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ENVIRONMENTAL CHEMICALS AND PAEDIATRIC MENTAL HEALTH: A NEUROCHEMICAL PERSPECTIVE

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Abstract

Environmental chemical denotes the compounds which form in nature either organically or man-made. The primary goal of this research was to examine the relationship between environmental chemical exposures with pediatric mental health. For achieving this research goal, this study utilized the secondary information on this research area. The outcomes of the secondary data analysis have shown that the impact of environmental chemical exposure through pollution can form various neurological diseases such as ADHD, Autism among children. Also, these compounds are able to decrease the cognitive development of a child.

Key Words: Environmental Chemicals, Neurotoxicity, ADHD, Autism, Cognitive Development.

1.0 Introduction

The term environmental chemicals denotes the chemical compounds which are present in nature and can cause different types of adverse effects on human health. It was found that many chemicals are normally formed in nature, however, most of them are synthesized by different types of human work procedures. There are multiple chemicals present in our environment which can form different health challenges to an individual. Over the past few years, numerous experimental research works have been conducted to understand more factors about these chemicals and their relation to human health. The influence of these harmful environmental chemicals are also found on the mental health of a human being. Formation of smallest dysfunction in the human nervous system can cause significant challenges for a person's mental health which also results in neurological diseases. In this particular research, the relationship between environmental chemical exposures with pediatric mental health are investigated.

2.0 Literature review

2.1 Environmental Chemicals

According to Richardson *et al.* 2019, environmental chemicals are divided into two parts. These two types include man-made chemicals and naturally formed chemicals. Among these

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environmentally found chemical compounds, the number of harmful chemicals are very high. This research paper has discussed the neurotoxic nature of these environmental chemical compounds. It was found that neurotoxicity denotes the process of direct or indirect chemical impacts which have the ability to negatively affect the operations of the human nervous system. It has been discovered that a number of chemical types can gravely harm human health. The authors have included examples of substances that have undergone biological production as well as details on their chemical properties.

It was identified that the chemicals formed biologically have more effects on human health than the chemicals formed non-biologically. It has been determined that the reasons behind this particular occurrence include biological compounds' high target specificity and dangerous potency. These biological substances come from a range of sources, including plants, fungus, amphibians, insects, mollusks, bacteria, algae, and arachnids. On the other hand, examples of non-biological chemicals include arsenic, lead, mercury, methylmercury, vitamin B6 etc.

In their paper, Faber, 2020, stated that the development of environmental chemicals are devided into two pathways. However, the release of these chemicals into the environment both intentionally and unintentionally causes environmental pollution. It was identified that these chemical environmental pollution become a major concern for public healthcare in the whole world. It was discovered that the most common chemical pollutants, including mercury (Hg), lead (Pb), cadmium (Cd), and arsenic (As), also pose a serious threat due to their detrimental effects.

2.2 Impact of Environmental Chemical on Human Health

According to Ghorani-Azam *et al*. 2016, because of a wide variety of chemical activities disease causing chemicals can release to the environment. It was found that these harmful chemicals develop air, water and soil pollution. Exposure to these chemicals can happen in three different pathways, which are inhalation, oral absorption, and ingestion.

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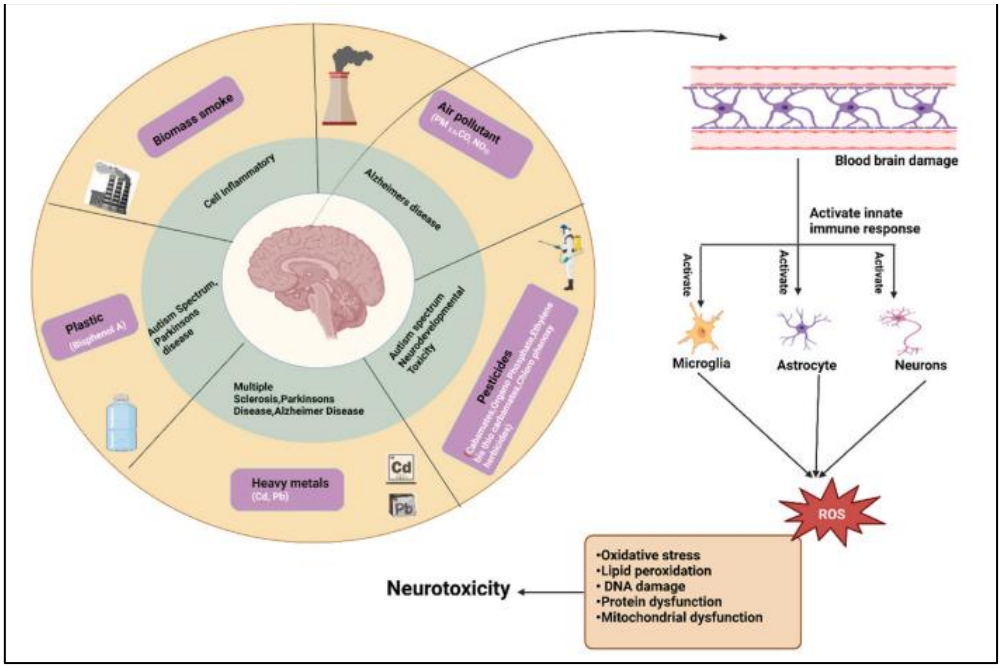

