ORIGINAL ARTICLE

EFFECT OF INSECTICIDES (PYRETHROIDS) ON LUNG FUNCTION PARAMETERS IN SCHOOL CHILDREN

Padma Rathore, Sikandar Ali Sheikh*, Ruqaya, Nida Lathiya****

Department of Physiology, Jinnah Sindh Medical University, Karachi, *Quetta Institute of Medical Sciences, Quetta, **Baqai Medical University, Karachi, Pakistan

Background: Mosquito repellants and many other insecticides contain Pyrethrins and Pyrethroids. Pyrethroids are the most commonly used household insecticides derived from Chrysanthemum flowers. These insecticides can cause several clinical problems like allergies, asthma attacks, wheezing and bronchospasm. Despite all associated side effects, pyrethroids are still considered to be least toxic. In the present study the effects of pyrethroids on lung function parameters of school children were analyzed. **Method:** The study was conducted at Government Girls Primary School, Sita Nagar, Karachi including 50 children 6–10 years old. They were divided equally into two groups. Group A (exposed to insecticidal spray) and group B (exposed to combustible coil). **Result:** The correlations between the insecticides (pyrethroids), and the spirometry variables (FVC, FEV_1, PEF, and FEV_1/FVC ratio) by linear regression analysis confirmed that pyrethroids had a strong correlation with the spirometric values under study exemplified by the significant decrease in FVC and FEV_1 after exposure to insecticidal spray. **Conclusion:** Highly significant values of FVC and FEV_1 were observed after combustible mosquito coil exposure. There was no association between FEV_1/FVC ratio, PEF, and exposure to insecticidal spray and mosquito coils.

Keywords: Pyrethrin (Natural), Pyrethroid (Synthetic), Forced Vital Capacity, FVC, Forced Expiratory Volume in 1st second (FEV_1), Peak Expiratory Flow (PEF)

Pak J Physiol 2017;13(1):26–9

INTRODUCTION

Pesticides are a classification of chemicals that are figured to execute or repulse a vermin or stop its multiplication. The actually happening pyrethrins are utilised as a model to deliver manufactured pyrethroids from petroleum subsidiaries.[1] Be that as it may, engineered pyrethroids are more tireless in the earth than the normally happening pyrethrins and are consequently utilised inside and in addition as a part of horticulture applications.[2] Pyrethrum is a general name covering both mixes. These of pyrethroids as a bug spray were perceived amid 1800 in Asia to murder ticks and different creepy crawlies, for example, bugs and mosquitoes.[3] Insecticidal properties of pyrethrins are gotten from ketoalcoholic esters of chrysanthemic and pyrethroic acids. These acids are emphatically lipophilic and quickly enter numerous creepy crawlies and deaden their sensory system.[4] Pyrethroids are nerve toxins following up on the axons in the fringe and focal sensory system of vertebrates and bugs. Their neurotoxic impact is controlled by a delayed opening of the Na^+ channel which inspires a dreary nerve activity connected with hyperactivity, tremor, ataxia, shakings and potentially loss of motion.[5] For people, pyrethroids are considerably less dangerous than different bug sprays.[6] They can bring about skin rash, upper respiratory tract aggravation, sensitivities and asthma assault.[7] It has additionally been reported that introduction to pyrethroids can bring about laryngeal indications, for example, hacking, laryngeal agony and raspiness of voice, wheezing, troublesome breathing and gentle obstacle of aviation routes.[8] There have been reports of declining lung capacities in a few asthmatics because of introduction to bug spray mist concentrates containing permethrin.[9] Diminishment in lung capacities have been seen in pesticide uncovered labourers in Lebanon.[9] In Agricultural Health Study, permethrin use on creatures and harvests was connected with wheeze and asthma in ranchers.[10] There was a report in regards to death of an asthmatic young lady because of respiratory capture while utilising cleanser containing 0.2% pyrethrin.[7] In kids, pesticide presentation was connected with insufficiencies in gross and fine engine coordination and fleeting memory.[11] Allethrin has been demonstrated to be hepatotoxic in felines.[12]

