Effect of Indoor Pesticide on Neurobehavior Test Battery among Basic School Children in a Rural Area, Menoufia Governorate, Egypt

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Abstract:
Background: Children's exposure to neurotoxic compounds as pesticide poses a major problem for child health.**Objective:** To assess the prevalence of indoor pesticide use and the effect of its use on the neurobehavior test battery of Basic School Children aged 9-13 years. **Methods**:A cross-sectional study was conducted on 260 school age children (9-13) years old in Munshaat Sultan primary and preparatory schools during the period of data collection. All studied children were evaluated through history taking, general and neurological examination. Five neurobehavioral test batteries measure cognitive domain were used to assess the neurobehavioral development. **Results:** Most of the study participants reported indoor pesticide use (89%)**.** It was found that indoor pesticide use was significantly higher among participant whose mothers didn't work and having a secondary education (62%, 57%) respectively (p value< 0.05). The studied participants with indoor pesticide use exhibited highly statistically significantly lower performance in neurobehavioral test batteries than non-user. Moreover, there was a statistically significant positive correlation between the number of pesticides' bottles used and neurobehavioral test (Trail making) (p value< 0.001) while this correlation was negative in Digital span, Digital symbols, Similarity test and PASAT (p-value <0.05). **Conclusion:** Children exposure to the indoor pesticide is a prevalent problem which had a significant effect on their neurobehaviour. So we recommend to increase the community awareness regarding indoor pesticide use and exposure.
Key Words: Batteries, children, neurobehavior**,** indoor pesticide.

Introduction: Pesticides are used widely to control weeds and insect infestation in agricultural fields and various pests and disease carriers (e.g., mosquitoes, flies, ticks, rats, and mice) in houses, malls, offices, and streets.(1) However, unintended exposure to pesticides can be considered extremely hazardous to humans and other living organisms as they are designed to be poisonous.(2)

Children have been identified as particularly vulnerable to uptake of pesticides from their environment due to frequent hand-to-mouth behavior, mouthing of nonfood items, increased contact with soil, floors, and carpets where spray residues settle, and higher concentrations of pesticide residues close to the floor in their breathing zone.(3) Even very low levels of pesticide exposure may have adverse health effects at early development.(4) Their physical makeup, behavior, and physiology of children make them more susceptible to pesticides hazards than adults.(5)

The hazards range from short-term (e.g., skin and eye irritation, headaches, acute neurologic toxicity, and nausea) to chronic impacts (e.g., cancer, chronic neuron developmental impairment, asthma, and diabetes, reproductive dysfunction, and possibly dysfunction of the immune and endocrine system).(6) Exposure to pesticides has been consistently linked to

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neurobehavioral deficits in children and adolescents as reported a dose-effect relationship between increased years of exposure to pesticides and cognitive deficits in adolescent Egyptian agricultural adolescents.[7] Numerous cross-sectional and longitudinal cohort studies have provided evidence of associations between neuro-behavioral performance impairments and postnatal childhood and adolescent pesticide exposure.[8]

The current study is aiming to assess the prevalence of indoor pesticide use and the effect of its use on the neurobehavior test battery of basic school children aged 9-13 years in a Rural Area, Menoufia Governorate, Egypt.

Methods: The study was approved by the Research Ethics Committee of Menoufia University, and written informed consent was signed by one of the parents.

This study was a cross-sectional study carried out in Munshaat Sultan village, Menouf district during the period from the 1st of July 2016 until the end of April 2018.. Menouf district was selected by multistage stratified random sampling from districts affiliated to Menoufia governorate (13 districts), then Munshaat Sultan village was selected randomly from villages affliated to Menouf district.

The target population was basic school children aged (9-13) years old in Munshaat Sultan primary and preparatory schools (1 primary, 1 preparatory) (this age group was selected to be able to deal with the battery tests).

The sample size was calculated using the online raosoft program, based on the prevalence of indoor pesticide use from previous literatures which was 75%.[9] Considering the confidence interval 95% and the power of the study 80%, the calculated sample was 240 children and increased to 260 children to avoid the dropout which was proportionally allocated according to the total number of children in each school (145 Children from primary school and 115 children from preparatory school). A class from each grade was selected, each class includes (50-60) children.

Pilot study was done, to measure the feasibility of study setting, content and validity of the used tools, on a convenient sample of ten accepted subjects and were excluded from the study.

