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Research Article

Factors that influence adequacy of asthma control in children residing in Naivasha, a flower growing area in Kenya

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Background: In Kenya, asthma affects 10% of the population. One of the modifiable risk factors contributing to asthma morbidity and mortality is environmental exposure**.** Naivasha flower farms introduce pesticides persistently into the environment and these may drift onto residential property or other areas where children play. Proximity of households to the pesticide treated farms may also increase exposure of children to the pesticides. Pesticide exposure has been shown to exacerbate already existing asthma, a relationship that has not been studied in Kenya.

Objectives: To identify risk factors that exacerbate asthma and influence adequacy of Asthma control in children residing in a flower growing area in Kenya.

Methodology: The design was a cross-sectional study that involved 150 asthmatic children aged 5-12 years residing a flower growing area. The study was conducted between May and July, 2014 in Naivasha, which is home to Kenya's largest horticultural flower farms. Participants were interviewed using a structured questionnaire while asthma control was measured using a validated Asthma control tool. Logistic regression was done to identify variables that affected asthma control.

Results: Majority of the asthmatic children were males (56.7%) while females were 43.33%. Risk factors that were found to be significantly associated with asthma control were; duration of stay in or near a flower farm (OR = 0.723, 95%CI (0.538-0.975), presence of a smoker in the family (OR = 0.463, 95%CI (0.094-22.629) and presence of household pet (OR = 4.358, 95%CI (1.182-16.057). There was no significant relationship between the child's asthma control and age of child, sex of child, distance of school from flower, guardian's level of education, guardian's income, and guardian's occupation as a flower farm worker, child's age of diagnosis and use of indoor pesticides.

Conclusion: The use of Integrated Pest Management (IPM) should be promoted as it keeps environmental exposure pesticides to a minimum.

Key words: asthma, household pet, flower farm, pesticide, smoking

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1. Introduction

There is a distinction between factors that increase the risk of developing asthma and those that exacerbate an asthmatic attack in persons who have developed asthma (Beasley et al, 2000; Murray et al, 2006).Asthma patients suffer frequent attacks when exposed to risk factors hence current treatment protocols of asthma are unable to adequately prevent asthmatic exacerbations in childhood. Therefore, in order to improve asthma

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management, it is imperative to clearly understand the causes of asthma exacerbations leading to poorly controlled asthma. This would aid in the development of proper interventions against the concerned risk factors.

The WHO fact sheet of 2005 cites an estimated 80% of asthma deaths occurring in low and middle income countries. Braman et al (2006) projected that by 2025 an additional 100 million persons will have asthma. About 10% of the Kenyan population has asthma (Bernard et al, 2011). Asthma risk factors can either increase the risk of developing asthma or increase the risk of an asthmatic attack or exacerbation asthmatics.

Factors that predict the subsequent onset of asthma included male sex, mother's age at the child's birth, pneumonia, whooping cough, tonsillectomy/ adenoidectomy, allergic rhinitis, eczema and periodic abdominal pain/vomiting attacks (Anderson et al, 1986).Passive smoking, the possession of animals, living in an urban setting, growing up in a farming environment and allergen exposures are considered environmental predictors of asthma and bronchial hyper responsiveness among children (Zacharasiewcz et al, 1999; Von et al, 2000). These studies demonstrated that children exposures to household pets, passive tobacco smoke and pesticides over an extended period of time interfere with asthma control.

Environmental factors such as pollutants also contribute to development and exacerbation of asthma (Salam et al, 2004). The pollutants include pesticides that are regularly sprayed to flowers. Naivasha flower farms introduce persistent pesticides into the environment, which are believed to promote development of asthma or exacerbate already existing asthma (Njoroge et al, 2013; Senthilselvan et al, 1992).Pesticides have been known to cause inhibition of cholinesterase and thus can arouse manifestations of bronchospasm through increased cholinergic activity. Some pesticides may however act as irritants to the airway (Karpati et al, 2006). Proximity of households to treated farms may increase children's exposure to pesticides. The children are exposed to these chemicals; through drift of the pesticides from the farms, while playing in the fields, through pesticide tracking into the residents by farm working parents or other household members and incidental ingestion through their hand to mouth behaviour among others (Lu et al, 2000).This exposure may continually exacerbate asthma and result in poor asthma control (Lu et al, 2000; Curl et al, 2002).

