Research Paper

Health Risk Assessment of Heavy Metals in Wheat Farms in the Northern Regions of Ahvaz

Sara Mansouri Moghadam[1], Khoshnaz Payandeh[2*], Azita Koshafar[1], Mohieddin Goosheh[2,3], Maryam Mohammadi Roozbahani[1]

1. *Department of Environment, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*
2. *Department of Soil Sciences, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*
3. *Soil & Water Research Department, Khuzestan Agricultural and Natural Resources Research and Education Center, AREEO, Ahvaz, Iran.*

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ABSTRACT

Background: Wheat as one of the agricultural products cultivated in many parts of the world is an essential component of our diet in the world. This study aimed to evaluate heavy metals in wheat farms in the north of Ahvaz.

Methods: This research was conducted in two areas of Weiss and Arab Assad located in the north of Ahvaz City. Twelve samples of wheat plants in each area were randomly selected from all the farms during harvesting. Chemical digestion was performed by a wet method, and heavy metals were measured by ICP model Varian 710-ES.

Results: The highest volume of heavy metals in Weiss and Arab Assad regions were 58.17 and 58.42 mg/Kg, respectively. Among the heavy metals, the lowest concentration was related to chromium which was equal to 1.07 and 1.14 mg/Kg in Weiss and Arab Assad farms, respectively. The highest hazard quotient (HQ) of heavy metals in children was related to manganese metal (13.51). The lowest value of heavy metal's HQ in the people was obtained in cobalt (0.21).

Conclusion: According to the results, because of the manganese metal, it seems that wheat consumption is dangerous for health in different age groups. In general, the results of health risk assessment of heavy metal in wheat showed that the consumption of this product can have an acute adverse impact on human health.

*** Corresponding Author:**
Khoshnaz Payandeh
Address: *Department of Soil Sciences, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*
Phone: *+98 (916) 1146786*
E-mail: *payandeh426@gmail.com*

1. Introduction

Wheat plant, also known as *Triticum dicoccum*, which is originated from Gramineae wheat genus includes *T. polonicim*, *T. turgidum*, *T. durum*, and *T. monococcum*. Wheat is an annual plant that its fibrous roots and stems are hollow cylinders in which each stem leads to a cluster of flower spikes. The leaves of the plant are long and slender that are planted in a dry and irrigated way in several countries [1, 2].

Although there is no specific definition of heavy metals, but they have been defined as a natural elements with high atomic weight whose density is five times higher than water [3, 4]. Among all pollutants, due to their toxic nature, the heavy metals have been considered by environmental chemists. Heavy metals usually exist in natural waters in trace amounts, though, many of them are toxic even at low concentration level [5, 6]. Arsenic, lead, cadmium, nickel, mercury, chromium, cobalt, zinc, and selenium are slightly toxic. The increase in number of heavy metals in the environment has caused many concerns. There are many effluents from various industries and agriculture that enter the metals into environment [7, 8]. Heavy metals are not metabolized by the body. Theyaccumulate in soft tissues, becoming toxic. They may enter the human body through food, water, air, or contact through agricultural, manufacturing, pharmaceutical, industrial, or residential areas. Industrial exposure is a common pathway for adult exposure. Swallowing is the most common route of exposure in children. Sources of heavy metals include natural and human activities that pollute the environment; humans discharge more than the environment can refine metals [9, 10].

Heavy metals are non-degradable and formed as major environmental pollutants that cause toxic, mutagenic and carcinogenic effects in animals [11]. Prolonged exposure to heavy metals such as cadmium, copper, lead, nickel and zinc can cause problems in humans. The biological half-lives of heavy metals are extended that can be stored in various organs of the body and therefore lead to side effects [12, 13]. Heavy metal contaminants can severely deplete some of the body's vital nutrients and lead to malnutrition-related disabilities and a higher incidence of cancer, especially upper gastrointestinal cancer [14]. Various heavy metals are essential for plants and play a vital role in producing enzymes for plant metabolism, catabolism and biosynthesis [15]. For example, zinc, iron, copper, chromium, and cobalt are vital nutrients, but become toxic elements in high significant volume. However lead and cadmium have no effect. They are biologically not desirable in plants and they are just poisonous and deadly [16]. The allowable lead thresholds for large and small fruits are 0.1 and 0.2 mg/Kg, respectively [17]. The plants in contaminated soils with zinc and copper store large amounts of metals in the roots. Copper is essential and toxic for biological systems [18, 19].