Figure 1: Environmental pollutants and its relation to neural health

(Source: https://www.cell.com/heliyon/fulltext/S2405-8440(23)06704-X)

The authors of this research paper have used the method of a comprehensive literature review to understand the impact of environmental pollutants to human health. The findings of this research have shown that the higher exposure to these chemical compounds can cause various neurological disorders. These chemicals also have the potential to cause neurotoxicity. Neurochemical reaction mechanisms in human nerve cells can result in several pathological states, including but not limited to oxidative stress, protein aggregation, DNA damage, and mitochondrial failure.

The research paper of Iqubal *et al*. 2020, shows that between the global public health challenges, diseases formed by environmental chemicals and pollutants are very concerning. These drugs have the potential to induce a variety of neurological disorders. Numerous epidemiological studies have shown that exposure to environmental contaminants raises the chance of acquiring conditions such endoplasmic reticulum stress, oxidative stress, and neuroinflammation.

2.3 Effects of Environmental Chemical on Pediatric Mental Health

The research paper of Berghuis *et al.* 2015, mentioned that the impact of environmental chemicals on mental health of child is a very significant element. Among these chemicals which can be found in different types of pollution, the air pollutants become the compounds with the highest amount of risk related to children's mental health. It can create different types of cognitive disabilities among children. Prolonged exposure to airborne contaminants can

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cause kids' sleep problems, which exacerbates their general health and wellbeing, in addition to diminishing their cognitive abilities. In addition, these toxic chemicals also have the ability to reduce regional grey matter in the human brain which creates memory loss problems in a child.

According to Thygesen *et al*. 2020, one of the largest threats to public and individual health was identified as the air pollutants. These chemical compounds hold a high risk percentage because the exposure to these pollutants are simple. On the other hand, early childhood lifespan of a person was identified as the period which includes the growth of cell and brain development. In this particular study, the researchers have also used the method of literature review. Some studies findings have shown high exposure to pollutants or harmful chemicals can form childhood disorders such as ADHD, autism etc. Although, accurate causes or disease forming mechanisms of these diseases with relation to environmental chemicals are not clinically proven.

3.0 Methods

The methodologies of this particular research study are described in this particular section. It includes the collection process of data and also the analysis techniques.

3.1 Research Method

In this research the use of mono research method was used to complete the investigation of environmental chemicals and child mental health's link. The procedure of the mono method described the use of one particular data type. In this study, only secondary data have been used to complete the investigation.

3.2 Research Approach

The deductive approach of research was used in this particular study. With the help of this research approach, the literature review process was completed. It helps to understand environmental chemicals, their sources, impacts and relation to child mental health and well-being.

3.3 Data Collection Method

The secondary data such as books, journals, articles, newspaper articles etc were collected in this research. All the data were collected from authentic sources of online literature databases.

3.4 Data Analysis Method

The analysis process of data includes a standard secondary data analysis process. The data collected for this research holds a critical analysis of secondary information.

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4.0 Result

The result section of this research holds the summarization of findings from the previously conducted research on this specific research area. These results become very important for understanding the relation between child mental health and exposure to toxic environmental chemicals.

It was identified that the intake of environmental chemicals because of different pollution types such as air, soil and water becomes a vital problem for a child's development (both physical and mental).