Children are more susceptible to the adverse effects of pesticides and may sustain higher exposures than adults in the same environment. Children living in agricultural areas may therefore be exposed to higher pesticide levels (Chan-Yeung et al, 2005). Pesticides can cause respiratory muscle weaknesses, bronchoconstriction, enhanced bronchial secretions, wheezing and general respiratory distress. Children are particularly vulnerable and reactions can occur even at very low concentrations (Salameh et al, 2003; Eskenazi et al, 1999).It has been suggested that children's hand to mouth behaviour, low ratio of skin surface to body mass, reduced ability to detoxify toxic substances and increased sensitivity of cholinergic receptors to pesticides make them more vulnerable to the toxic effects of pesticides especially during their early lives. Additionally since their respiratory system is immature, it is more vulnerable to the deleterious effects of pesticides (Sanborn et al, 1991; Salameh et al, 2003). This finding is confirmed by studies that have revealed high concentrations of organophosphate metabolites in urine samples of children who lived within 400m of pesticide treated orchard farms (Curl et al, 2002).

Although an association between various risk factors and asthma exacerbations have been reported previously, no study to date has investigated the relationship between pesticide exposure and asthma control in children in Naivasha. We therefore carried out a cross sectional study to investigate the possibility. We have also investigated other risk factors that may potentially interfere with adequate asthma control in order to determine where preventive strategies should be focused in the future.

2. Methodology

2.1 Study design, site and population

A cross sectional design was used to identify the risk factors of asthma and their effect on asthma control in children. The study was carried out in 3 health facilities in Naivasha sub-county between May and July, 2014.

2.2 Study population and eligibility criteria

The target population was asthmatic children aged 5-12 years old presenting at the outpatient clinic. Asthmatic children aged 5-12 years old with an asthma diagnosis presenting to the outpatient department.

Guardians/parents were required to give consent before they could be interviewed. Patients who presented with chronic bronchial hyper-responsiveness or wheezing at least three times a week for a period of at least three months were considered to be asthmatics.

Participants excluded from the study included those above 13 years and below 5 years old, those who had respiratory tract infections e.g. tuberculosis, those who had stayed in Naivasha for a period of less than three months and children or guardians who refused to assent or give consent to participate in the study respectively.

2.3 Data collection

Convenient sampling was used to select a sample of 150 participants from the outpatient department. Only those who met the inclusion criteria were selected. The parent/guardian of each child provided detailed information on demographics, family history of asthma, school attendance, household environment (pets, indoor pesticide use), and asthma control through a structured questionnaire.

The Asthma Control Tool was used to determine whether the patient had controlled asthma (Bernard et al, 2011).

2.4 Case definition

Patients who presented with a wheeze or chronic cough occurring persistently at least three times a week for a period of three months were considered to be asthmatic.

2.5 Data analysis

Anonymous but coded raw data was entered into a Microsoft access database then exported to STATA version 12. Association between asthma control and the various variables was done using multivariate analysis in which Chi-square test was used. Conditional logistic regression models were fitted to estimate odds ratio and 95% confidence intervals. This analysis was carried out to determine the effect of the significant predictor variables, taken together, on the outcome variable which is the level of asthma control.

2.6 Ethical consideration

Approval to carry out the study was granted by the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH/UoN ERC) as per the letter referenced **KNH/ERC/A/143** dated 15th May, 2014.

