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RESEARCH ARTICLE

Effect of vehicular pollution on mental performance of school going children (11-15 years) in a North Indian city

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ABSTRACT : School going children who spend most of their day time in school and playing outside are one of the most vulnerable towards deleterious and hazardous effects of environmental pollutants. In the following study an attempt was made to study the effect of exposure to vehicular pollution on the mental performance of school going children in Kanpur city. Initially the city was divided into four areas; highly polluted, moderately polluted, low polluted and unexposed/ negligible pollution areas on the basis of traffic congestion on roads. The traffic volume data of various areas was collected to measure the vehicular pollution of these areas. Out of these four areas, 320 children of 11-15 years, 80 children (40 boys and 40 girls) from two roadside schools of each area were selected using random cum purposive sampling method. The mental performance of children was measured in terms of forward immediate memory, recognition ability and vigilance using a part of Bhatia battery test, embedded figure test and bourdan wiersma vigilance test, respectively. The data collected was analyzed using ANNOVA test. A significant difference was found between the forward Immediate memory, recognition ability and vigilance of children of exposed areas and unexposed areas (F-ratio; 54.87, 70.98 and 16.65, respectively).

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Vehicles are said to be one of the major contributors of air pollution. With an increase in population day by day in various parts of world, there is a tremendous growth in number of vehicles being used every day. These vehicles emit large amount of pollutants in the breathing zone of people and thus contribute significantly to human exposure. Tailpipe emissions, engine evaporative emissions and wear of tyres and brakes are all responsible for release of large amounts of toxic air pollutants like carbon monoxide, suspended particulate matter, nitrogen oxides and sulphur-di-oxides in the air. Moreover, badly maintained roads, vehicles, mixed traffic pattern, road encroachments and meter gauge railway tracks transversing city length add to the impact of vehicular pollution. Cities often encounter severe dust and smoke problems and the prescribed limit of 100 µg/ mt^3 in terms of suspended particulate matter (SPM) is exceeded in many locations in the cities. Kanpur, a North Indian city is one such example of cities having this kind of automobile exhaust pollution problem.

Many epidemiological and observational studies have exhibited the impact of air pollution on morbidity and mortality of human population worldwide. According to a recent

estimate of WHO, air pollution ranks eighth among the leading risk factors for mortality and accounts for more than 80 per cent of all deaths in developing countries among children below five years of age (Narayan *et al.*, 2010). Over three millions premature deaths each year have been reported due to the suspended particulate matter (Mills *et al.*, 2009). A strong link has been identified between air pollution and impairment of pulmonary and cardio-vascular system functioning among various age groups (World Health Organization, 2003 and Health Effect Institute, 2002). Several recent studies have identified that the ultrafine and fine particles can enter the brain by translocation from the pulmonary tissues via blood capillaries or via the olfactory nerve that connects the nose and the brain directly (Elder *et al.*, 2006 and Oberdorster *et al.*, 2004). Children due to rapid growth are at greater risk from these environmental hazards (Chance and Harsman, 1998). They have immature immune and detoxification systems and are less able to cope with environmental exposures (Wigle, 2003). However, there is a dearth of studies which have taken into account the cumulative effect of all the pollutants found in automobile exhaust on children's brain functioning. Hence, forth, the present study was conducted with an aim to investigate the effect of vehicular pollution on the mental performance of school-going children in Kanpur city.

To study the toxic effect of various environmental pollutants *viz.*, carbon monoxide, nitrogen and sulphur oxides, lead, petroleum solvents etc. on human brain, several neuropsychological test batteries like neurobehavioural core test battery (NCTB) by World Health Organisations (WHO) and finland's institute of occupational health (FIOH) Test battery have been devised by these organizations and used. Tests like memory test/ learning test, attention test, visual perception/ vigilance test and motor speed test are the major tests incorporated in these test batteries. In these studies, exposure to automobile exhaust pollutants like organic solvents, lead, carbon mono-oxide, ozone and nitrogen-di-oxide have been found to be associated with decreased visual perception, ability to learn and performance of complicated task in children (Sinha, 1995; Dursin, 2000; Obeng, 2001; Moore, 2003; California Thoracic Society, 2004 and Koger *et al.*, 2000). In the present study, the mental performance of school-going children *i.e.*, the performance of children on various tasks using short term memory, vigilance and recognition ability as affected by the automobile exhaust pollutants was studied using tests on the similar guidelines.

