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Short Communication

Investigation of the cause of lead poisoning and the effect of probiotics in reducing lead poisoning

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Abstract

Manifestations of lead poisoning depend on the blood lead level, and the use of probiotics plays an important role in preventing lead poisoning and reducing its toxicity. The symptoms of this poisoning include lead colic, constipation, joint pain, myalgia, headache, anorexia, decreased libido, memory loss, Pale gums, basophilic stippling, and peripheral neuropathy. In general, the main sources of pollutants, depending on different locations and occupations, include paints, dust, drinking water, parents' work environment, air, and food. A 36-year-old man was referred to the Isfahan Provincial Health Center by the Governor's Crisis team after submitting a request to investigate the cause of his and his family's lead poisoning. Considering the Serum lead levels of family members and people who visited their homes, it was determined that all of these individuals had chronic lead poisoning, which had been present for a relatively long period of time. Considering the effect of using probiotics in preventing lead poisoning and reducing its toxicity, it is suggested that recommendations and training be provided for the general use of probiotics including *Streptococcus thermophilus*, *Lactobacillus* sp., *Pediococcus pentosaceus*, *Bacillus* sp., and *Saccharomyces cerevisiae*.

Keywords: Lead poisoning, Serum lead level, Complication, Probiotics.

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Introduction

With the increasing development of industry and technology, one of the disasters that is observed along with this development is the harm that is caused to humans and their environment. Among these, heavy metal poisoning, especially lead poisoning, is a particular public health problem in children (1). Lead is a heavy metal that has been used in various industries, commonly for water supply facilities and pipes, soldering, pottery glazes, paints, battery coatings, bullets, and other items. Despite its uses, lead is a known environmental toxin, exposure to which leads to negative health consequences. While adults and children are equally vulnerable to the negative effects of lead, children are particularly vulnerable (2). Lead has been used by humans since ancient times due to its physical and chemical properties. This metal has been used in the glazing of dishes since 7-5 thousand years BC. The Phoenicians obtained lead from the area of Spain and Cyprus 2 thousand years BC. Also in Iran, during the period of the prosperity of science, famous Islamic chemists such as Razi used lead compounds in pharmacy and medicine (1). Lead poisoning is one of the poisonings its manifestations depend on the level of lead in the blood. In addition, the symptoms are completely different from one person to another. In addition, depending on the acute, subacute or chronic exposure, the symptoms of poisoning will vary. These symptoms include lead colic, constipation, joint pain, myalgia, headache, anorexia, decreased libido, memory loss, anemia in the gums, Basophilic Stippling, peripheral neuropathy (weakness of the extensor muscles or drooping of the wrists and feet). In chronic and repeated exposure to lead, the Serum lead level is usually 30-70 µg/dl and the symptoms are completely non-specific or may be asymptomatic (3,10). Considering the complications of lead poisoning in children and its effects in preventing adequate growth and reducing IQ, as well as other side effects. Besides, today, even the standard level of the lead should not be easily ignored. The most common route of lead absorption into the body is through the digestive tract, and hand-to-mouth contact is the main route of lead contamination in children. Digestive absorption of lead varies depending on age, with absorption of ingested lead being about 10% in adults and about 40% in children, reaching 50% in children with iron deficiency anemia. Deficiency of protein, calcium, zinc, copper, iron, and high levels of fat and oil in the diet increase lead absorption (1,11). In general, the main sources of pollutants, depending on different locations and occupations, include paints, dust, drinking water, parents' work environment, air, and food (4). The normal Serum lead level in children is less than 5 µg/dl, and toxicity is considered with a value greater than 10 µg/dl. Also, in adults, Serum lead levels are normal when less than 20 µg/dl, mild toxicity is 20-45 µg/dl, moderate toxicity is 45-100 µg/dl, and severe toxicity is greater than 100 µg/dl (5). The structure and function of the intestinal mucosal barrier are critical for maintaining intestinal homeostasis. While extensive research has emphasized the establishment of a healthy gut microbiota through optimal dietary patterns and balanced nutrient intake to support beneficial bacteria, emerging evidence suggests that lead (Pb) exposure can significantly compromise this delicate balance. Lead exposure causes direct and indirect changes in the composition of the gut microbiota, disrupting intestinal homeostasis, and ultimately impairing host health (2). One way to prevent lead poisoning

