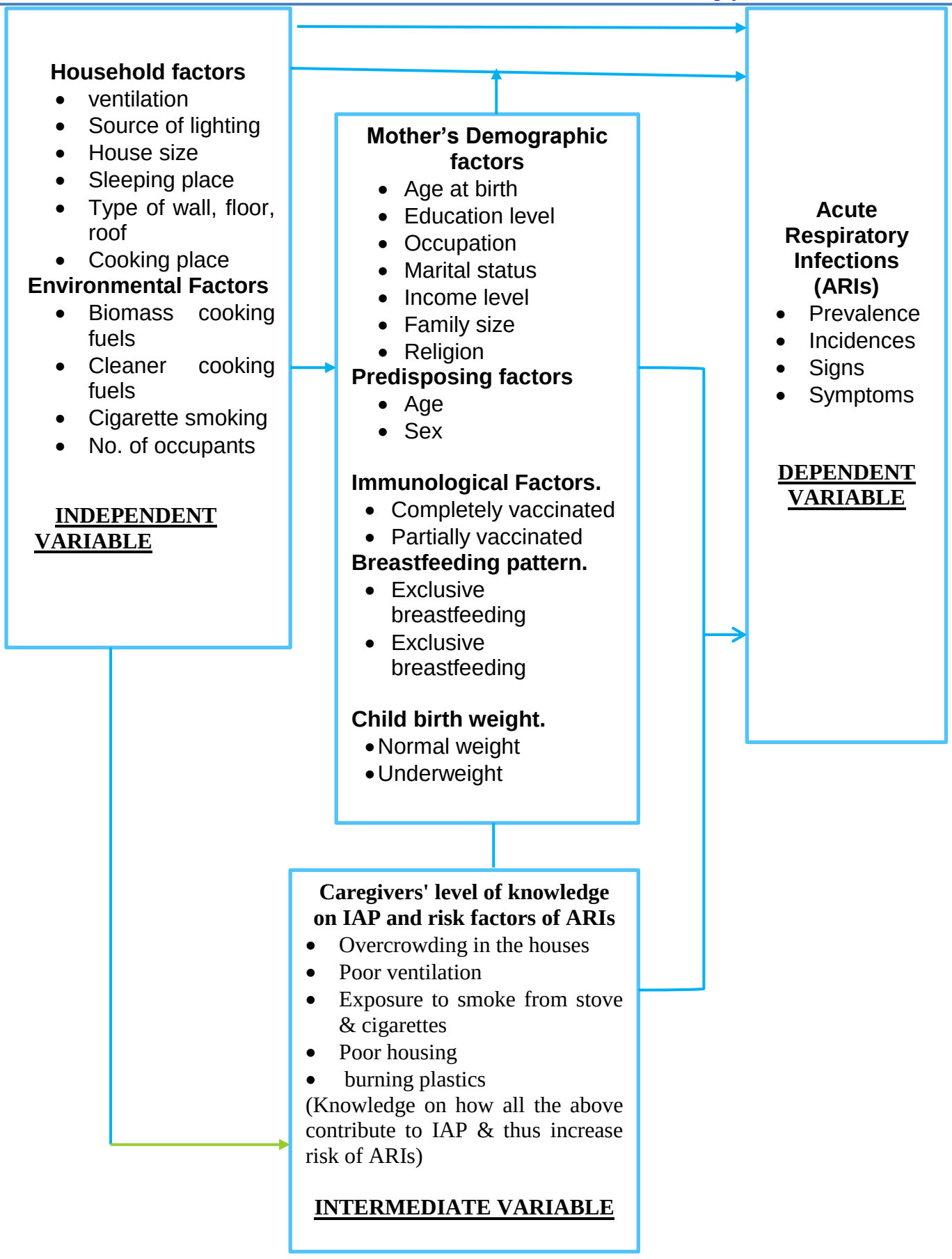

Figure 1: Conceptual Model; Constructed from Literature Review

2.0 MATERIALS AND METHODS

The study employed a cross-sectional analytical study design to determine the caregivers' level of knowledge on indoor air pollution and risk of acute respiratory infections among children below five years. Descriptive study design enabled collection of data from a pool of study participants with varied characteristics and assessment of relationships between variables in order to prove or dis-approve assumptions about the phenomena under inquiry. The study was conducted at Makadara Sub-County, Nairobi County. Makadara Sub-County is one of the seventeen (17) Sub-Counties in Nairobi County and it covers 1300 Sq. Km (Approx.). The target population for the study was children below five years and their caregivers in Makadara Sub-County, Nairobi County. From the study findings, the children below five years have registered the highest number of hospital visits and deaths in Makadara Sub-County. According to KNBS, (2013) the population in Makadara Sub-County is 160,434 people, and 22,978 children below five years. The population of sick children below five years was 261,088 and the total number of children less five years suffering from acute respiratory infections was 165,650. The study employed multi-stage sampling technique. Precisely, purposive sampling was embraced since Nairobi County had registered high rate of acute respiratory infections among children aged below five years, (KNBS, 2013). Cluster sampling were used to select one Sub-County where clusters were city blocks, townships, or sub-counties. Health facilities in the selected sub-county were sampled using simple random sampling. Caregivers with under-five children attending the health facilities for treatment of acute respiratory infections were included in the study using systematic sampling, at an interval of five. Every 5^{th} caregiver who attended the health facility was interviewed. The sample size for the study was 393 children less five years.

The study included both quantitative and qualitative data collection methods. To gather quantitative data, the questionnaires were administered, direct observation and observational checklist was used in the collection of qualitative data. The DustTruck II Aerosol Monitor 8541 was used to measure the levels of fine particulate matter in the households. Descriptive and inferential statistic (mean scores, standard deviations, percentages and frequency distribution) were used for the study. Completed questionnaires were edited for completeness and consistency, and quantitative data were cleaned, coded and analysed using Statistical Package for Social Sciences (SPSS) version 20.0 computer software. Chi square test and binary logistic analysis were used to determine the relationship between indoor air pollution and the risk of acute respiratory infections among children below five years. Multiple regression analysis was applied to establish the knowledge level of caregivers on the kind of relationship between indoor air pollution and the risk of acute respiratory infections among children below five years. Likewise, stepwise multiple regression analysis was used to test the relationship between knowledge level of caregivers, indoor air pollution, and the risk of acute respiratory infections among children below five years.

