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IMPACT OF NEUROTOXICANTS ON SOCIAL DEVELOPMENT OF CHILDREN AGED 6-7 YEARS AND THEIR AMELIORATION VIA AN INTERVENTION PROGRAMME

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ABSTRACT

The present study was undertaken to study the impact of neurotoxicants on social development of children aged 6-7 years and their amelioration via an intervention programme. in two eco-settings of Ludhiana city of the Punjab state in India. The residential locality around industrial area was termed as neurotoxicant polluted setting (NPS). The residential locality 20 km. away from industrial area was termed as neurotoxicant free setting (NFS). The neurotoxicant free setting (NFS) had no industry in its vicinity. The sample comprised of 240 children aged 6-7 years (belonging to low socio-economic status, born and brought up in the specified setting for the last six years and not of migrant family) randomly drawn from the Government schools located in the two settings. Out of these 240 children, 120 each were drawn purposively from the two eco-settings. The sample in each of the eco-setting was further distributed equally into intervention and control groups (n=60). It was once again distributed in the manner that equal number of children fall in the two sexes i.e. n=30 each. The Vineland Social Maturity Scale(Indian Version by Bharath Raj (1990)) was used to assess the respondents social development. The results indicate that the respondents (both boys and girls) of NFS are better than their counterparts in NPS on social development. Also Intervention had a positive effect in augmenting the social development of respondents.

KEY WORDS: *Social Development, Children, Neurotoxicant Polluted Eco-settings, Neurotoxicant Free Eco-settings, Intervention.*

INTRODUCTION

Children are partly the products of the environment both material and non- material, consequently any changes in it are likely to affect them as well. According to Schell (1991), child development and growth patterns are an indicator of the environmental health. For the same reason increasing concern is being expressed to the increase in environmental pollution that is releasing potentially dangerous chemicals or toxicants in the air the children breathe, water they drink and the land they live on.

It has been widely recognized that developing individuals (embryos, fetuses, newborns, infants and children) are a uniquely susceptible population to insults from environmental hazards (Guzelian *et al* 1992 and Bearer 1995). Their increased susceptibility can arise from increased exposure to environmental toxins (pound for pound of body weight, children drink more water, eat more food and breathe more air than adults), increased exposure of individual organ systems from differences in distribution of toxins, immaturity of excretory pathways, alterations in target organ susceptibility, and a longer life span in which to express illness. Children are indeed different from adults, both in patterns of exposure to environmental risk and in their responses to environmental hazards. There are several examples in the literature demonstrating that exposure to a chemical during a critical period of development will produce neurotoxicity, whereas exposure to the same chemical during adulthood will have little or no effect (Rodier 1976, Rodier *et al* 1979 and Balduini *et al* 1991). The major determinants of these differences are however related to the rapid growth and development of children.

Of the various toxicants, childhood lead poisoning is now recognized as the number one preventable global environmental disease of children. Lead poisoning affects children's health and development, especially in densely populated urban and industrial cities. According to Kalra (1998) a decline in IQ of children in heavily polluted cities is believed to have occurred as a result of chronic low level lead exposure. Thus, even a low-to-moderate level of lead poisoning results in irreversible loss of intelligence, behaviour and neuromotor problems (Sciarillo and Alexander 1991). Early subclinical exposure to lead thus appears to result in lifelong disability. Multiplied by the tens of thousands of children at risk, the societal and fiscal impact of this disability is enormous (Schwartz 1994). In addition, if the child is living in poverty or is from low socio-economic status, neurotoxicants have an even more damaging effect on him as his immediate home-environment is already deficit. It is beyond doubt that too often in our society the children most heavily exposed to environmental toxicants are poor children in underprivileged communities i.e. there is a pattern of disproportionate exposure most commonly termed as environmental injustice (Bullard and Wright 1993).

This potential for environmental contaminants to produce neurological, cognitive, motor or other behaviour deficits as a result of developmental exposure is receiving increasing attention. The focus has shifted from description of frank neurotoxicity observed in a relatively few individuals to more subtle impairment in a much greater number of children.The protection of children against chemical toxicants in the environment should be considered as a major challenge to the modern society especially to Indian society in which children constitute about 35 percent of the population as against 12-15 percent in the developed countries. On the contrary in India, children's environment health research has not been given priority by the Government. In fact, very little work has been carried out here in environmental health research focused on exposure patterns and health outcome for children with reference to various environmental toxins. We must think of identifying pattern of environmental diseases in children, assess children's exposure to environmental toxicants, determine developmental periods of vulnerability and quantify dose response relationship to bring us closer to prevention oriented intervention and also to intervention that helps to circumvent or minimize the deficits in the population already exposed to the toxicants.

