

## Arsenic, Cadmium, Chromium, and Lead in Children's Products in Iran

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### Abstract

**Background:** Non-standard creativity tools and entertainment products may contain heavy metals. Children are more sensitive than adults to this potentially toxic chemicals. This study aimed at investigating harmful elements in children's products in Iran.

**Methods:** In this descriptive-analytical study, Iranian samples (13 play dough samples, 6 finger paint, and 1 face paint sample) and 10 imported samples were investigated by atomic absorption spectrophotometry. The statistical analyses were performed using the SPSS statistical package (version 19).

**Results:** The results of this study showed that the lead content of 2 samples of play dough (76%), 10 samples of finger paint (100%) and 3 samples of face paint (100%) was higher than the permissible limits set by the Iranian National Standards Organization. Lead and cadmium contents of 100% of the samples of play dough, along with the face and finger paints exceeded the permissible limits set by the European Union.

**Conclusion:** Research on prolonged exposure to harmful elements and comprehensive risk characterization for toys is recommended.

**Key Words:** Cadmium, Children products, Face paint Toys, Finger paint, Potentially toxic elements.

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## 1- INTRODUCTION

Toys play an important role in children's education, development of mental skills, and strengthening social communication (1, 2). Entertainment tools are made of various materials such as metals, wood, fabric, plastic, and paint. Children are more sensitive than adults to potentially toxic chemicals due to their higher metabolic rate and higher surface area to mass ratios than adults, immature immune system, and rapid growth of brain and bones (3-5). In addition to skin exposure to metal and paint contents of toys, there is also the risk of gastrointestinal infections (6). Metal stabilizers are used for the softness, flexibility, and brightness of toys. According to the World Health Organization (WHO) metal-containing compounds are harmful to children (7, 8).

Non-standard creativity tools and entertainment products may contain metals such as Zinc (Zn), lead (Pb), cadmium (Cd) (9, 10). Large quantities of Pb are used in children's toys as paint dryers or stabilizers (9). Metals may be released in potentially toxic doses from toys through saliva during chewing (11), sweat during skin contact, or gastric fluids after ingestion (12).

Potentially toxic metals including Pb, Cd, As, Cr, Se, Hg, and Ba (13) are often added to a variety of toys to provide softness, brightness, and flexibility (8, 14-17). Exposure to high concentrations of these metals can have adverse health effects, such as high blood cholesterol and low blood sugar, reduced kidney function, osteoporosis, gastrointestinal disorders, and cancer (18, 19). There is a significant association between blood level of metals and ADHD (one of the most common neurobehavioral disorders) in school children (20). Lead, classified by the International Agency for Research on Cancer (IARC) in Group 2B carcinogens, is highly toxic (21). Research indicates

that Pb can exert toxic effects of concern on many organ systems (22) including impairment of red blood cell (RBC) formation/function, central nervous system (CNS) peripheral nervous system (PNS) (23), damage, and notable kidney damage/renal dysfunction (24).