3.0 FINDINGS

3.1 Socio-demographic characteristics of the study population

Characteristics of the women who participated in the survey are presented in Table 4.1. The gender of children was boys (57.7%) and girls were 42.3%. The age of the caregivers ranged from 18 to 59. Most of the caregivers were aged 21-29 years (47.8%), while majority are married (49.1%) and Protestants (48.8%). Further, most of the people had secondary school education (42.5%). Moreover, 33.1% of participants earn less than Ksh. 10,000 per month

while 26.0% earn their living from salaried employment. Table 4.1 below summarizes the results.

3.2 Risk factors of acute respiratory infections (ARIs) among children below five years

The results established that most of the risk factors of acute respiratory infections included immunization status, Breastfeeding pattern, child birth weight. Eight (2.1%) children had low birth weight during birth.

3.2.1 Type of infection and hours spent by the caregivers with children in the house

Fifty five percent (55%) of the caregivers spent over 6 hours with their kids in the house while 29.3% and 15.3% of the respondents noted that they spent 1-3 hours and 4-6 hours, respectively with their child in the house. Fifty seven point three percent (57.30%) of the children were suffering from acute respiratory infections (ARIs) while 21.9% and 20.9% were diagnosed with signs and symptoms such as coughing and flu. Moreover, 50.4% of the caregivers perceived their kids' health as 'normal condition' while 47.1% believed the condition was 'serious disease'. Table 1below shows the results.

Table 1: Type of infection and hours spent by the caregivers with children in house

Characteristics	Category	Frequency (n)	Percent (%)
Hours spent with child in house	1-3 hours	115	29.3
	4-6 hours	60	15.3
	Over 6 hours	218	55.5
	Total	**393**	**100**
Acute respiratory infection (ARIs)	No ARIs	168	42.7
	ARIs	225	57.3
	Total	**393**	**100**
Perception of this infection	It is a serious disease	185	47.1
	It's a normal condition	198	50.4
	Don't know	10	2.5
	Total	**393**	**100**

3.2.2 Medical care seeking behaviour

Most (34.2%) of the caregivers sought medical care for their sick children the following day after the child developed signs. All the respondents reported that they followed the prescriptions as instructed by their physicians. Finally, 66.7% of the children were fully immunized while 33.3% were still eligible for immunization. Table 2 below shows the results.

Table 2: Medical Care Seeking Behaviour

Characteristics	Category	Frequency (n)	Percent (%)
When medical care was sought	Immediately the child developed signs	131	33.3
	The following day after the child developed signs	137	34.9
	After two days from the day the child developed signs	1	0.3
	When the over the counter drugs didn't work	124	31.6
	Total	**393**	**100**

3.3. Association between Acute Respiratory Infections and risk factors

A chi square test between established risk factors and acute respiratory infections was conducted to determine the association between the two. However, there was no significant

statistical association between birth weight (P=0.675), breastfeeding (P=0.664), immunization (P=0.130) and ARIs. Table 3 below summarizes the results.