Confidentiality was maintained by using codes instead of patient names. All data was kept under lock and key. Consent to participate in the study was provided by parents/guardians

3. Results

Three health facilities namely; Karagita Health centre, Finlay's medical centre and Naivasha sub-county hospital were included in the study. From these facilities, 156 patients were conveniently sampled, screened for eligibility and included in the study. However 5 questionnaires had missing information.

The mean age of the children was 8.7 years. Of the 150 children, males represented 56.7% (n=85). Half of the children (n=75) attended schools that were near the flower farms while the other half attended schools that were far from the flower farms (**Table 1**). We defined "near flower farm" as a distance of 500m or less. This represented chronic exposure to pesticides on a regular basis.

Table 1: Socio-demographic characteristics of the Asthmatic children

Factor	Categories	n (%)
Sex	Male	85 (56.67)
	Female	65 (43.33)
School attendance	Yes	146 (97.33)
	No	4 (2.67)
Distance between school and flower farm	<500m	75 (50)
	>500m	75 (50)
Previous school attendance near a flower farm?	Yes	14 (9.33)
	No	58 (38.67)
	N/A	78 (52)

Majority of the children were accompanied by their mother while 18% of the guardians were fathers. Majority of the parents were flower farm workers, with 83% being fathers and 92% being mothers. Fifty three percent of the flower farm workers had worked for more than 5 years. This represents potential risk of chronic exposure. The other parents' occupations included businessmen (8.7%), motorcycle riders (7.3%) and housewives (13.3%). Among the guardians that were not flower farm workers, 74.7% had previously worked in a flower farm indicating a previous exposure.

Risk factors for Asthma

Majority (61.33%) of the children, were first diagnosed with asthma at age between 6 and 12 years. Only 22.67% of these children had a family history of asthma. Passive smoking within the house was present among 21.33% of the children and their asthma symptoms worsened on exposure to tobacco smoke. 74.67% of the guardians worked in a flower farm and approximately a similar percentage brought home farm equipment and clothes. This was regarded as a form of take-home pesticide exposure risk to the children.

Worth noting is that 70% of the asthmatic children's households had proximity to a flower farm. Families that lived near the flower farms were aware of pesticide use by the flower farms and they reported that they noted that 64% of the children's asthma worsened during the pesticide spraying period. Residential exposure such as pets, indoors pesticides, indoor pollution (smoke) and indoor pets were differently distributed among the households (**Table 2**).

Factors affecting the Level of asthma control

Only 76% of the 150 children in this study had uncontrolled asthma. The mean age of the children with uncontrolled asthma was 8.85 years whereas the age of those with controlled asthma was 8.22years. Although the children who had uncontrolled asthma were older, this had no statistical significance (p=0.105).

From the bivariate analysis, a number of risk factors were found to significantly interfere with asthma control. Our findings revealed that passive smoking in the household resulted in uncontrolled asthma, characterized by frequent asthma attack on inhalation of the cigarette smoke. A Chi square analysis revealed that there was a statistically significant association between the level of asthma control and the presence of a smoker in the house (p=0.008) (**Table 3**).

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Table 2: Distribution of risk factors for Asthma

Factor	Categories	n (%)
Age at first diagnosis	3 months-1 year	9(6)
	2-5 years	49(32. 67)
	6-12 years	92(61.33)
Family history of asthma	Yes	34(22.67)
	No	116(77.33)
Family member with asthma	Father	9(6)
	Mother	15(10)
	Grandfather	6(4)
	Grandmother	3(2)
	N/A	117(78)
Family history of allergies	Yes	46(30.67)
	No	104(69.33)
Allergen type	N/A	102*(68)
	Dust	13(8.67)
	Strong smell	4(2.67)
	Cold	10(6.67)
	Smoke	3(2)
	Dust and strong smell	7(4.67)
	Cold & Dust	6(4)
	Fur	3(2)
	Pollen	1(0.67)
	Fur & Dust	1(0.67)
Smoker in household	Yes	32(21.33)
	No	118(78.67)
Experience asthma attack while exposed to smoke	Yes	26(17.33)
	No	5(3.33)
	N/A	119(79.33)
Household member working on farm	Yes	112(74.67)
	No	38(25.33)
Residence near farm	Yes	106(70.67)
	No	44(29.33)
Previous home near a flower farm	Yes	30(20)
	No	15(10)
	N/A	105(70)
Mother worked on flower farm while pregnant	Yes	43(28.67)
	No	107(71.33)
Items the farm employee carries home	Work clothes	90(60)
	Farm equipment	5(3.33)
	Farm chemicals	1(0.67)
	N/A	38(25.33)
	None	16(10.67)