and reduce its toxicity, is the use of probiotics (6,7). Probiotics are live, non-pathogenic microorganisms that, when consumed, improve the intestinal microbial balance by inhibiting the growth of pathogens, thereby providing health benefits to the host. Probiotics include species of *Bifidobacterium*, *Lactobacillus*, and also yeast. Probiotics have long been widely used as dietary supplements worldwide and are generally considered safe and well-tolerated (6). Probiotics, dietary fiber, and vitamin C are involved in reducing lead toxicity primarily through the following processes. Probiotics (e.g., *Lactobacillus*, *Bifidobacterium*) compete with lead-absorbing pathogens for intestinal binding sites, reducing lead bioavailability. In addition, bacterial cell wall components (teichoic acids, peptidoglycans) directly chelate lead ions and microbial metabolites (8,9). Probiotic supplementation can be considered as a novel dietary therapeutic strategy against lead toxicity, in conjunction with conventional therapies, antioxidants, anti-inflammatories, and other supportive therapies. Dairy products such as curd, sour milk, yogurt, and other fermented dairy products contain these beneficial probiotics (6).

Case Presentation

A 36-year-old man was referred to the Isfahan province health center by the crisis headquarters after submitting a request to investigate the cause of his and his family's lead poisoning. He lived with his 2 children and his wife on the second floor of his father's house. A house with 2 floors and almost in the center of Isfahan, Iran. His children, 2 boys, 7 and 9 years old, were hospitalized due to severe heartache and constipation (above 100 µg/dl). Due to the high level of lead Serum in poisoned children from the rest of the family, blood tests were done in the hospital and it was found that the parents of the family and the grandmother of the family are also suffering from lead poisoning, but due to the lower level blood lead Serum (less than 100 µg/dl) was being treated with Succimer capsules And they had to take 50 of these capsules, which at the time of their visit, they had taken 10 capsules. The grandfather of the family had died several months ago due to severe kidney failure, and during the examinations conducted at that time, the cause of his death was reported to his family as severe and chronic lead poisoning. Grandfather of the family worked as mechanic. The father of the family, a cleric, and his wife were also housewives.. In order to investigate the cause of this family's poisoning, we visited their home. First, the neighborhood and neighbors were checked. It was necessary to ensure the proximity or lack of proximity of the house to workplaces and jobs related to lead, such as painting, dyeing, etc. On the right and left sides of the house, there were two residential buildings, one of which was abandoned and the other was used as a detergent warehouse. Behind the building was a printing workshop, a painting workshop, a shoemaking workshop, and a post-embroidery workshop. Across the alley, directly opposite the structure, was a residential building, and next to it was a dairy shop. The owner of the shop and his family lived in the house next to the dairy shop. A total of 10 people worked and lived in these workshops and the house opposite the building in question. Blood tests were taken from each of the 10 people, plus the maternal grandmother who lived in this house 2 days a week, and also the son-in-law of the family who frequented this house, and their Serum lead levels were measured. In addition to the tests, blood pressure, height, weight, BMI were measured,

Table 1. Characteristics of individuals suspected of lead poisoning.

Sex	Age	Occupation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
M*	36	Back Embroidery	1.76	63	20.3	110/80				*								5.08	-
M	43	Back Embroidery	1.75	91.5	29.9	140/90				*								7.82	-
M	23	Dairy	1.80	74	22.8	95/60				*								4.77	-
F*	22	Housewife	1.67	44	15.8	110/60			*	*								3.54	-
M	45	Dairy	1.78	86	27.1	122/80					*							4.71	-
F	41	Housewife	1.67	70	25.1	100/70				*	*							4.06	-
M	54	Groom of the family (Lathe)	1.67	49	17.6	130/90	*				*			*				29.2	+
M	60	Print	1.68	60	21.3	115/75												5.81	-
M	32	Print	1.68	49	17.4	100/65				*			*					5.08	-
M	51	Shoemaker	1.75	59	19.3	120/80				*	*	*						5.36	-
M	47	Shoemaker	1.73	72	24.1	120/80				*		*				*		5.24	-
F	78	Maternal grandmoter (Housewife)	1.46	79	37.1	130/80	*	*	*	*	*	*	*	*	*		*	44.2	+

* Male (M), Femal (F).1: Height (cm), 2: Weight (kg), 3: BMI, 4: Blood pressure (mmHg), 5: Anorexia, 6: Stomach ache, 7: Paleness, 8: Weakness and Lethargy, 9: Headache, 10: Boredom, 11: Drowsiness, 12: Agitation, 13: Irritability, 14: Lead line on the Gum, 15: Nausea and Vomiting, 16: Serum blood lead level (mg/dL), 17: Result of lead poisoning.

and the symptoms these people had were asked, and results were obtained based on (Table 1).