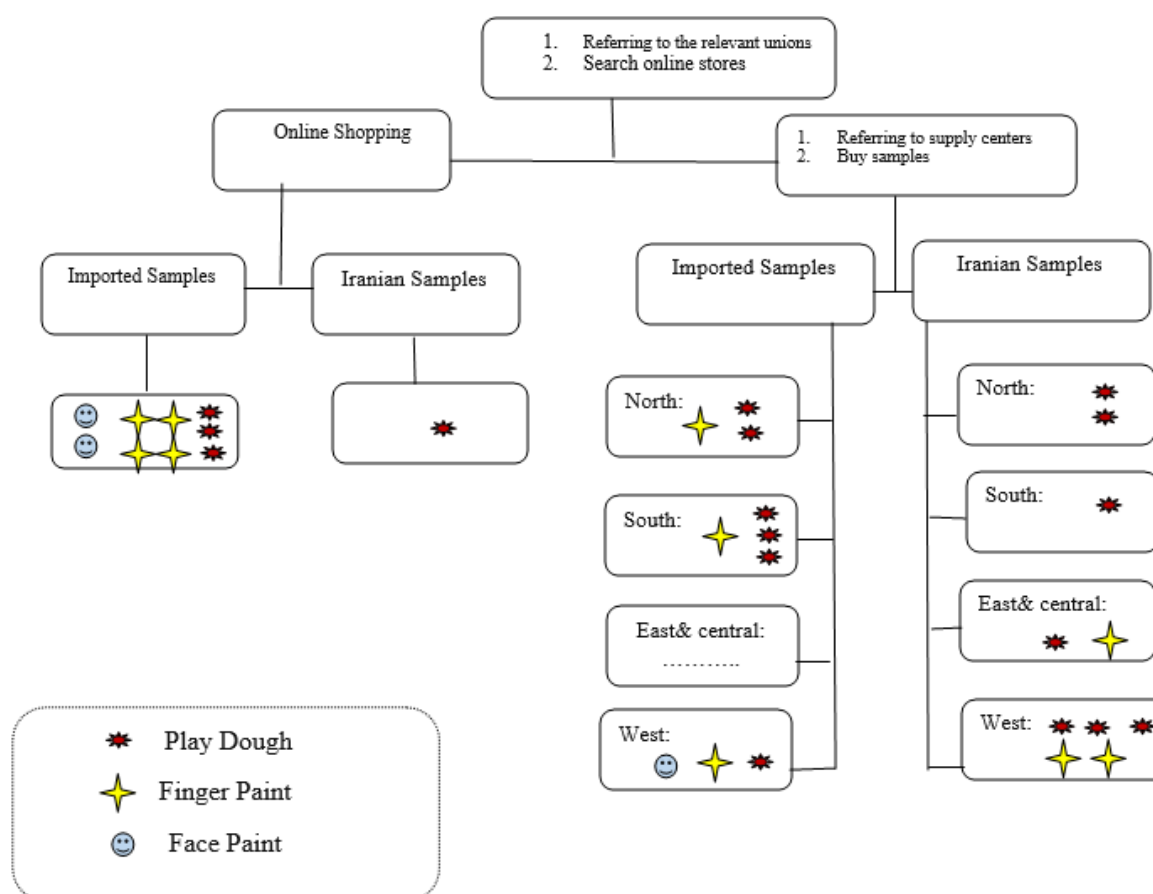
Arsenic is classified as Group 1 carcinogens by (IARC) (25). Arsenic poisoning causes various health problems, like dermal, neurological, abnormal heart rhythm, reduced white and red blood cell counts, and abdominal pain. In general, arsenic is a carcinogenic element that causes cancer of the lungs, bladder, and skin (26-30). Chromium is essential (31), but it can be a potential environmental hazard (32). While chromium metal and trivalent (III) chromium compounds do not seem to have health effects, hexavalent (VI) chromium is associated with lung, nasal, blood and sinus cancers (22-24). Complications of excessive chromium absorption can manifest as burning and itching in the gastric mucosa (33); hepatic necrosis, nephritis, internal bleeding, breathing problems, gastrointestinal cancer, and eventually death (34-36).

Some studies have been conducted on metal in play dough, face, and finger paints. Erbas et al. claimed that three of the play dough samples taken from Turkish markets had high cadmium concentrations while the other determined metals were at low concentrations. Four finger paint samples had high cadmium, copper, and lead content. Both of the face paint samples contained lead, cadmium, and copper at high concentrations (35). No studies so far have investigated the chemical compounds in play dough, face, and finger paints available on the Iranian market, and the safety of these products is not monitored in distribution centers. Therefore, this study aimed at investigating harmful elements in children's Products in Iran.

## 2- MATERIALS AND METHODS

In this descriptive-analytical study, a list of various brands of play dough, face and finger paints, and a list of supply centers were prepared by referring to the relevant unions in Iran. Then, the brands in the supply centers were identified and compared with the union's list. The samples from different brands available on Iranian market were selected through

convenience sampling method, and prepared during August, September and October 2019. Twenty Iranian samples (13 play dough samples, 6 finger paint samples, and 1 face paint sample) from different cities of Iran (North, South, East, west and Central Iran) and 10 imported samples (4 play dough, 4 finger paint, and 2 face paint samples) were bought. The sampling diagram is shown in **Fig. 1**.