	Total effect, β coefficient (95% CI); p value	Average causally mediated effect, β coefficient (95% CI); p value	Average direct effect, β coefficient (95% CI); p value	Percentage of the effect explained by the mediator (95% CI); p value
NO_2	0·16 (0·04–0·28); p=0·012	0·16 (0·09–0·22); p<0·0001	0·00 (–0·14 to 0·13); p=0·95	97·1% (43·0–396·0); p=0·012
$PM_{2·5}$	0·16 (0·04–0·29); p=0·0060	0·05 (0·02–0·08); p<0·0001	0·11 (–0·01 to 0·24); p=0·082	29·5% (12·0–117·0); p=0·0060
Day–evening–night noise level	0·17 (0·04–0·29); p=0·0060	0·06 (0·04–0·08); p<0·0001	0·11 (–0·02 to 0·23); p=0·096	35·2% (17·9–139·0); p=0·0060

Data are β coefficients (95% CI) with one IQR increase in environmental exposure, unless otherwise specified. Models control for sex, English as a second language status, season of birth, lone-parent household status, maternal age, Medical Services Plan subsidy status, neighbourhood-level material deprivation, and neighbourhood-level urbanicity. Models include teacher as a random effect. EDI=Early Development Instrument. NO_2=nitrogen dioxide. PM=particulate matter.

Table 2: **Adjusted associations and percentage of the association between greenspace and total EDI score explained by NO_2, $PM_{2·5}$, and noise (n=27 372)**

Figure 2: EDI scores of children by the exposure to environmental chemicals

(Source: https://www.thelancet.com/journals/lanplh/article/piis2542-5196(21)00235-7/fulltext)

This particular research was completed to find out the impact of environmental pollutants such as NO2, PMs etc on the early cognitive development characteristics of a child. In this particular research the data of 27,372 children were used to form the statistical analysis. There was a vital relationship was present between environmental chemicals and child's cognitive factors (Miri *et al*. 2020). The findings of this particular study have shown that at the interval rate of 95%, the effect of NO2 was the highest on the EDI scores of these children's. This particular effect was identified as 97.1%. It ultimately means that the high exposure to NO2 has significantly lessened the percentage of cognitive skills of children. However, the impact of PMs are comparatively lower than the effect of NO2.

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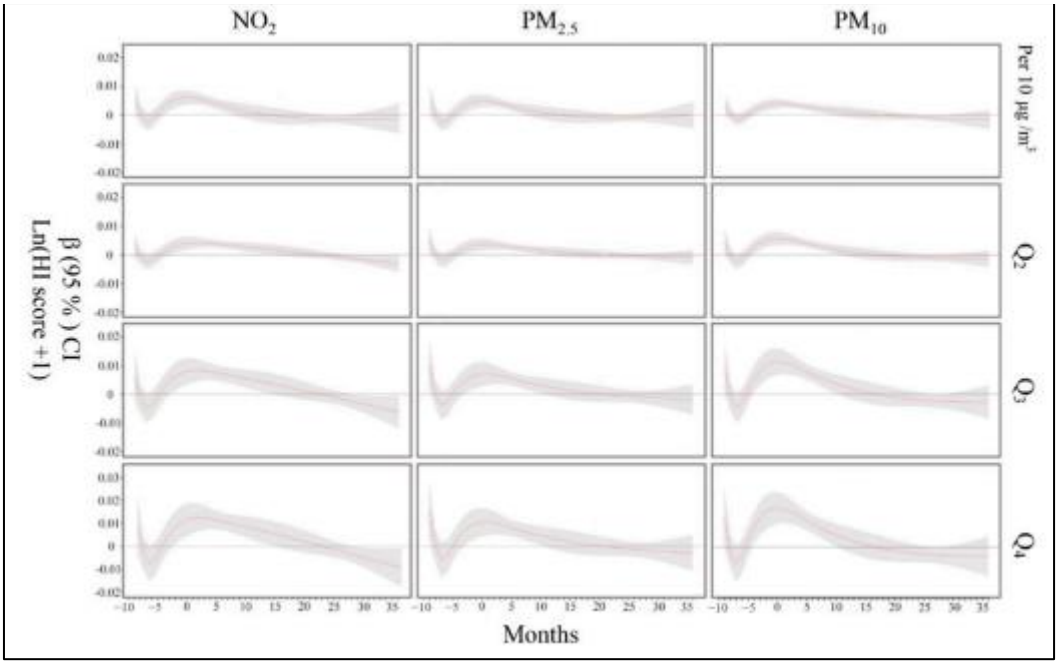

Figure 3: Changes in child ln (HI score + 1) at around 3 years old associated with monthly PM and NO2 exposure

(Source: https://www.mdpi.com/1660-4601/19/17/10482)

Figure 3 holds the HI score + 1 analysis of 3 years old children in relation to the presence of PM and NO2 exposure. It can be identified from this finding that the impact of PM and NO2 exposure increased the hyperactivity index of children.