EXPERIMENTAL METHODOLOGY

The study was conducted in Kanpur city. Initially the city was divided into highly congested, commercial and residential areas. The traffic volume data *i.e.*, the number of vehicles crossing the four way roads of these areas as per distribution of vehicle type was collected by the researcher. Counting of vehicles was done on the major crossings of the areas during peak hours (9-11a.m. and 5-8 p.m.). The average of seven days of the week was considered in addition to the average of morning and evening three hours. The areas having industries in the near vicinity were not included in the study. In this manner three areas having different levels of vehicular pollution; highly polluted areas (HPA), moderately polluted areas (MPA) and low polluted areas (LPA) of the Kanpur city were finalised for the study. Green areas on the outskirts of the city, having very few or no vehicles were considered as control group/ unexposed area (UA).

To study the mental performance of school-going children (11-15 years) of the exposed and unexposed areas, a total number of 320 children, 80 children; 40 girls and 40 boys from two government aided schools situated on roadside of each of the three polluted areas; HPA, MPA, LPA and unexposed area (UA) were selected using random cum purposive sampling method. Only the children studying in the same school and residing in the nearby area of the school (within two kilometres from the school) since a minimum number of five years were included in the sample. The children were selected from the government aided schools to match them on diet, parent's education and family income. The children were approached and tested in their respective schools after taking permission from their principals. An interview schedule constructed by the researcher was used to collect the personal data of the subjects/ children. The subjects were also enquired about their general health and presence of any diseases. The children suffering from any kind of respiratory disease, gastro-intestinal disease, liver disease or cardio-vascular disease were not included in the sample.

The mental performance of children was measured in terms of forward Immediate memory (FIM), recognition ability (RA) and vigilance using the Immediate

memory test which is a part of Bhatia battery intelligence test, embedded figure test (EFT) developed by valiciukas and singer and bourdan wiersema vigilance test, respectively.

EXPERIMENTAL FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Background information :

Majority of children (77 %) were of the age group 11-13 years. All of them were studying in the same school since last five years or more. About half of the children of the sample were residing in the same area since last five to 10 years and the rest half of the children were residing in the same area since birth. Majority of the parents both fathers and mothers of the children were reported to be educated till junior secondary to intermediate level. The major occupations of fathers were service and business (of 43% and 42%, respectively). Mothers were mainly housewives (88%). The monthly income of majority of families was in the range of Rs.5,000 to Rs.10,000. Most (73%) of the children belonged to nuclear families having about 6 family members. General diet pattern of the children revealed that almost all the children were consuming similar diet both in quantity as well as quality.

On examining the children for any clinical signs and symptoms of any deficiencies or ill health, majority of the children had no signs of abnormalities in the general appearance, face, tongue, nails, eyes, lips etc.

Mental performance of school-going children of the exposed and unexposed areas :

The mental performance *i.e.*, the forward immediate memory (FIM), recognition ability (RA) and vigilance of school going children as affected by pollution exposure was the dependent variable. Sex and pollution exposure were considered to be the two independent factors.

FIM, RA and vigilance are an important part of intelligence or mental performance of children. Forward Immediate memory (FIM) involves processes like attention, concentration and recall. Recognition ability (RA) or figure-ground relationship is the ability to distinguish various figures from their background, focussing on the figure and ignoring the unnecessary details in the background. It determines the success of a child's experience. Vigilance or perceptual speed and accuracy tests measure the ability of a child to focus attention and quickly process information. Success in school and other activities rely heavily on the mental performance of school-going children.

Girls were found to score more as compared to the boys in all the three tests of FIM and RA and vigilance as observed through the higher mean scores of girls in Table 1, 4 and 7. To test whether the difference between these mean values was significant or not ANNOVA test was applied. The differences in scores between girls and boys were found to be significant in case of two measures; forward immediate memory and recognition ability as shown by the significant F-ratios 19.40 and 12.43 in Tables 2 and 5. In case of vigilance, there was no significant difference in the mean scores of girls and boys of Kanpur as revealed by the F-ratio 0.28 in the Table 8.