**Fig. 1:** The diagram of sampling play dough, finger paint, and face paint

A total of 17 play dough, ten finger paint, and three face paint samples (30 in total) entered the study (for lab testing) of which the largest number of samples were from China (33.33%) and Iran (30%). The samples were examined based on Iran, Europe and US standards for heavy metal contents (**Table 1**). All products had

package labels with the country-of-origin information.

The same amount of each sample was weighed and a total of 5 grams of the samples was put into a crucible. It was then placed in an oven at 110 ° C for one hour. After cooling the crucible, concentrated nitric acid was added and the crucible was heated and dissolved at 80° C

for three hours. When the crucible reached room temperature, hydrochloric acid was added and the crucible was removed to a drying oven. It was then put in a digital furnace at 550 °C for one hour; and after cooling, it was diluted with 0.1 N nitric acid in a volumetric flask (37). Acid digestion was used to measure the quantity of arsenic. The atomic absorption instrument and other instrument conditions were optimized for the analysis of lead, cadmium, and chromium, according to the standards of AOAC999.11 (38). The calibration curve was plotted using Iran's standards (chrome standards of 5, 10, 25, and 50 mg/L; lead standards of 10, 25, 50, and 100 mg/L and cadmium standards of 62.0, 25.1, 2.5, and 5 mg/L) (54,55) and the concentrations of these elements in the samples were measured. For the Arsenic content of the samples,  $As^{5+}$  was converted to  $As^{3+}$  measured via atomic absorption spectroscopy. The same amount of each sample was weighed using a digital scale (precision 0.0001g), and a total of 5 grams of the samples were put into a crucible. 2 cc of 1.0 N hydrochloric acid and 2 cc of potassium iodide 1% (W/V) were added to the sample and it was heated for 2 hours at 70 ° C. Then, it was cooled and diluted to volume with 0.1 N nitric acid in a volumetric flask, Class A, 25 ml. The analytical measurement was performed immediately after preparation to reduce errors (39). The Varian 220 G was optimized for graphite-furnace atomic absorption analysis of lead, cadmium, and chromium, and the calibration curve was plotted using chromium, lead, and cadmium standards and the concentrations of these elements in the samples were measured.

### 2-1. Data Analysis

SPSS software (version 25) was used for data analysis. The independent T-test was used to compare the mean concentration of the elements with the standards of Iran

and the European Union, the significance level was set at 0.05. The Kolmogorov-Smirnov test was used to check whether metal concentrations were normally distributed. The results of this test showed normal distributions of the variables in all three stages of measurement ( $P < 0.05$ ).

### 3- RESULTS

According to the findings reported in **Table 2**, the lead content of 2 samples of play dough (76%), 10 samples of finger paint (100%), and 3 samples of face paint (100%) were higher than the permissible limits set by the Iranian National Standards Organization. Lead and cadmium contents of 100% of the samples of play dough, face, and finger paints exceeded the permissible limits set by the European Union. The chromium content of 40% (4 samples out of 10 samples) of finger paint samples and 33.30% (1 sample of 3 samples) of face paint samples exceeded the permissible limits set by the European Union.

**Table 3** shows the mean concentrations (mg/kg) of arsenic, cadmium, chromium, and lead in the samples of play dough, face, and finger paints domestically produced and imported. The imported play dough had the highest concentration of As (0.419) and Iranian finger paint had the lowest concentration of As (0.372). Iranian play dough and imported finger paint (6.47) had the highest (7.026) and lowest (6.47) mean concentrations of Cd, respectively. Cr and Pb contents of Iranian playdough were (15.96) and (73.89), respectively. That is, Iranian play dough had the highest scores compared with other samples. The imported face paint had the lowest Cr concentration (8.77) and the imported finger paint had the lowest Pb concentration (46.22).