In our country vast majority of children belong to weaker sections of society where illiteracy, ignorance, lack of awareness, dearth of resources and unhygienic conditions are prevalent. Thus the need for intervention arises from the awareness about the detrimental influence of restrictive, non-conducive and non-stimulating environment on the development of young children and the magnitude of gains resulting from the efforts to improve their environment as has been evidenced by various researchers.

However since it is not possible to cover the whole of India at one time, therefore the impact of neurotoxicants was assessed on children in Ludhiana, the industrial capital of Punjab with maximum industries; in the present study entitled ,"Impact of Neurotoxicants on social development of children aged 6-7 years and their amelioration via an intervention programme". The study was planned with the following objectives: -

1. To assess the social development of children across "neurotoxicant free" and "neurotoxicant polluted" eco-settings.
2. To develop appropriate intervention programme for children showing social deficits across the two eco-settings.
3. To compare the responsivity of children across the two eco-settings (neurotoxicant free and neurotoxicant polluted) to an intervention programme as per objective - second.

MATERIAL AND METHOD

The study is based on a saple of 240 children in the age groups of 6-7 years ,randomly drawn from the Government schools located in the two eco-settings of the Ludhiana district of the Punjab State in India. Neurotoxicant polluted eco-setting (NPS) was part of the industrial area and Neurotoxicant free eco-setting (NFS) was about 20 km from the industrial area. The NFS did not have any industry. The sample of drinking water from the two eco-settings were tested in the laboratory.**(Table 1)** The sample comprised of 240 children between the age group of 6-7 years randomly taken from the Government Schools. Out of the 240 children, 120 each were drawn purposively from the two eco-settings as mentioned above. The sample in each of the eco-setting was further distributed equally into intervention and control groups (n=60). It was once again distributed in the manner that equal number of children fall in the two sexes i.e. n=30 each **(see Fig. 1).**

The children included in the sample drawn from the two eco-settings satisfied the following criteria for their inclusion: -

a) Belonging to the low socio-economic status.
b) The child should be attending the school.
c) The child should not be of a migrant family.
d) The child should have minimum six years residence in the specified area.

Further, permission by the principals of the school was taken, before final selection of the schools, for conducting the study on their school children.

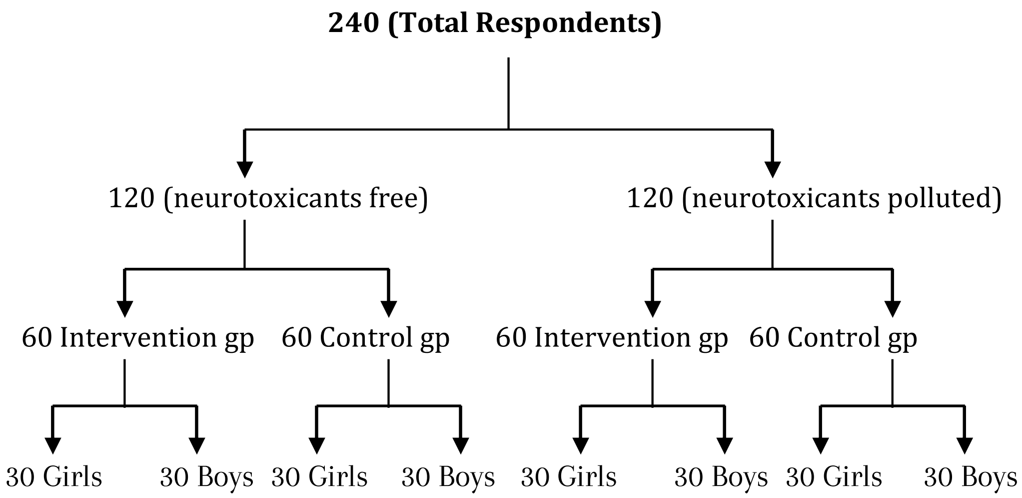

Fig. 1: Distribution of Respondents

Table 1: Amount (mg/litre) of various selected toxicants found in the drinking water samples.