Exclusion Criteria: Children in first, second, third primary grade and third preparatory, Children with any chronic medical disorders as diabetes mellitus, hypertension, or any neurological disorder e.g. epilepsy, chronic medication use, Uncooperative children or Parents were excluded from the study.

Each child of the study group was subjected to history taking, including personal data such as age, sex, father and mother education and occupation**.** Social workers

undertook home visits to get the parents' approval for participation in the study through a written consent and collect the data of the questionnaire after their training to avoid interpersonal bias.

The questionnaire consisted of socio-demographic data according to Fahmy et al., 2015[10], data about the presence of indoor insects, rats, the use of pesticide, pattern of applying and number of bottles used per month. This questionnaire classified the studied group into user and non user according to pesticide use inside houses. The neurobehavioral assessment was performed by using Five neurobehavioral validated and reliable test batteries (the Arabic version) measuring cognitive domain which were used in previous studies in Menoufia, Egypt.[7,11,13]

Similarities Test, Digit Span Test, Digit Symbol Test, Trail Making and Paired Auditory Serial Addition were selected. Better performance is evaluated by higher scores obtained on tests of Similarities Test, Digit Span Test, Digit Symbol Test and Paired Auditory Serial Addition Test by contrast lower latencies or time to complete Trail Making Test part A.[11] Neurobehavioral battery test were performed by the researcher after training.

Statistical analysis: Data were collected, tabulated, statistically analyzed using an IBM personal computer with Statistical Package for Social Science (SPSS) version 23. Quantitative data were presented as mean, standard deviation (SD) and range and analyzed using Student t-test. Qualitative data were presented in numbers and percentages and analyzed using a Chi-squared test. (P-value) less than 0.05 was considered statistically significant.

Results: The prevalence of indoor pesticide use among the studied children was 88.9% (**figure 1).**There was a statistically significant relationship between indoor pesticide use, Mother's work and education (p-value < 0.05), as about two third of the participants with indoor pesticides, use didn't work (62%) and with mothers having a secondary education (57%) (**table 1)**.

Most of the studied participants with indoor pesticide use reported that they did not reuse the empty bottles of pesticide (85%), close windows during pesticide use (71.2%) and store the pesticide bottles at a specific place (69.6%) **(table 2)**. The studied participants with indoor pesticide use exhibited highly statistically significantly lower performance in Similarity test, Digital symbols, Digital span, Trail making (sec), PASAT (p-value <0.001) (**table 3).**There was a positive significant correlation between the number of pesticides' bottles used and neurobehavioral test (Trail making) while this correlation was negative in Digital span, Digital symbols, Similarity test and PASAT (**table 4).**

Discussion: Daily, chronic low level of exposures to pesticides are more common today among children than acute pesticide poisoning.[12] The present study revealed that that the prevalence of indoor pesticide use among the studied participants was 89%. This is in concordance with the result of Farahat et al study who found that 80.5% of the studied Egyptian Agricultural Families use pesticide frequently in homes.[13]

Also, a study of Minnesota households with children found that pesticide products were stored in 97% of the households investigated, and as many as 88% of the households reportedly had used pesticides within the past year.[14] Also, the U.S. Environmental Protection Agency (EPA) has estimated that nearly 75% of American households use pesticides.[9]

As regards socio-demographic characteristics of the studied participants, the present study denoted that the use of indoor pesticide was statistically higher among participant with not working and with mothers having secondary education.This in agreement with Berkowitz et al., who showed that the higher proportions of pesticide exposure were significantly seen among the lowest educational females.[15] On the other hand, this study disagrees with Lizardi who reported that Father's years of education was the only characteristic that was significantly different between the original Exposed and Non-exposed as fathers in the Exposed group had significantly less number of years of education than the fathers in the Non-exposed group.**(16)** This difference may be attributed to the different culture and demographic data

Also against Dawson et al., who found that there was no difference between exposed and non exposed children in age, gender, years of education of child, mother, and father.[17]

The current study showed that most of the studied participants with indoor pesticide use reported that they did not reuse the empty bottles of pesticide, close windows during pesticide use and store the pesticide bottles at a specific place. Farahat et al., reported that 47.5% did not close windows during application of pesticides and only 12.5% reuse the empty bottles, and 77.5 % of women stored the empty containers in any place either inside or outside the home.[18] Also, Dawson et al., showed that only 10% reported that they reused their empty pesticide Containers.[8]