According to the results shown in **Table 4**, the mean concentrations of arsenic, cadmium, chromium, and lead in the samples of domestically produced and

imported play dough were significantly different from the guideline values recommended by the Iranian National Standards Organization, China guideline values, and International guideline values ( $p < 0.05$ ). Arsenic and chromium contents of domestically produced and imported samples of the face and finger paints were significantly different from permissible limits ( $p < 0.05$ ). However, cadmium and lead contents of domestically produced finger paint were not significantly different from permissible limits ( $p > 0.05$ ) while cadmium and lead contents of imported face and finger paints were significantly different from permissible limits ( $p < 0.05$ ). Based on the results shown in **Table 5**, the mean concentrations of arsenic, cadmium, chromium, and lead in the samples of domestically produced and imported playdough were significantly different from the guideline values recommended by the European Commission ( $p < 0.05$ ). Arsenic and cadmium contents of domestically produced and imported face and finger paints were significantly different from permissible limits ( $p < 0.05$ ). The chromium content of domestically produced and imported finger paints were not significantly different from the permissible limit ( $p > 0.05$ ). Lead content of domestically produced finger paint was not significantly different from the permissible limit ( $p > 0.05$ ) while lead content of imported face and finger paints was significantly different from permissible limits ( $p < 0.05$ ).

Based on the results of the independent t-test, there was no statistically significant difference in the mean concentrations of arsenic, cadmium, chromium, and lead between domestically produced and imported play dough, face, and finger paints ( $p > 0.05$ ).

#### 4- DISCUSSION

In today's world, toys meet the social, intellectual, emotional, and physical needs

of children (35). Play dough is a suitable, informative, and inexpensive pastime that can enhance children's creativity (36). Finger painting is one of the most effective means for mental development and sensory integration, especially in early childhood. Although in recent years, research has been conducted in Iran on heavy metal contents of kid's toys, no study has been carried out on heavy metal concentrations of finger paint and play dough. The result of the present study showed, lead and cadmium concentrations were detected in all samples of play dough (37.96-77.54 and 62.9-42.4 ml/kg, respectively), finger, and face paint (13.69-70.41 and 62.9-83.4 mg/kg, respectively). Chromium concentrations exceeded the permissible limits set by the European Union in 4 samples of finger paint and 1 sample of face paint. Ardakani et al. (2016) studied heavy metal concentrations of 30 best-selling toys. Chromium and lead concentration were  $6.20 \pm 5.41$  and  $7.58 \pm 2.12$  mg/kg, respectively (40). Palad et al. (2016) studied the potential link between playdough usage and lead exposure for children in Vancouver (41), Canada. Iranian children constitute 24.5% of the total population (42) Studies show a high prevalence of lead toxicity in Iranian children (37). On the other hand, Iran is the largest importer in the Middle East and one of the top ten toy importers in the world. Toy market is filled with 80% of Chinese products, leaving only 20% for domestic production. About 10% of the foreign toys are smuggled and the rest are imported legally (42). Erbas et al. reported that based on Turkish and European standards, finger paint and face paint had higher heavy-metal concentrations than play dough. Lead concentration in 3 samples of play dough was 4.1-8.4 mg/kg and in the rest of the samples, it was too low. Lead was detectable in all samples of finger and face paint (7.1-8 mg/kg).

**Table-1:** World standards of Play Dough, Face & Finger Paint

USA Standard (mg/kg)								European Commission Standard (mg/kg)								Iranian National Organization, China values, and International Standard (mg/kg)							
Pb		Cr		Cd		Ar		Pb		Cr		Cd		Ar		Pb		Cr		Cd		Ar	
Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough	Face & Finger Paints	Play Dough
90	90	25	60	50	75	25	25	0.5	2	9.4	37.5	0.3	1.3	0.9	3.8	25	90	25	25	15	50	10	25