Table 3: Association between Acute Respiratory Infections and Risk Factors

Variable	Acute respiratory infection		Chi square	P- value
	Yes (n=225)	No (n=168)		
Birth weight			χ^2=0.175 df=1	0.675
Normal birth weight	221 (57.4%)	164 (42.6%)		
low birth weight	4 (50.0%)	4 (50.0%)		
Breastfeeding pattern			χ^2=0.189 df=1	0.664
Mixed breast feeding	51 (59.3%)	35 (40.7%)		
Exclusive breastfeeding	174 (56.7%)	133 (131.2%)		
Immunization status			χ^2=2.293 df=1	0.130
Fully immunized	143 (54.6%)	119 (45.4%)		
Incomplete immunization	82 (62.6%)	49 (37.4%)		

3.4 Sources of Indoor Air Pollution in the Households

The majority of the study respondents resided in semi-permanent houses, 64.2% while 30.3% lived in permanent houses, only 5.3% lived in temporary houses. Sixty three point four per cent (63.4%) indicated that the air quality in their houses is poor while only 4.8 % indicated that the air quality was very good. The majority of people lived in houses made of concrete walls (70.2%) while 48.1% of the houses had iron sheets walls. Table 4 below summarizes the results:

Table 4: Sources of indoor air pollution in the households

Characteristics	Category	Number (n=393)	Proportion (%)
House type	Permanent	119	30.3
	Semi-permanent	253	64.2
	Temporary	21	5.3
Quality of air	Very poor	20	5.1
	Poor	249	63.4
	Neither Good nor bad	14	3.6
	Good	91	23.4
	Very good	19	4.8
Type of floor	Earth	68	17.3
	Cemented	325	82.7
	Total	**393**	**100**

3.4.1 Households Ventilation

Importantly, 19.1% of the houses (75 houses) had no windows or ventilation. Majority of the houses had one window (51.9%) while houses with 3 or more windows were the least

(10.4%). One hundred and eighty nine people (189) indicated that they open windows or doors when cooking while two hundred and four (204) people noted that they do not open windows and doors. One hundred and sixty two people (66.7%) pointed out the number of occupants in the house were one to three people while the rest (33.3%) specified that the number of occupants were four to six people. Table 5 below shows the results.

Table 5: Household Ventilation and Room Occupancy

Characteristics	Category	Frequency (n=393)	Proportion (%)
Windows existence	Yes	318	80.9
	No	75	19.1
	Total	**393**	**100**
Number of windows	None	75	19.1
	1	204	51.9
	2	73	18.6
	3 or more	41	10.4
	Total	**393**	**100**
Opening of windows/doors while cooking	Yes	189	48.1
	No	204	51.9
	Total	**393**	**100**
Number of occupants	1-3	162	66.7
	4-6	131	33.3
	Total	**393**	**100**

3.4.2: Type of fuel used for cooking

In terms of cooking, the respondents admitted that they were either using kerosene, gas or charcoal while cooking. Precisely, 77.9% reported that they use kerosene while the 12.7% use gas while cooking. **Figure 2. below shows the results.**

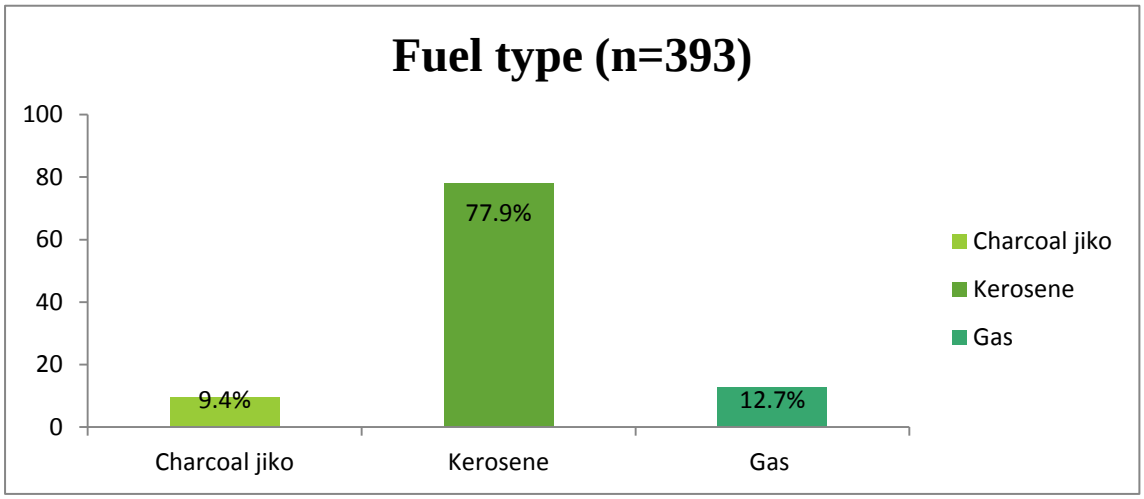

Figure 2. Type of fuel used for cooking

3.4.3: Cooking Area in the Households

Most of the respondents (51.7 %) cooked in the table room while 23.7% were cooking near the door while 16.0 % were cooking in the bedroom. The least number of respondents (8.7%) admitted that they were cooking in the kitchen. Figure 3.2 below shows the results.