Feszterova et al. investigated the content of heavy metals such as cadmium, copper, lead and zinc in wheat seeds grown in Slovakia in winter [20]. The results showed that the acceptable amounts of cadmium in soil samples in supervised arable soils exceeded 2017-2017. The average values of copper and zinc content do not exceed the limited values even in the amounts of lead (except in the spring period). Lead levels are higher than the acceptable values. This study showed that wheat seeds grown in winter and supervised arable lands, are not dangerous for consumers [20]. Xu et al. investigated the effects of the heavy metals lead, zinc and copper on the transfer of cadmium from soil to wheat grains [21]. Cadmium metal analysis showed that there was a positive correlation (r=0.459-0.946) between lead, zinc and copper (especially lead) [21].

Some heavy metals such as iron, cobalt, and zinc are essential nutrients for humans in small amounts, though, but they are toxic in higher amounts. However, minor metals such as lead, cadmium and mercury are toxic even in small amounts. The toxicity of heavy metals depends on the concentration, the period of exposure and the route of exposure. Exposure humans to heavy metals occurs through inhalation from the atmosphere, ingestion through drinking water, and ingestion through the skin through skin contact [22].

In recent years, many researches have been done on agricultural products of Khuzestan province such as wheat. However, the health risk of this product has not been studied. So, this study was conducted to assess the health risk of heavy metals namely zinc, iron, manganese, cadmium, lead, nickel, chromium, copper and cobalt as well as compare them with international standards.

2. Material and Methods

Location of the study area

This research was conducted in two areas of Weiss and Arab Assad located in the north of Ahvaz City. Arab Assad region includes agricultural lands downstream of Shushtar City which ends at Qir dam. These lands are located between Sheteyt and Gargar rivers (Figure 1). Weiss area starts from the bitumen dam and covers the north of Ahvaz City (Figure 2).

Sampling

For this purpose, in dual areas, twelve samples of wheat plants were randomly selected from each area's farm during harvesting in 2020 (Figure 3).

Laboratory analysis of heavy metals

For chemical digestion, the wheat samples were placed in an oven of 100 °C for 24 hours after transferring to the laboratory and then placed in a kiln of 550°C for 24 hours for ash. Extraction was performed using nitric acid and hydrochloric acid in a ratio of 3: 1. They were fermented on a hot plate and passed through a what man with 42 filters and a volume of 1% nitric acid to volume of 25 mL [23]. Digested samples were injected into ICP model Varian 710-ES and ppb detection limit to determine the number of elements in each sample [24].

Health risk assessment indicators

Heavy metal health risk assessment was performed based on the health risk assessment method introduced by the US environmental protection agency (USEPA) in two sections (i.e. carcinogenic and non-carcinogenic hazards). The daily absorption of heavy metals in each route was calculated using Equation 1. In this equation, the Add_{ing} is the average daily absorption of metals (mg/Kg-day) through swallowing. Also, C, Ing_R, EF, ED, BW and AT are concentration of metals in wheat (mg/Kg), swallowing rate (mg/day and m^3/day), frequency of metal exposure (day/year), duration of metal exposure (year), bodyweight of person exposed to metals (Kg) and duration of exposure to any number of metals on average (day), respectively. Details of each parameter in Equation 1 and its values used in the risk assessment relationships are given in Table 1 [25]:

$$1.\quad Add_{ing} = \frac{C \times IngR \times CF \times EF \times ED}{RW \times AT}$$

The Hazard Index (HI) of the entire swallowing, breathing and dermal absorption pathways for children and adults was determined using the total daily absorption of heavy metals (ADD) in each pathway compared to the reference value of that metal toxicity in Equation 2. In this equation, the HQ of non-carcinogenic risk of metals in each pathway is sum of daily metal uptake values in each pathway of metal exposure (mg/Kg-