**Table-2:** Concentrations of arsenic, cadmium, chromium and lead in Iranian and imported samples

NO.	Laboratory No.	Sample type	Average three times arsenic reading (mg/kg)	An average of three times the cadmium reading (mg/kg)	Chrome reads an average of three times (mg/kg)	An average of three lead readings (mg/kg)
1	1 China	Play Dough	0.373	4.92 $\phi$	17	67.13 $\phi$
2	2 China	Play Dough	0.322	9.62 $\phi$	16.4	84.80 $\phi$
3	3 Iran	Play Dough	0.389	4.42 $\phi$	19	96.27* $\phi$
4	4 Iran	Play Dough	0.385	4.63 $\phi$	12.8	61.63 $\phi$
5	7 Thailand	Play Dough	0.361	7.39 $\phi$	12.8	68.57 $\phi$
6	9 Iran	Play Dough	0.328	6.20 $\phi$	14.1	65.27 $\phi$
7	10 Iran	Play Dough	0.399	9.40 $\phi$	13	87.33 $\phi$
8	12 Thailand	Play Dough	0.442	6.71 $\phi$	16.8	54.77 $\phi$
9	15 Iran	Play Dough	0.483	7.44 $\phi$	17.6	73.93 $\phi$

Contamination by four harmful elements in children's Product in Iran

NO.	Laboratory No.	Sample type	Average three times arsenic reading (mg/kg)	An average of three times the cadmium reading (mg/kg)	Chrome reads an average of three times (mg/kg)	An average of three lead readings (mg/kg)
10	16 Germany	Play Dough	0.458	8.73 $\phi$	13.4	82.20 $\phi$
11	17 China	Play Dough	0.471	5.63 $\phi$	14	96.37 * $\phi$
12	24 Korea	Play Dough	0.433	7.48 $\phi$	17.1	62.07 $\phi$
13	25 Iran	Play Dough	0.435	6.40 $\phi$	16.7	74.83 $\phi$
14	27 China	Play Dough	0.463	5.56 $\phi$	18.4	64.03 $\phi$
15	28 China	Play Dough	0.476	5.11 $\phi$	14.1	74.43 $\phi$
16	29 Iran	Play Dough	0.421	5.66 $\phi$	18.4	58.07 $\phi$
17	30 China	Play Dough	0.389	6.44 $\phi$	14.1	56.67 $\phi$
18	5Netherlands	Finger Paint	0.371	4.91 $\phi$	10.8 $\phi$	53.93 * $\phi$
19	6 Turkey	Finger Paint	0.324	5.80 $\phi$	9.24	41.70 * $\phi$
20	8 China	Finger Paint	0.338	6.85 $\phi$	10.2 $\phi$	44.50 * $\phi$
21	11 Iran	Finger Paint	0.388	8.22 $\phi$	9.25	56.37 * $\phi$
22	13 Iran	Finger Paint	0.356	9.62 $\phi$	8.66	69.10 * $\phi$
23	18 China	Finger Paint	0.386	8.48 $\phi$	10 $\phi$	44.23* $\phi$
24	19 Mexico	Finger Paint	0.394	6.91 $\phi$	9.82 $\phi$	52.20 * $\phi$
25	20 Italy	Finger Paint	0.411	6.16 $\phi$	8.58	42.30 * $\phi$
26	22 Japan	Finger Paint	0.382	4.83 $\phi$	7.25	41.76 * $\phi$
27	26 China	Finger Paint	0.450	5.87 $\phi$	7.3	49.20 * $\phi$
28	14 China	Face Paint	0.395	8.25 $\phi$	8.96	52.20 * $\phi$
29	21 Taiwan	Face Paint	0.364	5.76 $\phi$	7.63	69.13* $\phi$
30	23 Korea	Face Paint	0.391	5.47 $\phi$	9.7 $\phi$	54.77 * $\phi$

$\phi$ : Metals exceeds the Proposed limits EU Directive, \*: Metals exceeds the Proposed limits Iran Directive

