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Short Communication

High concentration of toxic metals in children's scalps is likely the cause of autism

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ABSTRACT

Studies have shown that mineral imbalances in children with autism manifests as a result of an excess of some elements and a deficit of others. These studies also add that environmental factors may contribute to the pathogenesis of Autism Spectrum Disorder (ASD). Indeed, trace elements and toxic elements seem to play an important role in the homeostasis of the body. The objective of this work is to evaluate the concentration of essential heavy metals in the hair of autistic children. This work was carried out with the help of families whose children have autism. The study included 40 children with ASD and 40 matched controls without ASD with an average age of 4 ± 1.17 years for the entire sample. We opted for a sample of hair that is the best indicator of a given mineral in the body. Indeed hair samples of 80 boys and girls were carefully packed and sent to the laboratory for analysis. The result revealed a level of potentially toxic metals in the hair of children with autism; the concentration of lead (Pb), mercury (Hg) and uranium (Ur) was higher than the controls. For the other metals, no significant difference was found between the affected group and the controls. The abundance of toxic metals in the hair of our cohort leads us to conclude that these heavy metals probably play a role in the development of ASD.

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a heterogeneous group of behaviorally defined neurodevelopmental disorders characterized by communication and social interaction disorders, as well as restrictive and repetitive behaviors [1]. This disease affects children at a ratio of four boys to one girl [2]. Much evidence put industrial chemicals at the forefront of the development of neurobehavioral disorders, including autism spectrum disorders. Especially heavy metals are recognized as neurodevelopmental toxins as they can be responsible for neurological abnormalities, developmental delays, learning disabilities and behavioral abnormalities. Studies have shown a relationship between exposure to metals during the early childhood period and the increased risk of autism [3].

Neurodevelopmental disorders such as autism, attention deficit disorder, mental retardation and cerebral palsy affect between 400,000 and 600,000 children born in the United States each year [4]. In recent decades, there has been growing evidence that industrial chemicals contribute to neurobehavioral diseases [5]. Heavy metal contamination is one of the most serious threats to the environment. There is convincing evidence that heavy metals negatively affect neurodevelopment and increase the risk of Autism Spectrum Disorder (ASD) [6, 7]. Other studies have reported that

exposure to environmentally toxic substances such as mercury, lead, arsenic, polychlorinated biphenyls (PCBs) and toluene is the known cause of neuro-developmental disorders [5]. Studies have shown that the severity of ASD is associated with the estimated heavy metal body burden [8, 9]. The rate of autism is increasing, but the causes are not well understood.

PATIENTS AND METHOD

A group of 40 autistic children and 40 child controls was the subject of this study. The evaluation of the metal content forced us to make a small haircut; this technique is non-invasive and the best indicator of a given mineral in the body. These samples were collected from autistic children and controls. The length of the sample was about 1.5 to 2 cm and the sample was collected using steel scissors which was disinfected after each use.

For the hair analysis, a minimum of 5 mg sample was required. During haircuts, an adhesive paper was placed at the end closest to the scalp. The haircuts related to the controls were performed in the same way. The samples were then placed in sealed plastic bags and sent to the laboratory.

Statistical analysis

To overcome a large variation in measurements, we opted for non-parametric statistical methods of Mann and Whitney U-Test. This procedure was conducted to compare the outcomes of the two groups (children with autism and controls).

RESULTS

Table 1 shows that the autistic group comprised 32 boys and 8 girls; their average age was 6.24 ± 2.4 years. The control group consisted of 30 boys and 10 girls, with a mean age of 6.8 ± 3.04 years.

In the table 2 the values are expressed as μg/g. The results showed a highly significant value ($p < 0.001$) for mercury (Hg) (5.50 vs 0.81 μg/g), lead (Pb) (5.75 vs 3.29 μg/g), and uranium (0.45 vs 0.27 μg/g). Mean concentrations of the three toxic metals in hair were significantly higher in the ASD cases studied compared to controls. As for the other elements, the values are not significant between autistic children and controls.

Table 1. Characteristics of participants.

Parameter	Autism group	Controls
Male	32	30
Female	8	10
Male age (years)	6.24 ± 2.4	6.1 ± 2.4
Female age	6.8 ± 3.04	7.3 ± 3.04

Table 2. Excessive presence of toxic elements in the capillaries in autistic subjects compared to controls.