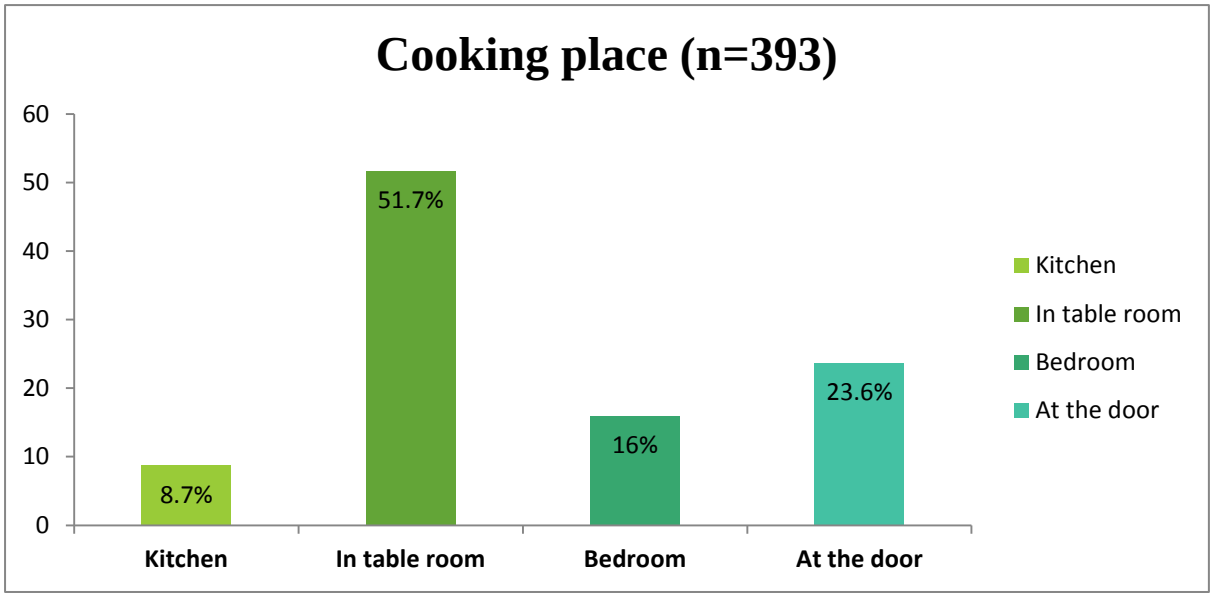

Figure 3. Cooking Area in the Households

3.4.4 Passive Smoking

The number of smokers inside the house was 11.7% while 88.3% of respondent indicated that there were no smokers in their houses. No respondent reported to be burning plastics inside their houses. Figure 3.3 below shows the results.