**Table-3:** Average concentrations of arsenic, cadmium, chromium and lead in Iranian and imported samples

Pb (mg/kg)	Cr (mg/kg)	Cd (mg/kg)	Ar (mg/kg)	Product brand	N	Samples
73.85 $\phi$	15.96	7.026 $\phi$	0.406	Iranian	7	Play Dough
71.10 $\phi$	15.42	6.76 $\phi$	0.419	Imported	10	
62.28 $\phi^*$	8.95	8.86 $\phi$	0.372	Iranian	2	Finger Paint
46.22 $\phi^*$	9.21	6.47 $\phi$	0.382	Imported	8	
58.70 $\phi^*$	8.77	6.49 $\phi$	0.383	Imported	3	Face Paint

$\phi$ : Metals exceeds the Proposed limits EU Directive,  $\phi^*$ : Metals exceeds the Proposed limits Iran Directive

Ar: Arsenic, Cd: Cadmium, Cr: Chromium, Pb: Lead

**Table-4:** Results of comparing the mean concentrations of arsenic, lead, cadmium and chromium in Iranian and imported samples (Iranian National Organization, China values, and International Standard)

Confidence Interval 95%		Mean difference	Sig.	Degree of Freedom	T-test	Variable		
Upper Limit	Lower Limit							
Test value-25								
-24.5493	-24.6382	-24.59373	0.000	6	-1353.369	Iranian	Play Dough	Ar
-24.5421	-24.6190	-24.58055	0.000	9	-1447.320	Imported		
Test value-10								
-9.4214	-9.8335	-9.62742	0.001	1	-593.674	Iranian	Finger Paint	Ar
-9.5841	-9.6504	-9.61721	0.000	7	-685.846	Imported		
-9.5748	-9.6573	-9.61604	.000	2	-1002.525	Imported	Face Paint	
Test value-50								
-41.1899	-44.7577	-42.97381	0.000	6	-58.947	Iranian	Play Dough	Cd
-42.1206	-44.3494	-43.23500	0.000	9	-87.764	Imported		
Test value-15								
2.1062	-14.3695	-6.13167	0.067	1	-9.458	Iranian	Finger Paint	Cd
-7.6188	-9.4237	-8.52125	0.000	7	-22.329	Imported		
-4.7155	-12.2890	-8.50222	0.011	2	-9.660	Imported	Face Paint	



Confidence Interval 95%		Mean difference	Sig.	Degree of Freedom	T-test	Variable		
Upper Limit	Lower Limit							
Test value-25								
-6.6449	-11.4189	-9.03190	0.000	6	-9.259	Iranian	Play Dough	Cr
-8.2010	-10.9510	-9.57600	0.000	9	-15.754	Imported		
Test value-25								
-12.2933	-19.7900	-16.04167	0.012	1	-54.379	Iranian	Finger Paint	Cr
-14.6126	-16.9624	-15.78750	0.000	7	-31.773	Imported		
-13.5827	-18.8684	-16.22556	0.001	2	-26.416	Imported	Face Paint	
Test value-90								
-3.3511	-28.9346	-16.14286	0.021	6	-3.088	Iranian	Play Dough	Pb
-9.3908	-28.4025	-18.89667	0.001	9	-4.497	Imported		
Test value-25								
112.4617	-37.8950	37.28333	0.100	1	6.301	Iranian	Finger Paint	Pb
25.3086	17.1498	21.22917	0.000	7	12.305	Imported		
56.3708	11.0292	33.70000	0.024	2	6.396	Imported	Face Paint	

Ar: Arsenic, Cd: Cadmium, Cr: Chromium, Pb: Lead

**Table-5:** Results of comparing the average concentrations of arsenic, lead, cadmium and chromium in Iranian and imported samples (European Commission Standard)

Confidence Interval 95%		Mean difference	Sig.	Degree of Freedom	T-test	Variable		
Upper Limit	Lower Limit							
Test value-3.8								
-3.3493	-3.4382	-3.39373	0.000	6	-186.754	Iranian	Play Dough	Ar
-3.3421	-3.4190	-3.38055	0.000	9	-199.049	Imported		
Test value-0.9								
-0.3214	-0.7335	-0.52742	0.020	1	-32.523	Iranian	Finger Paint	Ar
-0.4841	-0.5504	-0.51721	0.000	7	-36.884	Imported		