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Factor	Categories	n (%)
Frequency of asthma attacks after moving away from farm	No asthma attacks	4(2.67)
	Less frequent attacks	24(16)
	No difference	4(2.67)
	N/A	118(78.67)
Awareness of pesticide use	Yes	136(90.67)
	No	14(9.33)
Awareness of duration of pesticide use	Yes	111(74)
	No	27(18)
	N/A	12(8)
Frequency of asthma attacks during spraying period	No asthma attacks	96(64)
	Less frequent attacks	1(0.67)
	No difference	14(9.33)
	N/A	39(26)
Cooking source	Charcoal	119(79.33)
	Firewood	11(7.33)
	Gas	18(12)
	Stove	2(1.33)
Lighting source	Kerosene lamp	22(14.67)
	Electricity	127(84.67)
	Candles	1(0.67)
Keep pets	Yes	37(24.67)
	No	113(75.33)
Type of pet	Cats	31(20.67)
	Dogs	6(4)
	N/A	113(30.67)
Indoor pesticide use	Yes	46(30.67)
	No	104(69.33)
Type of indoor pesticide	Pyrethroids	69.33
	N/A	104(69.33)

Table 3: Factors affecting asthma control

		Level of asthma control		P value
		Asthma not controlled N (%)	Asthma controlled N (%)	
Duration guardian has worked in flower farm	<3 months	0 (0.0)	0 (0.0%)	**0.046***
	6 months	2 (40.0)	3 (60.0%)	
	1 year	4 (44.4)	5 (55.6%)	
	2 years	16 (66.7)	8 (33.3%)	
	5 years	20 (87.0)	3 (13.0%)	
	>5 years	41 (77.4)	12 (22.6%)	
Is there a smoker in the household?	Yes	30 (93.8)	2 (6.2%)	**0.008***
	No	84 (71.2)	34 (28.8%)	
Presence of household pets	Yes	34 (91.9)	3 (8.1%)	**0.009***
	No	80 (70.8)	33 (29.2%)	

*p< 0.05 is statistically significant.

Most of the guardians worked in flower farm for 5 years or more. There was a statistically significant association between the level of asthma control and the duration of staying in a flower farm (p=0.046). Parents who stayed near flower farms for long were more likely to have children with poorly controlled asthma than those whose parents had stayed in farms for shorter periods. On enquiry of whether they kept pets in the houses, majority reported that they did not have pets. Chi square analysis revealed that there was a statistically significant association between the level of asthma control and the presence of pets in a household as illustrated in **Table 3**.

Conditional logistic regression models were fitted to estimate odds ratio and 95% confidence intervals. This analysis was carried out to determine the effect of the significant predictor variables, taken together, on the outcome variable which is the level of asthma control (**Table 4**). Presence of pets and duration on farm were found to be independent predictors of asthma control.