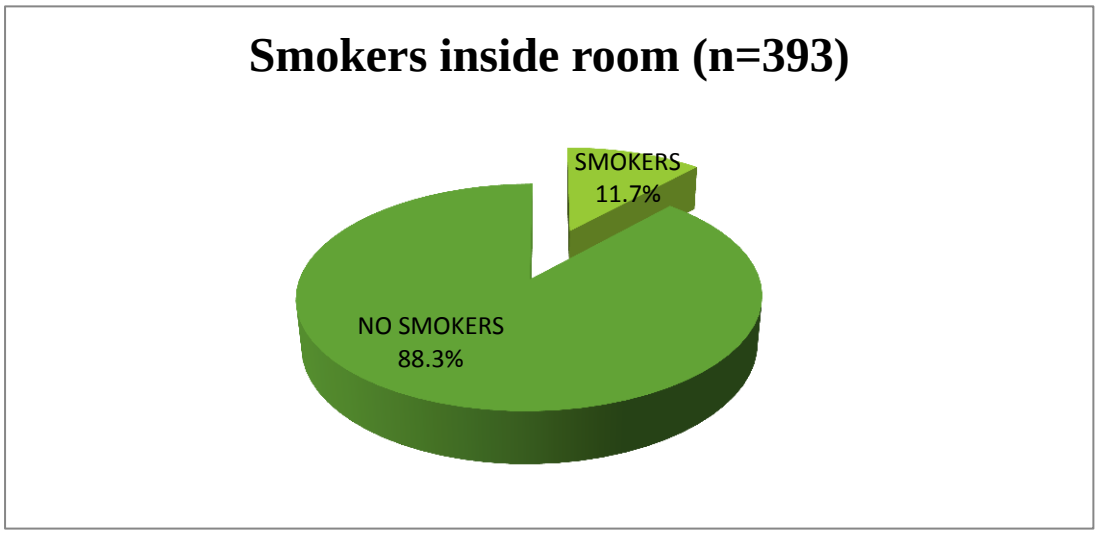

Figure 4: Passive Smoking

3.5 Levels of Indoor Air Pollution in the Households.

The levels of air pollutants collected from a sub-sample of the study area-twenty (20) households is presented in the table below. The particulate matter levels differed among the households and the types of fuel used. It was noted that most people at Makadara Sub-County use kerosene compared to those who use charcoal/firewood and gas for cooking. Most people

preferred using charcoal in preparing traditional foods especially those that take long in cooking such as traditional vegetables, githeri, beans and beef. They assume that they are much cheaper than gas or electricity. From the results, there is simultanious use of different fuels in the households, especially those that use liquified petroleum gas (LPG) and kerosene for cooking. Table 6 below summarizes the results.

Table 6. Mean particulate matter Levels

Type of fuel used	Particulate Matter level	
Charcoal/Wood	60.80	6.43 p<0.001)
Kerosene	50.70	8.23(p<0.001)
Gas/Electricy	38.95	9.58(p<0.001)

3.6 Association Between Sources of Indoor Air Pollution and Acute Respiratory Infections Among Children Below Five Years

A chi squared test indicated that there is significant statistical differences between acute respiratory infections among children below five years and cigarette smoke exposure (P<0.001), use of charcoal in cooking (P=0.002), room occupancy (P<0.001), and lack of ventilation (P=0.001). Therefore, the proportion of acute respiratory infections is higher among children exposed to passive smoke, those living in homes using charcoal in cooking, with room occupancy of 3 people, and those living in houses without ventilation. However, there was no significant association (P=0.577) between type of floor and acute respiratory infection (ARIs). Similarly, there was no significant association (P=0.877) between lantern use and acute respiratory infection. Table 7 below summarizes the results.

Table 7: Association between sources of indoor air pollution and Acute Respiratory Infections among children below five years.

Variable	**Acute respiratory infection**		**Chi square**	**P- value**
	Yes (n=225)	**No (n=168)**		
Type of floor			χ^2=0.311	
Earth	41 (18.2)	27 (16.1)	df=1	0.577
Cemented	184 (81.8)	141 (83.9)		
Type of fuel used in the households			χ^2=11.31	
Charcoal	30 (81.1)	7 (18.9)	df=2	
Kerosene	172 (56.2)	134 (43.8)		0.004
Gas	23 (46.0)	27 (54.0)		
Passive smoker			χ^2=35.04	<0.001
Yes	45 (94.4)	1 (5.6)	df = 1	
No	208 (59.94)	139 (40.06)		
Lantern use in the house			χ^2=0.057	0.811
Yes	60 (58.3)	43 (41.7)	df=1	
No	165 (56.9)	125 (43.1)		
Room occupancy			χ^2=94.74	<0.001
Less than 3	105 (46.7)	157 (93.5)	df=1	
More than 3	120 (53.3)	11 (6.5)		
Ventilation (windows)			χ^2=11.49	0.001
Yes	169 (75.1)	149 (46.9)	df =1	
No	56 (74.7)	19 (25.3)		

3.7 Caregivers' level of knowledge on indoor air pollution and risk of acute respiratory infections among children below five years

The mean knowledge level was 5.39, 95% confidence interval (CI); 5.07-5.72. Therefore, a mean of 5.39 out of 14 represent low knowledge level on indoor air pollution and the risk of acute respiratory infections. Persons who scored less than 40% were the majority at 52.4 percent, medium (scored 40%-69%) knowledge level at 34.9% and high (scored over 70%) at 12.7 percent. Table 8 below shows the results.

Table 8: Caregivers' level of knowledge on indoor air pollution and risk of acute respiratory infections among children below five years

Knowledge Level	Frequency (n)	Percent (%)
Low (Below 40%)	206	52.4
Medium (40-69%)	137	34.9
High (70-100%)	50	12.7

3.7.1 Association between availability of windows in the households and caregivers' level of knowledge on indoor air pollution.

A chi-squared test was conducted to determine the relationship between knowledge level of indoor air pollution and sources of indoor air pollution such as availability of windows. There was significant statistical association between availability of windows in the house and knowledge level of risk factors of indoor air pollution; χ^2 (2) = 11.09, P= 0.004. Table 3.10 below summarizes the results.