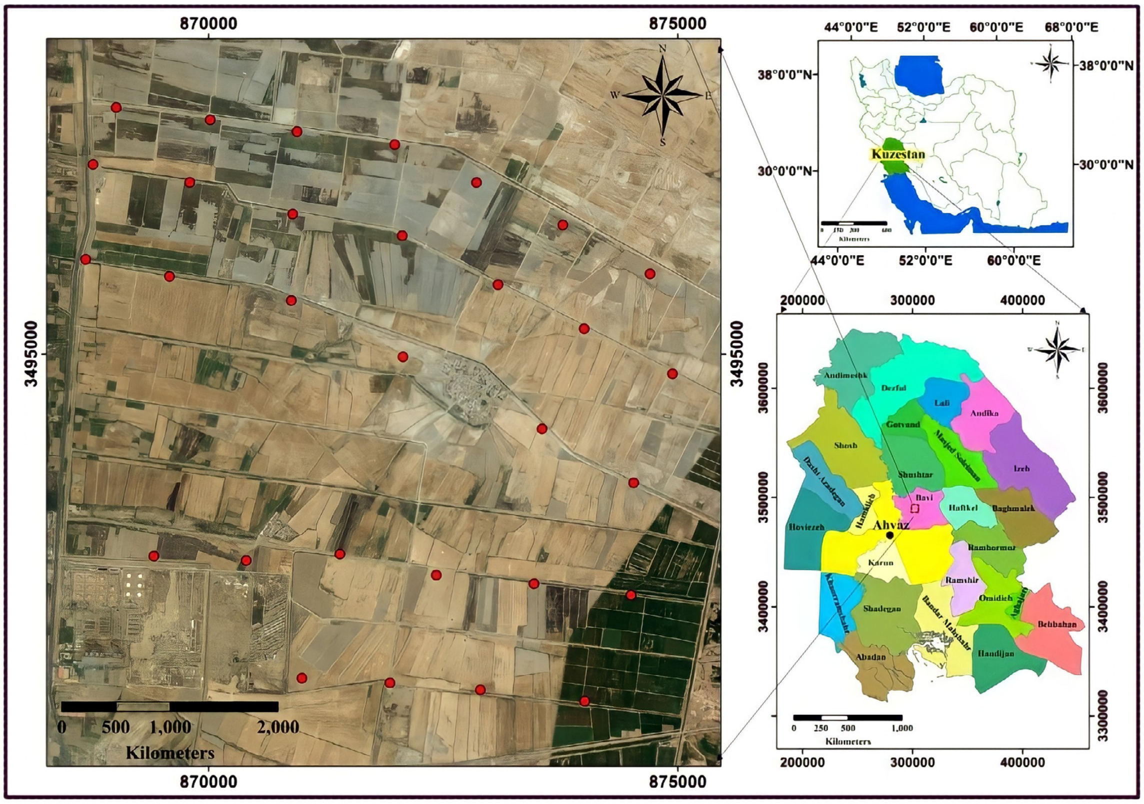

Figure 1. Geographical location of the sampling site of the Arab Assad

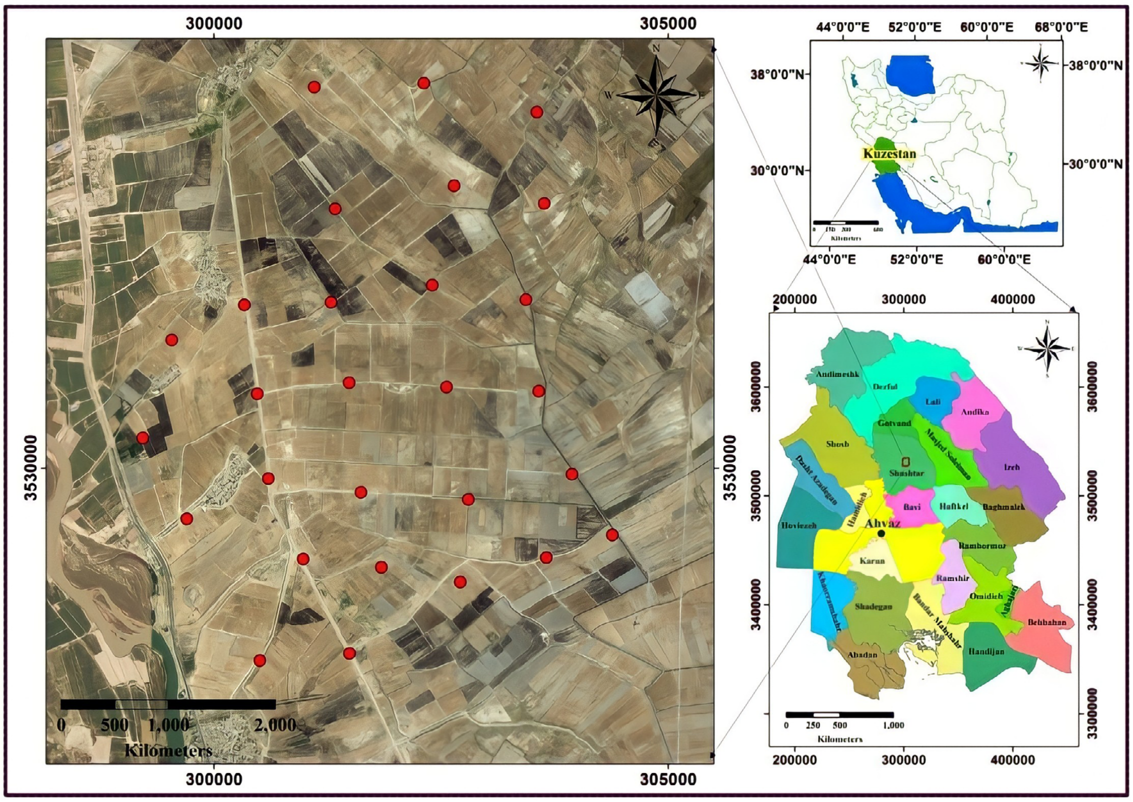

Figure 2. Geographical location of the sampling site of the Weiss

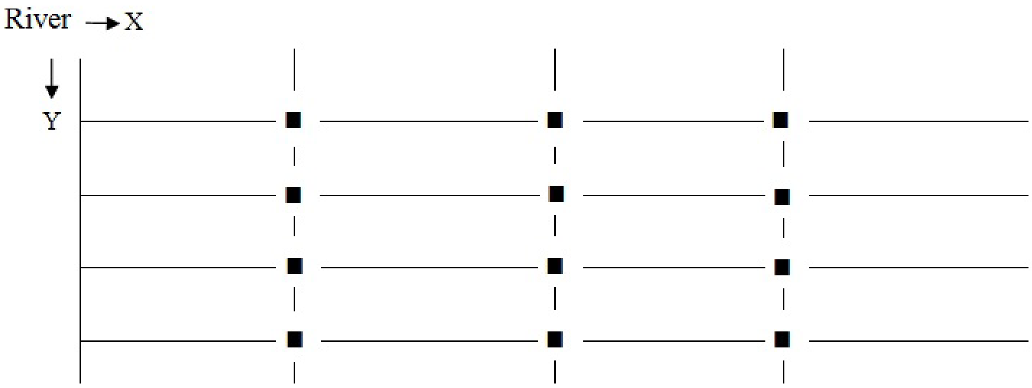

Figure 3. Soil sampling network in the two study areas; X and Y represent the sampling areas.

day). The HQ of less than 1 is not incompatible with human health, and the HQ of higher than 1 has adverse effects on human health (Equation 2) [25].

2. $HQ_i = \sum \frac{ADD_i}{R_f D_i}$

The cumulative hazard index (HI) value of the total metals for both adults and children were obtained using Equation 3 [25]:

3. $HI = \sum HQ_i$

Carcinogenicity assessment of each of the three pathways for these metals was performed using Equation 4 [25]:

4. $RI = \sum ADDi \times SFi$

In relation 4, RI of carcinogenic risk, is summation of Addi values of daily metal uptake in each of the metal exposure pathways (mg/Kg/day) and cancer risk factor per unit of metal exposure (mg/Kg/day).

Table 1. Values of heavy metals in health risk assessment relationships [25]

Parameters	Children	Adult
Ing_R (mg/day)	200	100
EF (day/year)	350	350
ED (year)	6	24
BW (Kg)	15	55.9
AT (days)	365×ED	365×ED
SF (mg/Kg/day)	Lead (4.2×10^{-2}), Cadmium (6.3×10^{-1}), Chromium (4.2×10^{-1}), Arsenic (1.51×10^{-1}), Nickel (8.4×10^{-1})	
R_fD_{ing} (mg/Kg-day)	Lead (3×10^{-3}), Zinc (3×10^{-1}), Copper (4×10^{-2}), Cadmium (1×10^{-3}), Chromium (3×10^{-3}), Arsenic (3×10^{-4}), Nickel (2×10^{-3}), Mercury (3×10^{-4})*	

* The values are the same for both children and adults

Data analysis

SPSS software, version 25 and Sigma Plot statistical software were used to analyze heavy metal data. Using one-way analysis of variance (ANOVA one-way), the mean values were compared to see the significant differences (P=0.05) and 95% confidence limits. The normality of the data were checked using Kolmogorov-Smirnov test. Excel software was also used to draw tables and calculate contamination indices.

3. Results and Discussion

The statistical parameters of heavy metals, including minimum, maximum, Mean±SD, standard error and variance of wheat data in Weiss and Arab Assad have been presented in Tables 2 and 3. As seen, the heavy metal accumulation in Weiss region was the highest in iron, and the minimum value was found in chromium. In wheat samples of agricultural fields in the Weiss region, the minimum and average of iron was higher than other heavy metals. On the other hand, the minimum and average of chromium were the lowest values among the heavy metals. The highest and lowest maximum heavy metals were related to manganese and cadmium metals. In Arab Assad region, the highest and lowest concentration were related to iron and cadmium, respectively. In wheat samples of agricultural fields in the Arab Assad region, the minimum, maximum and average of iron was higher than other heavy metals. The minimum, maximum and mean of chromium and cadmium had the lowest values among the studied heavy metals.