The current study showed that the neurobehavioral Performance is statistically lower among participants with indoor pesticide use**.**These result in agreement with effects (Farahat et al., 2003 and Abdel Rasoul et al., 2008) studies in adult pesticide workers and adolescent (9-15 y) pesticide applicators respectively in the same governorate in Egypt.[7, 11] Also Rohlman et al., who showed that adolescents working in agricultural had a

poorer performance with Digit Span, Digit Symbol, and Serial Digit Learning tests.[19]

More-ever, Eckerman et al., denoted that increasing pesticide exposure was found to be associated with impairments in Tapping, Digit Span, and Selective Attention.[20] In contrast**,** lizard et al., found that Higher OP pesticide metabolites in urine were correlated with higher performance on some tests of the Wisconsin Card Sorting tests.[17] Also**,** Fiedler et al revealed no significant adverse neurobehavioral effects were observed between participant groups during either the high or low pesticide use season.[21] The variation between studies may be attributed to the differences in study design and population, exposure measurement, and neurobehavioral tests.

The present study denotes that the higher the number of pesticides' bottles used the lower performance in trail making test, Digital span, Digital symbols, Similarity test and PASAT.This agrees with Dawson et al who showed that several neurobehavioral outcomes were significantly poorer for the high exposed pesticide handlers compared to the low exposed referent farmers in the univariate analysis, The higher exposure assessed by the duration of pesticide use, the frequency of use.[8]

Conclusion: Children exposed to indoor pesticide are a prevalent problem which had a significant effect on their neuro-behavior, so it is recommended to increase the community awareness regarding indoor pesticide use and exposure.

Study limitation: Difficulty to follow the study steps. Neurobehavioral assessment was difficult because many tests are time consuming and need long time to explain how to perform these tests. Also, laboratory investigations were difficult due to high cost.

Conflict of interest: No conflict of interest.

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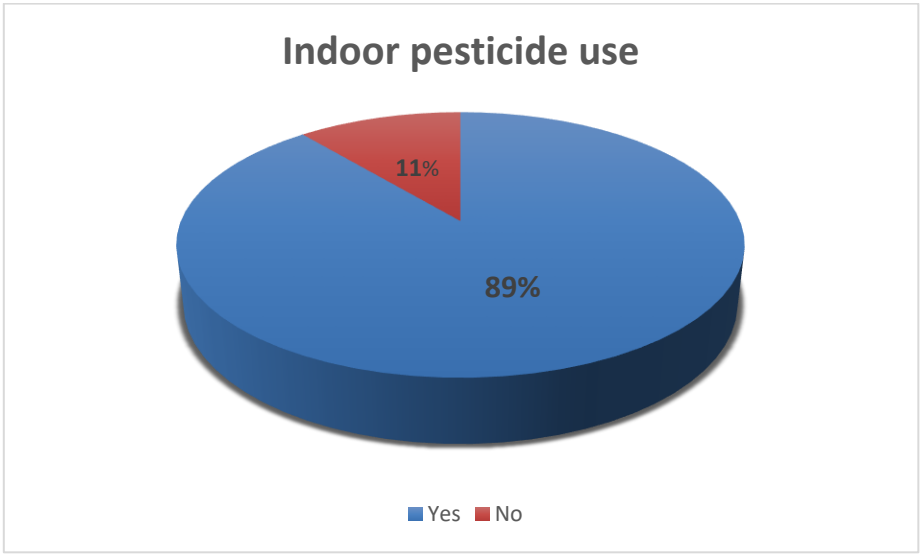

Fig (1): Frequency of indoor pesticide use among the studied participants.

Table (1): Relationship between indoor pesticide use and sociodemographic characteristics of the studied participants

Parameter	Indoor pesticide use				X^2	P value
	User		Non user			
	n(231)	%	n(29)	%		
Mother work						
▪ Not Working	144	62.3	12	41.4	**4.7**	**0.03**
▪ Working	87	37.7	17	58.6		
Father work						
▪ Not Working	11	4.8	0	0	1.4	0.23
▪ Working	220	95.2	29	100		
Mother education						
▪ Illiterate& read /write	43	18.6	5	17.2		
▪ Basic	34	14.7	2	6.9	**15.4**	**0.002**
▪ Secondary	132	57.1	12	41.4		
▪ Above Secondary	22	9.5	10	34.5		
Father education						
▪ Illiterate& read /write	18	7.8	1	3.4		
▪ Basic	29	12.6	4	13.8	3.8	0.282
▪ Secondary	138	59.7	14	48.3		
▪ Above Secondary	46	19.9	10	34.5		
Socioeconomic status						
▪ Low	12	5.2	2	6.9	3.4	0.183
▪ Middle	137	59.3	12	41.4		
▪ High	82	35.5	15	51.7		