In the previous couple of decades, there was an increment in the occurrence of respiratory sicknesses which requires right finding for fitting administration. Among different examination modalities accessible, Pulmonary Function Tests (PFTs) are significant devices for appraisal of lung capacities.[11] The PFTs give information about the degree of utilitarian unsettling of lungs and for assessing the after-effects of different remedial regimens.[13] PFTs are target markers of respiratory wellbeing and an indicator of cardiorespiratory horribleness and mortality.[14] The objective of a standard PFT is to quantify wind stream rates, lung volumes and the rate of gas exchange from the alveoli to the aspiratory vessels as accurately as could reasonably be expected; the relative exactness of the gadget utilised, in this way decides the nature of the acquired results.[13] Restrictive lung ailments, for example fibrosis of the lung, lung growth, sarcoidosis, and scleroderma make the lungs scarred and littler with the goal that they contain too little air and are poor at moving oxygen into the blood.[15] Spirometry and measurement of lung volumes and capacities should be possible in kids in the event that they require undergoing such tests. With proper drilling, youngsters as youthful as 5 years old are regularly ready to perform adequate spirometry.[14] In youthful kids, Respiratory System Resistance is another approach to test lung capacity in which the child takes in and out discreetly on a mouthpiece and the flow rates and pressure changes at the mouth are measured.[16] In kids, FVC exceeds FEV_1, prompting falls in FEV_1/FVC ratio.[16]

MATERIAL AND METHODS

It was a cross-sectional analytical study carried out at Physiology Department, Fatima Lab, Baqai Medical University Teaching Hospital, and Government Primary School, Sita Nagar, Karachi. The study was approved by Ethical Committee of Baqai Medical University. A total of 50 school children of ages between 6 and 10 years, including boys and girls, was taken as test group and was divided equally into two groups A and B. Group A was exposed to insecticidal spray and Group B was exposed to combustible mosquito coils. A performa was filled regarding information about name, age, sex, height, and weight, after taking brief history and consent from parents.

Using a handheld portable spirometer model MD02374, FVC, FEV_1, PEF, FEV_1/FVC% were measured before exposure to pyrethroids. Minimum six seconds were required for exhalation to obtain maximal FVC results. Each subject performed the test three times and the best performance was taken as final.[17]

After spraying Mortein® insecticide, the classrooms were ventilated for 30 minutes and after that, group A students attended their classes as per routine. Similarly, in a separate room, group B students sat where Mortein® coils had been ignited. The process was repeated for three consecutive days.[18] Post-exposure spirometric values of both groups were taken using the same electronic portable spirometer model MD02374 and compared with pre-exposure values.[17] The concentration of pyrethroid from dust surface samples was taken through cotton swabs and then measured using mass Gas Chromatography[19] at PCSIR Laboratories. Prior to pulmonary function testing, each child was interviewed for a clinical assessment and detailed medical history.[18]

All the students were subjected to spirometry between 9:00 AM to 1:00 PM using the same equipment, i.e., handheld portable spirometer model MD02374. Children were made to sit upright while performing the test. Each child was instructed to take a full breath in, then to close the lips around the mouthpiece and blow out as hard as possible. Inspiration was full and expiration had to be maximal, forced, and continuous without pause.[18] During spirometry the nose was pinched off and the subject breathed through a disposable mouthpiece attached to the spirometer. Applying nose clips assured breathing only through the mouth and had no effect on the breathing effort and results of spirometry.[17]

A minimum of three reproducible FVC measurements were obtained.[20] Care was taken to assure that the previous normal inspiration and expiration is complete. Then a new breath was taken in as much as possible and the mouthpiece placed in the open mouth and lips pursed aroud the mouthpiece securely to avoid any leakage of expired air. The subjects were encouraged to exhale as rapidly and completely as possible. If the subjects coughed or took premature inspiration, the procedure was repeated.

The results were analysed using MS Excel. Means and Standard Deviation were calculated. Student's t-test was used to compare the two groups and $p \leq 0.05$ was taken as statistically significant.

RESULTS

In group A (exposed to insecticidal spray) the mean FVC was 1.602±0.04 before exposure and the post exposure value was 1.521±0.029 ($p<0.05$). In group B (exposed to combustible mosquito coils), the mean FVC was 1.635±0.043 before exposure and post exposure value was 1.515±0.028 ($p<0.001$) (Table-1). The mean FEV_1 of group A was 1.517±0.041 before exposure to insecticidal spray and in group B, the mean FEV_1 was 1.568±0.044 before exposure to mosquito coils. (Table-2). In group A the mean PEF was 128.68±6.314 before exposure to insecticidal spray and post-exposure value was 121.72±4.047. (Table-3).

Table-1: Comparison of pre and post exposure values of FVC in study groups (Mean±SD)

Exposure Groups	FVC	*P*
Group A (Spray) n=25		
Pre exposure	1.602±0.04	0.016
Post exposure	1.521±0.029	
Group B (Coil) n=25		
Pre exposure	1.635±0.043	0.000
Post exposure	1.515±0.028	

Table-2: Comparison of pre- and post-exposure values of FEV_1 in group A and group B

Exposure Groups	Mean FEV_1	*p*
Group A (Spray) n=25		
Pre exposure	1.517±0.041	0.021
Post exposure	1.45±0.028	
Group B (Coil) n=25		
Pre exposure	1.568±0.044	0.000
Post exposure	1.455±0.028	

Table-3: Comparison of pre and post exposure values of PEF in group A and group B

Exposure Groups	Mean PEF	*P*
Group A (Spray) n=25		
Pre exposure	128.68±6.314	0.179
Post exposure	121.72±4.047	
Group B (Coil) n=25		
Pre exposure	122.48±3.258	0.0319
Post exposure	118.64±2.443	

The mean FEV_1/FVC ratio in both groups were found to be insignificant in comparison to pre exposure values which were 93±0.737 in group A and 93.44±7.423 in group B. (Table-4).