Confidence Interval 95%		Mean difference	Sig.	Degree of Freedom	T-test	Variable		
Upper Limit	Lower Limit							
-0.4748	-0.5573	-0.51604	0.000	2	-53.800	Imported	Face Paint	
Test value-1.3								
7.5101	3.9423	5.72619	0.000	6	7.855	Iranian	Play Dough	Cd
6.5794	4.3506	5.46500	0.000	9	11.094	Imported		
Test value-0.3								
16.8062	0.3305	8.56833	0.048	1	13.216	Iranian	Finger Paint	Cd
7.0812	5.2763	6.17875	0.000	7	16.190	Imported		
9.9845	2.4110	6.19778	0.020	2	7.042	Imported	Face Paint	
Test value-37.5								
-19.1449	-23.9189	-21.53190	0.000	6	-22.072	Iranian	Play Dough	Cr
-20.7010	-23.4510	-22.07600	0.000	9	-36.319	Imported		
Test value-9.4								
3.3067	-4.1900	-0.44167	0.375	1	-1.497	Iranian	Finger Paint	Cr
.9874	-1.3624	-0.18750	0.717	7	-.377	Imported		
2.0173	-3.2684	-0.62556	0.416	2	-1.018	Imported	Face Paint	
Test value-2								
84.6489	59.0654	71.85714	0.000	6	13.745	Iranian	Play Dough	Pb
78.6092	59.5975	69.10333	0.000	9	16.445	Imported		
Test value-0.5								
136.9617	-13.3950	61.78333	0.061	1	10.442	Iranian	Finger Paint	Pb
49.8086	41.6498	45.72917	0.000	7	26.507	Imported		
80.8708	35.5292	58.20000	0.008	2	11.046	Imported	Face Paint	

Ar: Arsenic, Cd: Cadmium, Cr: Chromium, Pb: Lead

The cadmium concentration was 2-5.0 mg/kg in 4 samples of play dough and in the rest of the samples, it was too low. Finger and face paints had higher lead and cadmium concentrations than play dough (35). But in the present study, play dough had higher lead concentrations than finger and face paints; both groups had equal cadmium concentrations. The difference can be attributed to different brands and measurement methods. The element concentration pattern in the mentioned study was: cobalt <cadmium <lead <nickel <manganese <copper but in the present study was: arsenic <cadmium <chromium <lead.

The results of this study were not consistent with the findings of Ardakani et al.'s study. Chromium concentrations in the domestic and imported toy samples were, respectively, 5.41 and 6.2 Mg/kg; and lead concentrations were 2.12 and 7.58 Mg/kg. The element concentration patterns in the imported and domestic samples were arsenic <cadmium <chromium <lead and arsenic <cadmium <lead <chromium, respectively (40). In the study conducted by Pourmoghaddas et al. on 75 samples of plastic toys in Isfahan, Lead and cadmium had the highest and lowest concentrations (43).

Murphy et al. examined the heavy metal concentration of cheap jewelry and toys in Cambodia and found that arsenic, cadmium, and lead concentrations in 3.6, 8.4, and 2.4 percent of the samples exceeded guideline values set by the European Union. In general, the heavy metal concentration of 38% of the toys exceeded the EU guideline values (44). Pinto et al. investigated heavy metal concentration in drawing colors (n=54) and face paints (n=12) used in preschool institutions and sold in cheap stores in Porto, Portugal. Gouache and finger paint had the highest and the lowest lead and cadmium concentrations, respectively. Watercolor had the highest chromium

concentration which was significantly higher than the concentration in finger paint. The element concentration pattern in that study was Cadmium <Cobalt <Lead <Nickel <Chromium <Manganese <Copper <Zinc, which is not consistent with the results of the present study because of the difference between the brands of the samples (45).