Table 9: Association between availability of windows in the households and caregivers' level of knowledge on indoor air pollution

Knowledge level	Windows Availability		Chi-square, *P*-value
	Yes (%)	No (%)	
Low	155 (75.2)	51 (24.8)	χ^2=11.09
Medium	116 (84.7)	21 (15.3)	P= 0.004 df=2
High	47 (94.0)	3 (6.0)	
Total	**318**	**75**	

3.7.2 Association between number of windows and caregivers' knowledge level on indoor air pollution

A chi-squared test assessed the relationship between knowledge level on the indoor air pollution and the number of windows in the house. There was a statistical significant difference between knowledge level on indoor air pollution and number of windows in the house; χ^2 (6) =20.31, P=0.002. Table 10 below shows the results.

Table 10: Association between number of windows and caregivers' knowledge level of indoor air pollution.

Number of Windows	Caregivers' Knowledge Level			Chi square (P-value)
	Low (%)	Medium (%)	High (%)	
0	51 (68.0)	21 (28.0)	3 (4.0)	χ^2=20.31 *P*=0.002 df=6
1	103 (51.0)	73 (36.1)	26 (12.9)	
2	34 (45.9)	31 (41.9)	9 (12.2)	
3 or more	18 (42.9)	12 (28.6)	12 (28.6)	

3.8 Test of hypothesis

Based on the findings of the study, there is a relationship between knowledge level on the indoor air pollution and sources of indoor air pollution in terms of lack of ventilation such as windows. Therefore, we reject the first null hypothesis that there is no relationship between knowledge level of indoor air pollution (IAP) and risk of acute respiratory infections (ARIs) and sources of indoor air pollution.

4.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1. Discussion

4.1.1 Socio-Economic and Demographic Characteristics of the Caregivers of Children Below Five Years

The findings of the study show that majority of the caregivers were married women aged below thirty (30) years (47.8%), which are consistent with a study by Chege et al., (2016) and a report of World Data Atlas (2015) on Nigerian women of child bearing age. They were also christians. The study findings indicated that the mean household size in the study area was six (6) people. Majority of participants had acquired secondary school education (42.5%) while the mean household income was KES 10,000 per month , therefore were unable to finance their basic needs including supporting their travel to the health facilities early and frequently.

4.1.2 Risk Factors Associated with Acute Respiratory Infections Among Children Aged Below Five Years

The risk factors linked with acute respiratory infections among children aged below five years include child's immunization status, lack of breastfeeding, indoor air pollution, overcrowding in the houses, parent age, low child birth weight and late healthcare seeking behaviour. The study observed that there was no significant association between low birth weight of the child and the risk of acute respiratory infections. The findings of this study are

similar to a study by Tazinya et al., (2018) which was hospital based study in Cameroon. The results could be due to the fact that the impact of low birth weight on acute respiratory infections is more pronounced in neonates but this study did not include neonates.

The study observed that there was no significant association between breastfeeding and acute respiratory infections in children below five years. The study is similar to findings by Tazinya et al., (2018) which did not find any significant difference between mixed and exclusive breastfeeding in children. Exclusive breastfeeding in the early period of life is linked to stronger immunity which reduces the risk of acute respiratory infections. There was no significant statistical difference between children who were fully immunized and those who were partially immunized in terms of acute respiratory infections. Children below five years receive vaccines such as haemophilic influenza B and pneumococcal vaccines which are protective against diseases. The findings of this study are consistent to studies by Coz et al., (2017) and Tazinya et al., (2018) in Malawi and Cameroon respectively.

In the healthcare seeking behaviour, the study noted that some caregivers (34.9%) seeks medical care the following day while 31.6% sought for medical care in the health facilities after over the counter drugs do not work. This is in line with a study done by Hajat et al., (2013) which indicated that mothers sought for medical care in the health facilities when its late and the infection has worsen thus poses danger to the health of the children. The findings are also similar to Gordon et al., (2014) study which indicated that late persuing of medical care in the health facilities leads to high percentage of ARI deaths.

4.1.3 Sources of Indoor Air Pollution in the Urban Areas.

The study established that sources of indoor air pollution such as exposure to second hand smoke (passive smoking), and overcrowding increases the risk of acute respiratory infections (ARIs) among children below five years. The study findings are similar to a study by Sonego, et al., (2015) which noted that there was intensified risk of deaths from acute respiratory infections for children who lived in a home where one of the occupants was smoking. Based on this study, the chances of contracting acute respiratory infections among the under five children exposed to tobacco smoke (passive smokers) in a room was high. A study by Ujunwa & Ezeonu, (2014) indicated that smoking is linked to acute respiratory infections development. The findings of this study are similar to a study by Sanbata et al., (2014) which was conducted in Ethiopia.