Table 1 : Mean values of forward immediate memory (FIM) of girls and boys in different pollution exposed groups

	HPA	MPA	LPA	UA	Gr Mean
Girls	5.15	5.325	6	7.525	6.00
Boys	4.95	4.75	5.475	6.575	5.44
Gr Mean	5.05	5.04	5.74	7.05	5.72

Table 2 : ANNOVA of forward immediate memory of children of both sex, pollution levels and their interaction

Sources of variation	Df	S.S.	M.S.S.	F-ratio
Sex - girls and boys	1	25	25.31	19.40**
Pollution exposure	3	215	71.57	54.87**
Sex x pollution	3	56	18.76	14.38**
Within treatments (Errors)	312	407	1.30	
Total	319	703		

** indicate significance of value P=0.01

On considering pollution exposure as an independent variable the effect on all the three measures *i.e.*, forward immediate memory (FIM), recognition ability (RA) and vigilance was found to be significant as shown by the significant F-ratios; 54.87, 70.98 and 16.65, respectively in Table 2, 5 and 8. This clearly states that the vehicular pollution exposure was found to have an adverse effect on all the three measures of mental performance *i.e.*, the forward immediate memory (FIM), recognition ability (RA) and vigilance. The mean scores of FIM, RA and vigilance of children were found to increase with decreasing level of pollution exposure (Table 1, 4 and 7). To test whether the differences between cumulative mean scores of children (Girls and Boys) of different groups HPA, MPA, LPA and UA were significant or not, t-value was worked out (Table 3, 6 and 9). In case of FIM, the mean score of children in HPA was greater than the children in MPA. However, the difference was not significant as revealed by the t-value 0.06 in the Table 3. The FIM scores in other areas MPA, LPA and UA were found to increase with decreasing level of pollution exposure because of which, pollution exposure was found to affect the forward immediate memory (FIM) of children negatively as mentioned above.

The results were found to be consistent with the findings of Koger *et al*. (2000); Moore, (2003); California Thoracic society (2004) and Kumar and Kesaree (1999). During the early years of 1970's and 1980's a number of studies were conducted to study the impact of lead, a constituent of automobile exhaust on the intelligence of people. Lead even at low doses was found to be associated with subtle symptoms like defective memory, irritability, inability to concentrate, hear and perceive language in both children as well as adults (Valciukas *et al.*, 1978; Aub *et al.*, 1976; Winneke and Kraemer, 1984; Dictrich *et al.*, 1987, Needleman *et al.*, 1979). Carbon monoxide and certain VOCs were also reported to lead to reduced performance of children on tasks related to immediate memory (Beard and Wertheim, 1968 and Grandstaff, 1974). Later on, during the 1990's and 2000 onwards the concern was shifted to vehicular pollution and air pollution *i.e.*, the cumulative effect of all pollutant released in emmission through automobiles (California Thoracic Society, 2004; Dursin, 2000; Moore, 2003; Obeng, 2001 and Vincent and Tan, 1997).

The interaction of sex and pollution exposure was

Table 3 : t - value of comparison of means of forward memory of children of different pollution exposed groups

Between	Mean difference	S.E. of difference	t-value
HPA and MPA	0.01	0.19	0.07 (NS)
HPA and LPA	-0.69	0.16	-4.20 (NS)
HPA and UA	-2.00	0.20	-10.23 (NS)
MPA and LPA	-0.70	0.18	-3.97 (NS)
MPA and UA	-2.01	0.21	-9.76 (NS)
LPA and UA	-1.31	0.19	-7.05 (NS)

NS = Non-significant

Table 4 : Mean values of recognition ability (RA) of girls and boys in different pollution exposed groups

	HPA	MPA	LPA	UA	Gr Mean
Girls	3.51	4.64	4.93	6.96	5.01
Boys	4.29	3.64	4.73	5.59	4.56
Gr Mean	3.90	4.14	4.83	6.28	4.79

Table 5 : ANNOVA of recognition ability of children of both sex, pollution levels and their interaction

Sources of variation	Df	S.S.	M.S.S.	F-ratio
Sex - girls and boys	1	15.98	15.98	12.43**
Pollution exposure	3	273.59	91.20	70.98**
Sex x pollution	3	86.45	28.82	22.43**
Within treatments (Errors)	312	400.86	1.28	
Total	319	776.88		

** indicate significance of value at P=0.01

also found to be significant in two measures of mental performance namely FIM and RA (F-ratios; 14.38 and 22.43) leaving behind one aspect *i.e.*, vigilance (Table 2 and 5). The girls outperformed the boys in memory and recognition ability tests in the exposed areas (Table 1 and 4). Thus, the boys were found to be more affected by the vehicular exposure as compared to the girls. The reason could be the boys being more involved in outdoor activities as compared to the girls of this age group. However, in unexposed area also the girls were found to outscore the boys on the tests of FIM and RA (Table 1 and 4). Several studies indicate the presence of similar sex differences in memory and spatial reasoning (Geary, 1998; Linn and Petersen, 1985). Hippocampus, an area of brain involved in storing memories and the spatial mapping of the environment has been found to be larger in girls than boys (Frings *et al.*, 2006; Goldstein *et al.*, 2001 and Kimura, 1992).