Cadmium is ten times more toxic than lead (46). The EU standard for the maximum cadmium concentration of toys was 3.1 mg/kg (47). According to some studies, the use of lead-contaminated material to produce toys has been reduced because manufacturers now use cadmium as an alternative (43). Cadmium accumulates in the liver, kidney, and pancreas, affect bone metabolism, and may cause lung and respiratory tract cancer as well as kidney diseases, encephalopathy, and anemia (44). Children are more susceptible to toxic metals than adults (48).

The U.S. EPA's and ATSDR standards for the maximum allowable blood cadmium levels are 1.7 mg/L and 1.4 mg/L, respectively (47). Horton et al. showed that arsenic concentration in the blood and urine of children in India, Indonesia, Russia, South Korea, Taiwan, and Turkey was higher than the US standards; this may lead to skin lesions and low birth weight. Although some studies in Iran have also investigated the arsenic concentration of environmental sources and the human body (hair, nails, urine, etc.), no study has been performed on children's entertainment products (49).

In 30 samples of cheap plastic toys and 23 samples of play dough imported to Lebanon, heavy metal concentrations, except for cadmium and arsenic, were lower than EU permissible limits. The cadmium concentration of 83% of the samples was 9.1 µg/g, much higher than the EU permissible limit (1.9 µg/g) which was consistent with the present study. The element concentration patterns for plastic

toys and play dough were arsenic <cadmium <lead <chromium and arsenic <lead <chromium <cadmium, respectively.

In Nigeria, the lead, cadmium, chromium concentration of 51 toy samples made in different countries was 53.577 mg/kg, 76.1 mg/kg, and 99.17 mg/kg, respectively (50). The element concentrations differ from the present study because different toys were studied. About 2.92% of the toys were made of plastic. Lead and cadmium are used as a dye for play dough, face, and finger paints.

In general, the results of the present study indicate that heavy metal contents of the imported samples exceeded the permissible standards of Iran. It indicates that these products are smuggled into Iran or customs officials and importers are not aware of the clearance system, or adequate laboratory examinations have not been performed, though toy safety standards have become nationwide mandatory in Iran on 13/09/2014.

Some reputable laboratories and manufacturers in the country are not able to perform experiments on play dough, face and finger paints due to a lack of experience and familiarity with these experiments, and manufacturing companies have to send their samples to some special laboratories for evaluation.

WHO International Standard was introduced by the Iranian National Standardization Organization as the standard reference for the permissible limits of heavy metal contents of toys; and toy safety is determined with the health apple badge (Manufacturing License) by the Food and Drug Administration, Ministry of Health. The companies producing playdough and paint can receive an Apple Health Badge (manufacturing health license), if they adhere to the standards of the Food and Drug Administration.

#### 4-1. Limitations of the study

The present study had the following limitations:

- 1- The national standards on play dough, face, and finger paints were not up-to-date.
- 2- The national standards were in some cases different from the standards set by the Food and Drug Administration
- 3- The high diversity of play dough, face, and finger paints. According to international standards, these products contained 8-19 metals but only 4 metals were examined in the present study due to the high costs and huge volume of data.

#### 5- CONCLUSION

The use of toys and entertainment tools has become more common, and children spend their time with these tools in kindergartens and preschool centers due to changes in family size and enhanced women's education and employment. Therefore, children, today, face greater exposure to toxic compounds in comparison to previous generations. Accordingly, the application of international and national standards to ensure adherence to health and safety principles for the raw materials used in the toy manufacturing industry as well as the establishment of strict rules about the imports of toys are recommended.

Given the diversity of play dough, face, and finger paints, further studies may be needed. They should focus on removing lead and other heavy metal contents of these products and replacing them with suitable alternatives. Moreover, specialized laboratories must monitor the production of domestic products and prevent the illegal imports of dangerous products under the supervision of the Iranian National Standards Organization. In addition, necessary training should be provided to families.

## 6- ETHICAL CONSIDERATION

The necessary research permits were acquired (IR.YUMS.REC.1397.044). The brand names of the samples of play dough, face, and finger paints were not mentioned.

## 7- ACKNOWLEDGMENTS

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## 8- CONFLICT OF INTEREST

None.

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