S.No.	Toxicants (mg/l)	Max. permissible limits	NPS	NFS
1.	Lead	0.1	0.38	0.1
2.	Arsenic	0.05	0.37	0.1
3.	Cadmium	0.005	0.85	-0.0008
4.	Copper	0.05	0.26	0.009

The Socio-Economic Status Scale (Form A urban) designed by S.P. Kulshreshta (1981) was used to measure the socio-economic status of the selected children. This scale inquired about the background characteristics of children and their families such as age, sex, education, occupation, income, moveable and immoveable property in the family.

The Vineland Social Maturity Scale(Indian Version by Bharath Raj (1990)) was used to assess the social development of children. It was originally devised by E.A. Doll in 1935 and since then this test is being used in many parts of the world. It proved itself to be uniquely useful instrument in measuring Social Maturity of Children and young adults. Since its first publication, it has served the useful purpose of estimating the differential social capacities of an individual. The very first attempt to adapt this scale to Indian culture conditions was done by Rev. Fr. Dr. A. J. Malin while working at the Nagpur child guidance center. The present scale by Bharath Raj (1990) is only an extended version of the original scale. It not only provides a measure of Social Age and Social quotient but it also indicates the social deficit and social assets in a growing child (1 to 15 years).

In order to assess whether a particular behavioural (social) characteristic has emerged or has not emerged in the repertory of the child, the following procedure is followed. If the particular characteristic described by the item has clearly emerged, a "+" mark may be made on the left side of the item. But if the evidence proves that it has not emerged a "-" mark may be put on the left side of the item. At the end of assessment positive

(+) credits may be counted. If the total score falls exactly on the last item of an age level, the child is given the full social age at that age level.

The procedure for obtaining the Social Age from the Raw Score is as follows. Social Age can be directly read off from the table given in the manual and then converted to **Social Quotient** by the formula:

$$S.Q. = \frac{\text{Social Age}}{\text{Actual Age}} \times 100$$

The interpretations of S.Q. are on similar lines as that of I.Q. except that S.Q's have a social life reference.

An intervention package was prepared keeping in view the social deficits in the sample, their developmental needs and their socio-economic status after consulting the experts in the field and relevant literature. The package-included information regarding hygiene practices, play materials and ways to become more socially and intellectually mature. Intervention was administered to the sample included in the intervention group (see Fig. 1) Intervention was repeated every fortnight with appropriate change / repetition as per the age and responsivity of the children. Assessments for various aspects of intervention and children's developmental outcomes were made after three months, for all subjects of both intervention and control group in the two eco-settings viz. neurotoxicant polluted and neurotoxicant free.

A systematic schedule was developed for collection of data, administration of intervention and pre and post intervention assessments. This is presented here in the tabular form for 6-year children. Same scheme was followed for 7-year children.

Age (in years)	Intervention Group	Control Group
5.7.15	Established rapport with children and teachers and administered Kulshrestra's S.E.S Scale to assess the children's socio-economic status.	Same as in intervention group
5.8	Assessment of the social development of the children using Vineland Social Maturity Scale	Same as in intervention group
5.9-5.11	Age and development appropriate information to foster their social development given.	-
6.0	Reassessment of the social status of the children using above measures.	Same as in intervention group

The collected data was classified and tabulated in accordance with the objectives to arrive at meaningful and relevant inferences. The data was analyzed using the frequencies and percentages.

RESULTS AND DISCUSSION

The data in Table-2 shows that the respondents in both the eco-settings were almost similar in their socio-personal aspects.