In case of vigilance, the interaction of sex and pollution exposure was non-significant (F-ratio:2.91) as there was no significant difference in the mean scores of vigilance of girls and boys (Table 8). Vigilance, *i.e.*, perceptual speed and accuracy of both boys and girls of striking groups of four dots from groups of three, four and five dots, had no significant differences as also

Table 6 : t - value of comparison of means of recognition ability of children of different pollution exposed groups

Between	Mean difference	S.E. of difference	t-value
HPA and MPA	-0.24	0.19	-1.24 (NS)
HPA and LPA	-0.92	0.20	-4.61 (NS)
HPA and UA	-2.38	0.19	-12.46 (NS)
MPA and LPA	-0.68	0.20	-3.48 (NS)
MPA and UA	-2.13	0.19	-11.47 (NS)
LPA and UA	-1.45	0.19	-7.58 (NS)

NS = Non-significant

Table 7 : Mean values of vigilance of girls and boys in different pollution exposed groups

	HPA	MPA	LPA	UA	Gr Mean
Girls	41.25	49.40	52.13	53.48	49.06
Boys	42.23	46.28	46.30	58.43	48.31
Gr Mean	41.74	47.84	49.21	55.95	48.68

Table 8 : ANNOVA of vigilance of children of both sex, pollution levels and their interaction

Sources of variation	Df	S.S.	M.S.S.	F-ratio
Sex - girls and boys	1	46	45.75	0.28(NS)
Pollution exposure	3	8164	2721.19	16.65**
Sex x pollution	3	1429	476.25	2.91(NS)
Within treatments (errors)	312	50981	163.40	
Total	319	60619		

** indicate significance of value at P=0.01 NS = Non-significant

Table 9 : t - value of comparison of means of vigilance of children of different pollution exposed groups

Between	Mean difference	S.E. of difference	t value
HPA and MPA	-6.10	1.93	-3.16 (NS)
HPA and LPA	-7.48	2.13	-3.51 (NS)
HPA and UA	-14.21	2.17	-6.55 (NS)
MPA and LPA	-1.38	1.89	-0.73 (NS)
MPA and UA	-8.11	1.94	-4.19 (NS)
LPA and UA	-6.74	2.13	-3.16 (NS)

NS = Non-significant

reported in another study by Kimura (1992).

Conclusion :

The present investigation throws light on the sub-clinical and subtle effect of automobile exhaust pollution on the performance of school-going children on mental tasks. If these toxic emissions will not be controlled, the day won't be far when our children will be wearing oxygen masks to their schools and even for playing outside. The researcher suggests certain measures which can be taken in a city like Kanpur to save the school-going children from the emissions of pollutants from vehicles and improve the quality of air.

–The roads near the schools should be improved to avoid congestion of traffic. Improvement of roads includes both widening of roads by removing encroachments, providing proper parking area etc. as well as proper maintenance of ill maintained roads.

- The schools situated in the heart of the city near wholesale markets and bus stop should be shifted to open areas or the outskirts of the city.
- Green belts should be provided at various places especially around the schools.
- Flyovers should be made on congested roads and near commercial areas.
- Public transportation should be improved to minimize the use of personal vehicles, as these personal vehicles like cars, scooters and motorcycles are the major contributors of vehicular pollution.

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REFERENCES

Aub, J.C., Fairhall, L.T., Minot, A.S. and Rezenikoff (1976). Lead poisoning, *Med. Moonogr*., **7** : 1-26.

Beard, R.R. and Wertheim, G. (1968). Behavioral impairment associated with small doses of carbon monoxide. *American J. Public Health*, **57** : 2012-2022.

Chance, G.W. and Harsman, E. (1998). Children are different : Environmental contaminants and children's health. *Canadian J. Public Health*, **89** (1): 9-13.

Dursin, Kanis (2000). Jakarta is high on octane, low in IQ. *Asiatimes.com.*

Elder, A., Gelein, R., Silva, V., Feikert, T., Opanashuk, L., Carter, J. and Potter, R. (2006). Translocation of inhaled ultrafine manganese oxide particles to the central nervous system. *Environ Health Perspect*, **114** (8) : 1172–1178.

Frings, L., Wagner, K., Unterrainer, J., Spreer, J., Halsband, U. and Schulze-Bonhage, A. (2006). Gender-related differences in lateralization of hippocampal activation and cognitive strategy. *NeuroReport*, **17** (4):417–421.doi:10.1097/01.wnr.0000203623.02082.e3. PMID 16514369.