Table-4: Comparison of pre and post exposure values of FEV_1/FVC% in group A and group B

Exposure Groups	Mean FEV_1/FVC%	*P*
Group A (Spray) n=25		
Pre exposure	93±0.737	0.327
Post exposure	94±0.529	
Group B (Coil) n=25		
Pre exposure	93.44±7.423	0.668
Post exposure	93.76±3.606	

DISCUSSION

Children and their parents often get protection from nuisance and disease bearing mosquitoes using insecticides.[7] In recent years, the use and marketing of synthetic pyrethroids is increasing as having a relatively low human toxicity.[11] However, there are reports of allergic responses to synthetic pyrethroids including allergic rhinitis and contact dermatitis in adults. People use insecticide products such as mosquito coils, liquid vaporizers, mats, lotions, creams, and aerosol sprays for preventing the menace of diseases such as malaria, filariasis and dengue etc. caused by mosquitoe bites and other household insects. The annual worldwide consumption of these residential insecticide products are in billions of units.[15]

On comparing groups A and B, highly significant differences exist between pre- and post-exposure values of group B using mosquito coils. Mosquito coils effect FVC more when compared with insecticidal spray. In a case control study of 140 Nigerian asthmatic children, there was a strong and significant association between asthma and mosquito coil.[21] In another study, household chemical exposure was associated with decline in FVC, FEV_1 and $FEF_{25–75}$ in children aged ≤8 years.[22]

In a study on 19 pesticide factory workers (exposed to pyrethroid and carbamate), there was significant decrease in FVC after 4 hours of work.[23] On comparing Group A and B, highly significant decrease in FEV_1 was observed in group B after using mosquito coil. Group A also showed significant decrease in FEV_1 after exposure to insecticidal spray. These findings are supported by a cross-sectional study of primary school children aged between 7–12 years in Tunisian Children, where exposure to mosquito coil smoke was associated with asthma and wheeze which causes decrements in lung function parameters.[24] A cross-sectional study of pesticide workers in Spain showed that acute exposure to pesticides was associated with reduced FEV_1 and chronic exposure caused decline in forced expiratory flow rate.[25] The mean FEV_1/FVC ratio in both groups were found to be insignificant in comparison to pre-exposure values in group A and in group B. It might be due to reduction in both the FVC and FEV_1 values which would result in almost normal FEV_1/FVC ratio. These results are not in accordance with the study conducted by Salameh *et al*[26] in adults in which pesticide exposed workers had 5.6 times higher risk of abnormal FEV_1/FVC ratio. The occupational exposure to vapours, gases, dust, fumes and pesticides was associated with decline in FEV_1 and FEV_1/FVC with a higher prevalence of airway obstruction in adults.[27] On comparison in group A the mean value of PEF before exposure to insecticidal spray and post-exposure values insignificant differences were found. There was insignificant association between PEF and mosquito coil usage. It might be due to acute exposure of insecticides as continuous exposure to pesticides may affect small airways, leading to peripheral airway obstruction and $FEF_{25–75}$ is believed to be a more sensitive index of airway obstruction than the FEV_1.[28] It is in accordance with a previous study in which pesticide sprayers had reduced $FEF_{25–75}$.[29] In another study, occupational exposure to insecticides was associated with lower $FEF_{25–75}$ in adults.[30]

CONCLUSION

Insecticides (Pyrethroids) exposure in the form of mosquito coil cause a highly significant decrease in FVC and FEV_1 compared to insecticidal spray. There was no association between FEV_1/FVC ratio, PEF and exposure to insecticidal spray or mosquito coil.

ACKNOWLEDGMENT

We are thankful to staff of Physiology Department, Fatima Lab, Baqai Medical University Teaching Hospital, an all participants of Government Primary School Sita Nagar, Karachi for their cooperation to complete this study.

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Address for Correspondence:

Dr Padma Rathore, Assistant Professor, Department of Physiology, Jinnah Sindh Medical University, Karachi-Pakistan. **Cell:** +92-333-2403844
Email: drpadmarathore@gmail.com

Received: 25 Jan 2017 Reviewed: 20 Mar 2017 Accepted: 24 Mar 2017