Table 2 : Socio-personal characteristics of children

No.	Characteristics	Neuro-toxicant free (intervention)		Neurotoxicant polluted (intervention)		Neuro-toxicant free (control)		Neurotoxicant polluted (control)	
1.	Mother's education								
	– Illiterate	44	(73.3)	39	(65.0)	43	(71.7)	49	(81.7)
	– Primary	14	(23.3)	19	(31.7)	15	(25.0)	10	(16.7)
	– Middle	1	(1.7)	--		2	(3.3)	--	
	– Matric & above	--		1	(1.7)	--		--	
2.	Father's education								
	– Illiterate	5	(8.3)	10	(16.7)	8	(13.3)	15	(25.0)
	– Primary	40	(66.7)	40	(66.7)	48	(80.0)	45	(75.0)
	– Middle	14	(23.3)	6	(10.0)	2	(3.3)	--	
	– Matric & above	--		2	(3.3)	--		--	
3.	Father's occupation								
	– Labour	42	(70.0)	29	(48.3)	38	(63.3)	44	(73.3)
	– Service	7	(11.7)	7	(11.7)	13	(21.7)	1	(1.7)
	– Business	10	(16.7)	38	(63.3)	7	(11.7)	15	(25.0)
	– Others	--		--		--		--	
4.	Mother's occupation								
	– Labour	29	(48.3)	6	(10.0)	32	(53.3)	17	(28.3)
	– Service	--		3	(5.0)	--		--	
	– Business	--		--		3	(5.0)	1	(1.7)
	– Nil	30	(50.0)	50	(83.3)	25	(41.7)	41	(68.3)
	– Others	--		--		--		--	
5.	Family type								
	– Nuclear	46	(76.7)	43	(71.7)	44	(73.3)	40	(66.7)
	– Joint	14	(23.3)	17	(28.3)	16	(26.7)	20	(33.3)
6.	Family size								
	– Large(8& above)	16	(26.7)	8	(13.3)	15	(25.0)	20	(33.3)
	– Medium (5-7)	41	(68.3)	38	(63.3)	38	(63.3)	35	(58.3)
	– Small (4 or less)	3	(5.0)	14	(23.3)	7	(11.7)	5	(8.3)
7.	Birth order								
	– First	5	(8.3)	19	(31.7)	11	(18.3)	8	(13.3)
	– Second	18	(30.0)	23	(38.3)	10	(16.7)	15	(25.0)
	– Third or later	37	(61.7)	18	(30.0)	39	(65.0)	37	(61.7)

Figures in parenthesis indicate percentages.

SOCIAL DEVELOPMENT OF RESPONDENTS OF NPS & NFS ECO-SETTINGS

Table 3 presents a detailed account of the distribution of the respondents of neurotoxicant free and neurotoxicant polluted eco-settings on the various levels of social development and at the pre-intervention stage.

It is quite evident from the data that in the **neurotoxicant free** eco-setting, majority of the respondents (81.7%) showed the normal level (100-124) of social development. Next predominant category was of low level of social development which housed around 15 percent of the respondents. Only 3.3 percent of the respondents had high level of social development (125 and above).

In the **neurotoxicant polluted** eco-setting, on the other hand, the respondents were concentrated in the two categories only viz. normal and low. The majority of the respondents were however present in the low category (55%). Around 45 percent of the respondents in this eco-setting had normal level of social development. This eco-setting, however had nil respondents with high level of social development.

Table 3 : Distribution of the respondents of neurotoxicant free and neurotoxicant polluted eco-settings on the various levels of social development (pre-intervention status)

Levels of social development	Neurotoxicant Free	Neurotoxicant Polluted
High (125 & above)	4 (3.3)	--
Normal (100-124)	98 (81.7)	54 (45)
Low (less than 100)	18 (15)	66 (55)

Figures in parenthesis indicates percentage

Thus the position was almost balanced in the neurotoxicant polluted eco-setting with almost equal number of respondents in both the normal and low level of social development. The balance was however skewed towards the normal level of social development in the neurotoxicant free eco-setting.

Further when comparisons among both the eco-settings was made a quite startling relevation emerged i.e. as compared to the neurotoxicant free eco-setting, the neurotoxicant polluted eco-setting housed around 3.6 times more number of respondents with low level of social development who are more likely to develop antisocial tendencies and thus anti-social characters in their society.

The results thus reveal that neurotoxicants effect the social development of children as well. The findings are consistent with the findings of Needleman *et al* (1979) who reported that compared to children with low dentin lead level, children with high dentin lead levels were rated by their teachers as scoring higher on such classroom behaviour problem as distractibility, decreased persistence, impulsivity, day dreaming and dependency.

Needleman *et al* also found the same results on 212, 11-14 year old boys in 1996. Similarly Bellinger *et al* (1994b) reported among more than 1000 Boston school children that dentin lead level was significantly positively related to teacher's rating of internalizing and externalizing behaviour problems.

EFFECT OF INTERVENTION ON SOCIAL DEVELOPENT OF RESPONDENTS OF NPS & NFS ECO-SETTINGS

Data in the *Table 4* presents the distribution of the respondents of the neurotoxicant free and neurotoxicant polluted eco-settings (both intervention and control groups), on the basis of the various levels of social development (both at the pre and post intervention stage).