Geary, D.C. (1998). In male female the evolution of human sex differences. American Psychological Association Books, Chapter 8 sex differences in brain and cognition, 153p. WASHINGTON, D.C., U.S.A.

Goldstein, J.M., Seidman, L.J., Horton, N.J., Makris, N., Kennedy, D.N., Caviness, V.S., Faraone, S.V. and Tsuang, M.T. (2001). Normal sexual dimorphism of the adult human brain assessed by *in vivo* Magnetic Resonance Imaging, *Cereb Cortex*, **11**(6): 490-497.

Grandstaff, Nett G.W. (1974). Carbon monoxide and human gunction. Early fetection of occupational hazards. C.Xintaras *et al.*, U.S. Deptt. of H.E.W., National Institute of Occupational Safety and Health, pp. 292-305, WASHINGTON, D.C., U.S.A.

Health Effect Institute (HEI) (2002). Understanding the health effects of the particulate matter mix: Progress and next steps: HEI perspective.

Kimura, D. (1992). Sex differences in the brain, *Sci. Am.*, **67**: 118-125.

Koger, Susan M., Schettler, Ted and Bernard, M. (2000). Environmental toxicants and developmental disabilities: Challenge for Psychologists,' *American Psychologist*, **60** (3): 240-249.

Kumar, R. Kishore and Kesaree, Nirmala (1999). Blood lead levels in urban and rural Indian children. *Indian Paediat.*, **36**: 303 – 306.

Linn, M.C. and Petersen, A.C. (1985). Emergence and characterization of sex differences in spatial ability a meta-analysis, *Child De*, **56**: 1479-1498.

Mills, Nicholas, L., Paddy, Ken Donaldson, Hadoke, W., Boon, William, Nicholas A. MacNee, Cassee, Flemming R., Thomas Sandström, Anders Blomberg and David, E. (2009). Adverse cardio-vascular effects of air pollution. *Nat. Clinic. Pract. Cardio-vascular Med.*, **6** (1): 36–44.

Moore, Colleen F. (2003). Silent scourge: Children, pollution, and why scientists disagree'. University of the Wisconsin, Madison, 328 pp.

Narayan, K.M., Ali, M.K. and Koplan, J.P. (2010). Global non-communicable diseases - were worlds meet. *New England J. Med.*, **363** (13): 1196–1198.

Needleman, H.L., Hunnoe, C., Leviton, A., Reed, R., Peresie, H., Maher and Barrett, P. (1979). Deficits in psychological and classroom performance in children with elevated dentine lead levels. *New England J. Med.*, **300**: 584 - 695.

Obeng, Letitia A. (2001). Clean air initiative in sub-saharan African cities. Regional Conference on Phasing-out leaded gasoline. Dakar, Senegal.

Oberdörster, G.1., Sharp, Z, Atudorei, V., Elder, A., Gelein, R., Kreyling, W. and Cox, C. (2004). Translocation of inhaled ultrafine particles to the brain. *Inhal Toxicol.*,**16** (6-7) : 437-445.

Sinha, S.P. (1995). Neurotoxic effects of lead (Pb) on intelligence and psychomotor behaviour of school going children of Agra city. Report of UGC Project. Dayalbagh Agra. 100p.

Valciukas, J.A., Lilis, R., Fischbein, A., Selikoff, I.J., Eisinger, J. and Blumberg, W.E. (1978). Central nervous system dysfunction due to lead exposure. *Science,* **201**(4354):465-467.

Vincent, J.R. and Tan, C.Y. (1997). *Air pollution and health* (Chapter 9)' *In*: Vincent, J. R., R. Mohammad Ali and associates, *Environment and Development in a Resource-Rich Economy Malaysia under the New Economic Policy,* Harvard University Press, Harvard.

Wigle, D. (2003). *Child health and the environment*. Oxford University Press, NEW YORK, U.S.A.

Winneke, G. and Kraemer, U. (1984). Neuropsychological effects of lead in children: Interactions with social background variables. *Neuropsychobiology,* **11**(3) : 195-202.

WEBLOGRAPGHY

California Thoracic Society (2004). *Air pollution : A cloud over tour child's heath. Medical Section of the American Lung Association. Tustin, CA. website: http://www. thoracic. org/ca.html.*

World Health Organization (WHO) Working Group. (2003). *Aspects of air pollution with particulate matter ozone and nitrogen dioxide, Available from: http://www.euro.who.int/__data/assets/pdf_file/0005/112199/E79097.pdf.*