Table (2): Total home pesticide use and Practice towards pesticide exposure

Parameter	N(231)	%
Closing windows during pecticide use ▪ Yes ▪ No	 186 45	 71.2 17.3
Site of storage ▪ Any place ▪ Specific	 50 181	 19.2 69.6
Bottle reuse ▪ Yes ▪ No	10 221	3.9 85

Table (3): Relationship between indoor pesticide use and neurobehavior tests

Neurobehavioral tests	**Indoor pesticide use**		***T test***	***P value***
	User *n(231)*	**Non user *n(29)***		
Similarity test	10.5±3.7	14.7±2.9	**5.8**	**<0.001**
Trial making test	82.1±21.2	67.4±18.1	**3.5**	**<0.001**
Digital symbols test	22.8±4.04	24.8±2.1	**2.6**	**0.001**
Digital span test	11.3±3	14.3±3	**5.2**	**<0.001**
PASAT*	16.5±4.6	19.7±3.5	**3.6**	**<0.001**

***Paired Auditory Serial Addition Test**

Table (4): Correlation coefficient (r) between the number of pesticides' bottles used and neurobehavioral tests of the studied group

Neurobehavioral tests	***N of bottles***	
	R	***P value***
Similarity test	**-0.35**	**<0.001**
Trial making test	0.28	<0.001
Digital symbols test	-0.197	0.003
Digital span test	**-0.38**	**<0.001**
PASAT*	-0.23	0.001

***Paired Auditory Serial Addition Test**

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الملخص العربي

تأثير المبيدات الحشرية داخل المنازل على بطاريه اختبارات السلوك العصبي لدى أطفال المدارس الأساسية في منطقة ريفية ، محافظة المنوفية ، مصر

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الخلفية: ان تعرض الأطفال لمركبات السمية العصبية كالمبيدات الحشرية يمثل مشكلة رئيسية لصحة الاطفال

الاهداف : تهدف هذه الدراسة الي تقييم معدل استخدام المبيدات الحشريه داخل المنازل و تاثيرها على بطاريه اختبارات السلوك العصبي لدى الأطفال الذين تتراوح أعمارهم بين 9-13 سنة.

المنهجية و طرق البحث: الدراسة الحالية كانت مقطعية مستعرضة وقد اجريت الدراسة على260 طفل في سن الدراسة (9-13سنه)من المقيدين في مدارس منشأه سلطان الابتدائية والإعدادية. خلال فترة جمع البيانات. تم تقييم جميع الأطفال من خلال أخذ التاريخ ، والفحص العام والعصبي. تم إجراء تقييم السلوكيات العصبية عن طريق استخدام خمس بطاريات اختبار لقياس السلوك العصبي المعرفي.

النتائج: اظهرت النتائج ان ما يقرب من 89٪ من المشاركين في الدراسة يقومون باستخدام مبيدات الآفات داخل المباني. وقد وجد أن استخدام مبيدات الآفات داخل المنازل كان بدرجة كبيرة بين المشاركين الذين لم تعمل أمهاتهم واللاتي حصلوا على تعليم ثانوي بنسبة (62%و 57٪) على التوالي.

وقد أظهرت الدراسه ان المشاركون الذين استخدموا مبيدات الآفات داخل المباني كان أداءًئهم أقل بكثير في اختبارات السلوك العصبي كما كانت هناك علاقة ارتباطية موجبة بين عدد قوارير المبيدات المستخدمة واختبارالسلوك العصبي توصيل الدوائر للمجموعة المدروسة التي أجريت بينما كانت هذه العلاقة سلبية في اختبارات السلوك العصبي اعادة الارقام والرموز الرقمية واختبار المتشابهات و اختبار الجمع.

الاستنتاج: يعد تعرض الأطفال لمبيدات الآفات داخل المباني مشكلة سائدة ولها تأثير كبير على سلوكهم العصبي ، لذا يوصى بزيادة الوعي المجتمعي فيما يتعلق باستخدام مبيدات الآفات داخل المباني والتعرض لها.

الكلمات المفتاحية: مبيدات حشرية منزليه ، أطفال ، سلوك عصبي,بطاريات.