At the pre-intervention stage, the following observations were made regarding the groups given below

(i) The majority of the respondents of both the control (83.3%) and intervention (80%) groups of the neurotoxicant free eco-setting were present in the category indicative of their normal level of social development.

(ii) In the **neurotoxicant polluted eco-setting**, whereas, those in the **control group** predominantly had low level of social development (81.7%), those in the **intervention group** were normal (71.7%).

(iii) When comparisons between the **control groups of the neurotoxicant free and neurotoxicant polluted eco-setting** were made, it was observed that whereas those in the neurotoxicant free eco-setting were predominantly in the normal level (83.3%) those in the neurotoxicant polluted eco-setting, were in the low level (81.7%).

(iv) Amongst the **intervention groups of both the eco-settings** it was observed that both the groups had same level of social development i.e. majority of the respondents of both the eco-settings had normal level of social development (80% in neurotoxicant free eco-setting and 71.7% in the neurotoxicant polluted eco-setting).

Table 4 :Distribution of the respondents of the neurotoxicant free and neurotoxicant polluted; intervention and control groups, on the basis of the various levels of social development (pre and post intervention status)

Levels of social development	Neurotoxicant Free				Neurotoxicant Polluted			
	Control		Intervention		Control		Intervention	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High (125 & above)	2 (3.3)	2 (3.3)	2 (3.3)	17 (28.3)	--	--	--	6 (10)
Normal (100-124)	50 (83.3)	55 (91.7)	48 (80)	43 (71.7)	11 (18.3)	22 (36.7)	43 (71.7)	54 (90)
Low (less than 100)	8 (13.3)	3 (5)	10 (16.7)	--	49 (81.7)	38 (63.3)	17 (28.3)	--

Figures in parenthesis indicate percentages.

At the **post-intervention stage,** the social development of the respondents was as follows :

(i) The majority of the respondents of both the **control** (91.7%) and **intervention groups** (71.7%) **of neurotoxicant free eco-setting** were still normal. However, a starting relevation was that in the intervention group of this eco-setting whereas none of the respondents were left in the low level of social development, those in the high level increased by around 25 percent.

(ii) In the **neurotoxicant polluted eco-setting**, on the other hand, in the **control group** still the maximum number of respondents had low level of social development (63.3%). In the **intervention group**, however, even though 10 percent of the respondents graduated to high level of social development but the majority was still the normal level (90%) in this group. Like the intervention group of neurotoxicant free eco-setting, here too; none of the respondent of the intervention group was left in the low level of social development.

(iii) Comparison among the **control groups of neurotoxicant free** and **neurotoxicant polluted eco-settings** revealed that in the control group of the neurotoxicant free eco-setting still the dominant category was that of normal level of social development (91.7%), whereas in the neurotoxicant polluted eco-setting, it was that of low level of social development (63.3%).

(iv) In the **intervention groups of both the eco-settings**, still the majority of the respondents had normal level of social development (71.7% - neurotoxicant free intervention group and 90% - neurotoxicant polluted intervention group).

Thus it can be concluded that before intervention, the social developmental level of the control group was better than those of the intervention group in the neurotoxicant free eco-setting. Opposite situation was observed in the neurotoxicant polluted eco-setting i.e. intervention group was better. After intervention, however the developmental level of those of the intervention groups of both the eco-settings improved. Further among the intervention and control groups of both the eco-setting, it was observed that those in the neurotoxicant free eco-setting had higher and better level of social development as compared to those in the neurotoxicant polluted eco-setting.

The findings thus reveal the positive effect of intervention on the social development of the respondents. These results are consistent with the findings of Brooks-Gunn *et al* (1993) and Vanden Boom (1994) who reported that intervention produced significant improvement in children's sociability and lower behaviour problem scores.

The findings also aptly demonstrate the negative effect of neurotoxicants on social development as well, as justified by Needleman *et al* (1979 , 1996 and 2011) and Bellinger *et al* (1994b).

CONCLUSIONS

It was concluded that neurotoxicants affect the social development of children in a negative manner. Greater number of children from neurotoxicant polluted eco-settings showed low levels of social development as compared to the greater number of children of neurotoxicant free eco-setting in the normal social development.

Intervention, however had positive effect on the social development of the children from both the settings though positive affect of intervention was more observable in the children of neurotoxicant free eco-setting than neurotoxicant polluted children.

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