Table 4: Associations between asthma control and selected predictor variables**.**

Predictor Variable	Odds Ratio	95% CI Lower	95% CI Upper	Coefficient	p value
Presence of a Smoker	0.463	0.094	22.629	0.77	0.698
Attacks on exposure to smoke	4.040	0.409	39.896	1.40	0.232
Presence of pets	4.358	1.182	16.057	1.47	**0.027***
Duration of stay in farm	0.723	0.538	0.975	-0.32	**0.032***

*p< 0.05 is statistically significant

4. Discussion

There is a distinction between risk factors that increase the risk of developing asthma and those that increase the risk of an asthmatic exacerbation in persons who have developed asthma (Bernard et al, 2011). Asthma patients suffer exacerbations when exposed to risk factors. In previous study, factors that have been found to predict the subsequent onset of asthma included male sex of child, mothers age at the child's birth, pneumonia, whooping cough, tonsillectomy/adenoidectomy, allergic rhinitis, eczema and periodic abdominal pain/vomiting attacks(Anderson et al, 1986). Hence avoidance of individual risk factors has not been successful in preventing the development of asthma and improving asthma control (Chan-Yeung et al, 2005). Passive smoking, the possession of animals, living in an urban setting, growing up in a farming environment and allergen exposures are considered environmental predictors of asthma and bronchial hyper responsiveness among children (Zacharasiewcz et al, 1999; Von et al, 2000). This study demonstrated that exposure of children to household pets, passive tobacco smoke and pesticides over an extended period of time interfered with their asthma control.

In our findings, 93% of children who were exposed to household passive smoke had uncontrolled asthma. These results are consistent with an accumulating body of evidence that have indicated that environmental tobacco smoke resulted in diminished pulmonary function and frequent asthma exacerbations (Chilmonczyk et al, 1993).Educational interventions that emphasize reduction in environmental tobacco smoke exposure results in a significant reduction in acute exacerbations of asthma and related hospitalizations (Wilson et al, 2001).

Residing near pesticide treated areas or in agricultural regions also contributes to exposure to children. Proximity to pesticide treated farms expose children to these chemicals through drift of the pesticides from the farms, contaminated breast milk from farm worker mothers, playing in the fields, pesticide tracking into the residents by farm working parents or other household members and incidental ingestion through their hand to mouth behaviour among others (Lu et al, 2000).This study added the element of time to distance from pesticide treated flower farms. Most families had stayed near flower farms for more than 5 years and a chi square analysis revealed that there was a statistically significant association between the level of asthma control and the duration of staying in a flower farm. We hypothesized that the cumulative effect of small amounts of pesticides exposure over time is responsible for the uncontrolled asthma. Subsequent and prolonged exposure to a stimulus can cause an extreme reaction in a hyper-reactive airway.

Studies have shown that pesticides alter the nerve function controlling the smooth muscle lining of the airway, causing the airway to contract and restrain airflow thus leading to an asthma attack. Pesticides can also trigger asthma attacks by directly damaging the cell the line the lungs (Mushak et al, 1992; Vial et al, 1996). Epidemiological studies carried indicate that children of farmworkers are at elevated risk for pesticide related diseases including asthma (Maysoon et al, 2007)

Another risk factor assessed in this study was household pets. It was found that there was a statistically significant association between the level of asthma control and presence of household pets. Pets interfere with asthma control because their dander, saliva and urine can cause an allergic reaction. In addition the hair or fur can collect dust, mold and other allergens that can in turn trigger an asthmatic attack. Animal hair is often spread throughout the home via floor and ceiling fan, wind and forced air breathing (Field et al, 2002).

Studies have given contradicting findings with regards to pets and asthma. One study revealed that children with no family history of asthma had a reduced risk of wheezing on exposure to a cat, while those with a family history of asthma had an increased risk of wheezing at or after the age of 3 years. The study found no association between wheezing and exposure to dog or dog allergen. Other studies have found no association between asthma and pet exposure while others found pet ownership protective of asthma (Salam et al, 2004).

5. Conclusion

The risk factors that had a statistically significant association with asthma control were environmental tobacco smoke, residing near a pesticide farm for more than 5 years and presence of household pets. Age of child, gender of child, distance of school from flower, guardian's attributes like level of education, income, and occupation as a flower farm worker, age of child at diagnosis and use of indoor pesticides were not significant to the child's level of asthma control.

Conflict of Interest

The authors declare no conflict of interest.

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