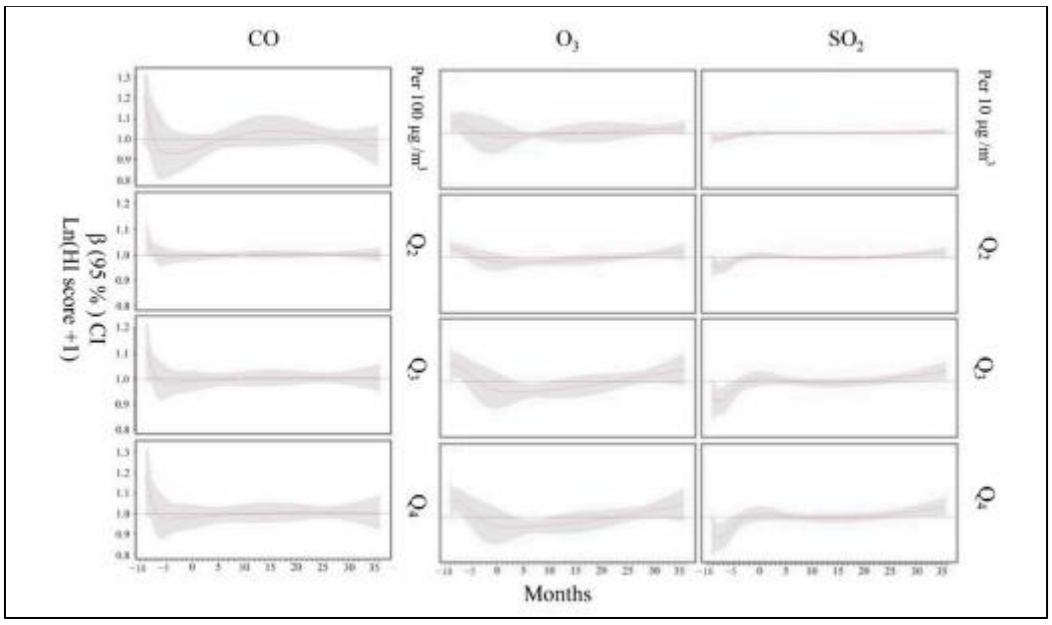

Figure 4: Changes in child ln (HI score +1) around 3 years old associated with monthly CO, O3 and SO2 exposure

(Source: https://www.mdpi.com/1660-4601/19/17/10482)

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Figure 4 holds the HI score + 1 analysis of 3 years old children in relation to the presence of CO, O3 and SO2 exposure. It can be understood from this graph that the impact of CO, O3 and SO2 exposure increased the hyperactivity index of children effectively.

5.0 Discussion

The discussion part of this study described the secondary findings mentioned in the above-section. It was found that EDI can be significantly impacted by environmental pollutants exposure (Roberts *et al*. 2019). In figure 2, the correlation between the EDI scores of children and PMs and NO2 exposure. The EDI score denotes the early childhood development index which is used to examine the cognitive abilities of a child. A low score suggests that his/her cognitive skills are underdeveloped. The correlation shows that children who were exposed to high pollution areas have low EDI scores which means their cognitive development was affected significantly.

On the other hand, figure 3 and 4 displayed the relation between formation of higher HI scores in association to the exposure to CO, O3 and SO2, NO2 and PMs. The result outputs of this research was more significant towards higher scores (Kooij *et al*. 2019). The outcomes of the graphs have shown that the impact of CO, O3 and SO2, NO2 and PMs exposure have expanded the outcomes of ADHD among children.

6.0 Future Directions

The relationship between environmental chemicals and the mental health development of a child holds a significant relationship. Previously completed papers have shown vital relation of environmental chemicals and the mental health of children (Driga and Drigas, 2019). However, in most of these research, only epidemiological experiments are performed. Primary studies on this research area are few (Makwana, 2019). Therefore, the future direction of this study should be more focused on the formation of clinical research. The participants of this future research should include the clinical data of children from locations highly exposed by.

7.0 Conclusion

In this whole study, understanding of the impacts of environmental chemicals and the mental health of children are described properly. A well-structured literature review was conducted in this particular report by using existing literature linked to this particular research area. Essential concepts such as environmental chemicals, neurotoxicity, impact of chemicals on human health and pediatric mental health are gathered from this literature review. The methods utilized to complete this report are also described in the method part. The use of a secondary data collection and analysis process was implemented in this research to find out the impact of

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environmental toxic chemicals and pediatric mental health. The secondary findings of this study have provided valuable information about these two components' relation. It was found that environmental pollutants can decrease the cognitive abilities of children. Also, the risk factor of neurological disease formation such as ADHD, Autism increases due to the high exposure of environmental chemicals.

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