Toxic elements	Autistics	Controls	*P* value
Aluminum	30.0 (59.0, 70.0)	31.0 (58.3, 67.0)	NS
Arsenic	0.09 (0.12, 0.18)	0.10 (0.11, 0.16)	NS
Cadmium	0.14 (0.12, 0.16)	0.19 (0.13, 0.18)	NS
Mercury	5.50 (4.10, 4.90)	0.81 (0.24, 0.40)	$p < 0.001$
Lead	5.75 (5.70, 7.00)	3.29 (2.80, 4.0)	$p < 0.001$
Uranium	0.45 (0.40, 0.50)	0.27 (0.12, 0.18)	$p < 0.001$

DISCUSSION

Autism Spectrum Disorder (ASD) is a heterogeneous group of behaviorally defined neurodevelopmental disorders characterized by communication and social interaction disorders, as well as restrictive and repetitive behaviors [1]. Other researchers have defined autism as a complex neurodevelopmental disorder with a largely unknown etiology. It is characterized by altered language, disturbed mutual social interactions and stereotyped behaviors and interests [10]. In this study, high concentrations of three potentially toxic elements were found in the hair of ASD subjects: lead, mercury and uranium. Previous studies have separately dealt with the three elements we found abundant in the hair of our cohort and have shown that excess of one of them is capable of causing autism. Another study pointed out that exposure to mercury can produce autistic spectrum disorders [11]. Other studies report that mercury poisoning has also sometimes been presumptively diagnosed as autism of unknown etiology until mercury poisoning was established [12]. According to [13] the main sources of human exposure to mercury are dental amalgams, pharmaceuticals, cosmetics and food, mainly contaminated fish. Others have stated that mercury is one of the toxic elements that is widely distributed in nature [14]. Researchers have identified five industrial chemicals as developmental neurotoxicants based on epidemiological evidence: lead, methyl-mercury, polychlorinated biphenyls, arsenic, and toluene [5]. A previous study indicates that lead poisoning in children is one of the most common causes of neurodevelopmental disorders. Lead poisoning in children has deleterious effects on the development of large areas of the brain, including those involved in cognitive functioning, communication, and social functioning [15]. Furthermore, lead causes significant oxidative stress and lipid peroxidation whether directly or indirectly [16]. Accordingly, many authors postulated that lead is never safe whatever its level is and can result in aberrant learning and defective neurobehavior at levels as low as 10 μg/dl [17, 18]. One in every six children has a developmental disability and in most cases these disabilities affect the nervous system [19]. Some studies have found that cadmium, arsenic, lead and mercury have been linked to autism, attention deficit disorder, mental retardation and child death [20]. Other authors have reported that maternal inflammatory and autoimmune diseases can damage fetal tissues, aggravate a genetic problem or damage the nervous system [21]. Several studies have indicated a higher prevalence of gastrointestinal problems such as abdominal pain, constipation, chronic diarrhea, vomiting, and gastroesophageal reflux disease in ASD patients [22]. The presence of one or more disorders was often associated with the diagnosis of ASD, including gastrointestinal diseases and dysbiosis [22], autoimmune diseases [23] and mental retardation [24]. Communication and learning problems are common in ASD patients. Researchers [25] have found that high levels of lead were associated with negative effects on child development, cognitive abilities, learning and behavioural disorders, attention deficit hyperactivity disorder, impulsivity and inability to prevent an inappropriate response. With regard to the onset of this disease, studies have reported that in some cases, autistic infants appear to develop normally until the age of 1 to 3 years, then sudden changes occur that indicate the presence of ASD [26]. Recent studies have shown that maternal exposure to insecticides in early pregnancy is associated with a higher risk of autism in their children [27]. With regard to neurodevelopmental disorders, some longitudinal studies have reported effects of prenatal exposure to polyfluoroalkyl substances (PFAS), such as increased hyperactivity, behavioral problems and a composite score for autism screening [28].

Our visit to certain families of autistic children revealed to us that these children are difficult to control; they go through several crises caused by the slightest change in their usual routine, like the change in the places where they play.

CONCLUSION

In conclusion, this study made us discover the suffering of families whose children are autistic; in parallel the research provided further evidence of a probable link between mercury, lead, uranium and a diagnosis of ASD. The results obtained are consistent with those of previous studies and highlight mechanistic ideas about the relationship between increased concentrations of these three elements and the increased severity of ASD

diagnosis. This study also confirmed the link between neurodevelopmental disorder of autism and exposure to the toxic elements that was the focus of this work.

CONFLICT OF INTEREST STATEMENT

This is to certify that the reported work in the article entitled 'High concentration of toxic metals in children's scalps is likely the cause of autism' submitted for publication in the journal Current Topics in Toxicology has no conflicts of interest and this is a personal work.

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