The findings have demonstrated that type of fuel used for cooking determines the development of acute respiratory infections among under five children. Indoor air pollution has serious impact on the respiratory morbidity and mortality. Higher cases of acute respiratory infections were reported among children using charcoal, and there is significant association between the use of charcoal and acute respiratory infections. This kind of stove when used inside a house causes higher rate of indoor air pollution which is linked to high cases of acute respiratory infections among children under-five years. A hospital based study by Solomon et al., (2018) held this observation. Based on this study findings, use of lantern lamps in the house was also linked with acute respiratory infections among children under-five years. The results are similar to a study conducted by Solomon et al., (2018) which observed that use of non-cleaner fuel such as kerosene increases the risk of acute respiratory infections (ARIs).

The risk of acute respiratory infections among under five children increases when the number of adults sleeping in a room increases. Specifically, when the number of adults sleeping in one room is more than children it increases the probability of contracting the acute respiratory infections. The results are similar to a study by Ahmed et al., (2015) in Nigeria. The study

also observed higher cases of acute respiratory infections among children under five years in overcrowded homes. Finally, lack of ventilation such as windows raises the level of indoor air pollution and was associated to increased risk of acute respiratory infections among children less five years. The findings are similar to a study by Sanbata et al., (2014) in Ethiopia which indicated that lack of ventilation contributed to higher prevalence of acute respiratory infections.

In the study, particulate matter ($PM_{2.5)}$ levels was collected from a sub-sample of twenty (20) households in the study area. The study revealed variations of particulate matter levels in Makadara Sub-County among the different households and the different types of fuel used. The mean particulate matter ($PM_{2.5}$) level was high mainly in the households that use charcoal and wood, as the mean particulate matter ($PM_{2.5)}$ level was 60.8 $\mu g/m^3$, and standard deviation (S.D) was 13; the households that use kerosene had a mean particulate matter ($PM_{2.5}$) level of 50.7 $\mu g/m^3$ and standard deviation of 16; for those that use liquefied petroleum gas (LPG) the mean $PM_{2.5}$ level was 38.95 $\mu g/m^3$ with a standard deviation of 10. It was noted that some households were below the WHO limits of 25 $\mu g/m^3$ while others exceeded the limit. Residents in Makadara Sub-County are exposed to high levels of indoor air pollution in their homes. The findings of this study are similar to those done by Kanyiva et al., (2016) which established that, residents in low income settlements are exposed to high levels of indoor air pollution due to exposure to open flames and emisions from cooking and lighting fuels, passive smoking, and inadequate ventilation in the houses. The high levels of fine particulate matter in the households increases the risk of acute respiratory infections among children below five years, therefore, there is need for interventions focusing on clean technology especially on cooking and lighting fuels to reduce the levels of indoor air pollution in the households thus reduction in the risk of acute respiratory infections.

4.1.4 The Caregivers' Level of Knowledge on Indoor Air Pollution And Risk of Acute Respiratory Infections Among Children Below Five Years

The study indicated low knowledge level on risk factors for acute respiratory infections and indoor air pollution with an average score of 5.39/14. Higher knowledge level of indoor air pollution and risk factors of acute respiratory infections among the caregivers is associated with low risk of the disease among children under five years. The findings of this study are similar to a study by Al-Khamees, (2018) conducted in Kuwait which demonstrated that the respondents had a low knowledge level on indoor air pollution at 7.88/19.

4.1.5 Indoor Air Pollution and Risk of Acute Respiratory Infections among children Below five years

The study established that indoor air pollution can increase the risk of acute respiratory infections among children below five years. This findings concur with the study by WHO (2018) which noted that air pollution increase the problem of lower and upper respiratory infections in early childhood. The indoor air pollutants such as exposure to second hand smoke, overcrowding, use of charcoal/wood for cooking increases the risk of acute respiratory infections among children below five years. Exposure of children to cigarette and charcoal smoke can adversely affect the defence mechanisms of the respiratory tract against infectious microorganisms. Also, exposure to indoor air pollutants such as kerosene and diesel fumes can an cause severe inflammation of the respiratory tract and compromised pulmonary function. This can increase the severity, morbidity and mortality rate of the lower respiratory tract infections among children below five years. This is also in line with the study by Shi et al., (2015) which established that poor housing, congestion, smoke

emissions, and exposure to air pollution from charcoal is associated with chronic respiratory infections, lung functioning, and increase in hospital visits of children below five years.