According to the results, it was determined that there was no source of lead contamination in the neighborhood and that the poisoning of the family, the son-in-law of the family, and the maternal grandmother of the family was related to the interior of the house. For this purpose, by placing an air sampling pump (SKC model with MCE membrane filter) for 24 hours in the home environment (kitchen and living rooms) and then measuring the amount of lead in the air sample by atomic absorption method (5), the amount of lead in the kitchen air was 0.003 ppm and the amount of lead in the living room air was below the detection limit.

After that, samples were taken from the water and food consumed by the family that were likely to be contaminated with lead. Materials such as salt, which was prepared and consumed in bulk, yogurt, which was prepared ready-made from yogurt, and fish. Samples were also taken from the kitchen tap water, samovar water (given that it had been repaired and soldered), water from the tanker on the roof (because it was galvanized), and aquarium water and were sent to the Pars Standard Knowledge Laboratory for testing. The results of the water and food tests were obtained based on Table (2). Also, containers such as frying pans, pots, and pressure cookers were sent to the laboratory to measure the amount of lead, and the test results were reported negative in terms of contamination and causing lead poisoning. The study revealed that the parents of the children used foods containing probiotics that can play a role in reducing lead poisoning, such as yogurt, and therefore the amount of lead poisoning in these people was lower than in their children (6).

Further investigation revealed that the members of this family do not use any medications (chemical and herbal), herbal teas, or any

specific foods other than those they consume daily. Urine tests for drug addiction were also conducted on all members of this family, which were negative.

Table 2. The amount of lead in the tested samples.

Sample	The amount of lead	Unit
Water tanker on the roof	<0.002	mg/l
Samovar water	<0.002	mg/l
Kitchen tap water	<0.002	mg/l
Aquarium water	0.111898	ppm
Fish	0.17	mg/kg
Salt	<0.20	mg/kg
Doogh beverage	0.09105	mg/l

Discussion

Considering the Serum lead levels of family members and people who frequented their home, as well as the death of the father of the family due to severe kidney failure (lead deposition in soft tissue) caused by chronic and severe lead poisoning, as well as lead deposition on the children's wrist bones, it was determined that all of these people had chronic lead poisoning and had been poisoned for a relatively long period of time (more than a year). Also, during the investigations and tests conducted regarding the contamination of the environment, air, water, and food, it was determined that none of these factors had caused the poisoning of these people. Finally, in order to identify the cause of the poisoning and whether this poisoning process would continue in another place for this family, it was suggested that they live in another house. After the family moved to another place and during the continuation of the treatment process for 6 months, the Serum lead levels of these people normalized. After 2 years, the Serum lead levels of these people were tested again, and the numbers obtained were all within the normal range. Then the family returned to their previous place of residence and after 6 months of living in that house, the Serum lead level of these people was measured again and it was higher than normal (mild poisoning). Considering the course of these events and the fact that the source of contamination was in their house, it was suggested that correspondence be conducted with the Atomic Energy Organization regarding the measurement of lead radioisotopes and the possibility of its presence in this house and that additional investigations be conducted in this regard. Also, considering some studies conducted (6,7) regarding the use of probiotics to prevent lead poisoning and reduce its toxicity, it is suggested that recommendations and necessary training be made for the general use of probiotics including *Streptococcus thermophilus*, *Lactobacillus* sp., *Pediococcus pentosaceus*, *Bacillus* sp. and *Saccharomyces cerevisiae*, and that these probiotics be used in the treatment of people who have been poisoned by this metal, and that studies be conducted regarding the role of probiotics and their effect in the prevention, reduction of poisoning and treatment of lead poisoning.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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