The study also noted that indoor air pollution can increase the vulnarabibilty of children below five years to acute respiratory infections. This findings are similar to the study by Li et al., (2008) which established that children are susceptible to acute respiratory infections through inflammatory response and urban air pollution. This may impair defence mechanisms and oxidant pollutants, in particular, that can increase virus-induced inflammation of the respiratory system.

4.2 Conclusions

The factors such as birth weight, immunization status, and breastfeeding are not sigficant risk factors for acute respiratory infections. Based on the results of this study it can be concluded that the prevalence of acute respiratory infections among the under five children was high (57.3%). Indoor air pollution can be linked to high mortality cases of acute respiratory infections among children below five years. From the study, some of the indoor air pollution sources included use of charcoal and firewood while cooking, cigarettes-smoking inside the house, poor ventilation and overcrowding in the houses. This increases the risk of acute respiratory infections among children below five years in the the slums like Makadara.

Knowledge about the indoor air pollution and risk factors of acute respiratory infections among caregivers of children below five years is an essential determinant to manipulate and explicate human behaviours. It can be concluded that persons with low knowledge about the risk factors of acute respiratory infections are less likely to adopt preventative measures. Moreover, knowledge level on indoor air pollution plays a mediating role in health-related practices and behaviour of caregivers, and risk of developing acute respiratory infections among children below five years.

Indoor air pollution is one of the main causes of acute respiratory infections among children below five years. Children below five years exposed to indoor air pollutants such as exposure to second hand smoke, overcrowding, use of charcoal for cooking are more vulnerable to acute respiratory infections than children not exposed. Indoor air pollution can be associates with risk of contracting acute respiratory infections among children below five years in Makadara, Nairobi City County.

4.3 Recommendations

The study has the following recommendations.

4.3.1 Recommendation on Policy

From the study, indoor air pollution is linked to increased vulnarabity of children below five years to acute respiratoty conditions. Therefore, there is need to ensure implementation and compliance of the existing government policies on environmental pollution especially on indoor air pollution that can lead to reduction of risk factors of acute respiratory infections. This can be achieved through regular awareness creation through trainings and counselling of caregivers on the sources of indoor air pollution and risk factors associated with acute respiratory infections among children below five years. Higher knowledge level on indoor air pollution and risk factors of acute respiratory infections among the caregivers can lead to reduction of risk of the disease among children below five years.

Compliance on the existing policies for reduction in levels of air pollution especially indoor air pollution this can help in lowering the national burden of acute respiratory infections

among children below five years. Similarly, prevention of indoor air pollution demands compliance of existing policies such as Public Health Act, Cap 242 on renewable energy sources, spacious housing, and clean living environments. Studies have also indicated that interventions to reduce air pollution include changing from household use of solid fuels to cleaner fuels, and proper ventilation in the houses.

4.3.2 Recommendation for Practice

The study established that the proportion of ARIs is higher among children exposed to passive smoke, those living in homes using charcoal, those with room occupancy of more than three (3) people, and those living in houses with inadequate ventilation. Indoor air pollution is one of the main causes of acute respiratory infections and is a key environmental-linked health hazards among children below five years. Although outdoor pollutants and second-hand tobacco smoking are renowned risk factors for respiratory infections, household air pollution is significant contributor to the burden of acute respiratory infections (Matu, 2015). The study findings recorded high prevalence of acute respiratory infections among children below five years, therefore, there's need for the caregivers to have health-related practices and behaviours such as the use of cleaner fuels, improved ventilations, and stop smoking in the houses.

The effectiveness in the management and prevention of acute respiratory infections is dependent on the risk factors of the infections as well as the caregivers' practices and behaviours towards prevention mechanism, illness identification, and transmission at the household level. The study established that the knowledge level on dangerous indoor air pollutants particularly among people living in low socio-economic areas is low. Therefore, due to the low knowledge level (5.39/14) of caregivers on indoor airpollution and risk of acute respiratory infections among under-fives at informal settlements, there is need to improve on the knowledge and the minimization of indoor air pollution exposure and the reduction of the risk and cases of respiratory infections especially among children below five years at Nairobi County. This can be done through regular awareness creation to caregivers of children below five years which can be done through trainings and counselling on the sources of indoor air pollution and risks of acute respiratory infections among children below five years. Also, a wide range of mitigation approaches should be put in place such as improving ventilation conditions and introduction of cheaper cooking fuels to reduce exposure of indoor air pollution.

4.3.3: Recommendations for Further Research

Further studies should be conducted to compare the caregivers' level of knowledge on indoor air pollution and acute respiratory conditions among children below five years in various regions with varying socio-economic status in the county.

Further studies should also be conducted to compare the difference between various regions with varying socio-economic status in the county in terms of acute respiratory conditions prevalence among under five children.

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