Table 2. Statistical parameters of heavy metals in wheat of Weiss farms

Heavy Metals	Min	Max	Mean±SD (mg/Kg)
Cadmium	0.98	1.27	1.14±0.07
Lead	5.02	6.82	5.61±0.39
Nickel	5.69	7.85	6.18±0.42
Chromium	0.85	1.54	1.07±0.15
Copper	2.39	5.02	3.58±0.68
Zinc	12.30	19.10	15.44±1.75
Cobalt	1.29	138	6.30±2.87
Iron	42.60	75.50	58.17±8.12
Manganese	13.60	227.90	27.88±3.98

Table 3. Statistical parameters of heavy metals in wheat of agricultural fields in Assad region

Heavy Metals	Min	Max	Mean±SD (mg/Kg)
Cadmium	0.95	1.35	1.15±0.10
Lead	4.13	5.90	5.04±0.40
Nickel	5.02	5.85	5.42±0.21
Chromium	0.95	1.39	1.14±0.10
Copper	2.55	4.12	3.27±0.36
Zinc	10.07	16	13.86±1.52
Cobalt	0.92	2.11	1.35±0.24
Iron	42.32	73.10	58.42±7.41
Manganese	16.80	25.10	20.68±1.97

According to the results of heavy metals, it can be inferred that the uptake and accumulation of heavy metals in wheat are directly resulted from the accumulated amounts of heavy metals of the soil. The alkaline nature of soil, organic matter and fine-grained texture of agricultural soil are probably the reasons for transfer of heavy metals from soil to the wheat grain [26]. In a study, the highest accumulations of copper, iron, zinc, cadmium and manganese in the wheat were 33.1, 1554.3, 94.85, 0.557 and 494 mg/Kg in wheat root, respectively [27]. Also, the concentration of heavy metals in wheat grains were as following: zinc:13.98-15.9, cobalt: 1.6-1.19, iron: 16.51-23.05, copper: 2.13-6.87, and chromium: 0.476-0.887 mg/Kg [19] respectively. The result is consistent with the results of the present study. Rastmanesh et al. (2015) also reported the accumulation of nickel and chromium in wheat samples of agricultural farms in Ahvaz [26]. Another study reported that the accumulation of cobalt metals in all wheat samples were lower than the detection limit in the wheat produced in Bushehr [28]. The amount of cobalt and copper in the samples of wheat and rice was less than the permissible level and, therefore, they had no problem for human health. In another study conducted in Pakistan, the accumulation of manganese and chromium were the highest and lowest, respectively [16]. This results were different from our results. The reasons for the difference in the accumulation of heavy metals in wheat samples from different regions of Iran and the world can be due to differences in soil conditions, amount and frequency of fertilization, type of chemical fertilizer and irrigation water source and anthropogenic and natural sources of heavy metals entering into agricultural farms [29, 30].

The statistical analysis showed that the amounts of cobalt, manganese and zinc in the wheat samples were significantly different ($P<0.05$ between Weiss and Arab Assad regions.) Concentrations of cadmium, lead and chromium were not statistically different ($P>0.05$). The amount of nickel, lead and copper in the wheat of agricultural fields in Weiss was higher than the Arab Assad region ($P>0.05$). However, the amount of cadmium, chromium and iron in Arab Assad region was higher than Weiss region ($P>0.05$). Also, the amount of cobalt, manganese and zinc in the wheat samples of agricultural fields in Weiss region was higher than Arab Assad ($P<0.05$). The highest amounts of heavy metals in the wheat of Weiss and Arab Assad regions were 58.17 and 58.42 mg/Kg , respectively. Chromium had the lowest concentrations among heavy metals in wheat of Weiss and Arab Assad farms which were equal to 1.07 and 1.14 mg/Kg, respectively (Table 4). The range of cobalt concentration was 0.92-1.80 mg/Kg. In previous studies, the average concentration of cobalt was 32.3 mg/Kg [31]. The cobalt , especially in contaminated soil, can seriously affect plant growth and metabolic performance. Excising of cobalt up to 50 mg/Kg in the soil is toxic to plants [32]. In the environment, the distribution of cobalt has many adverse effects on plants and humans [33]. Chemical industries, mineral fertilizers, untreated industrial effluents and wastes and mineral effluents are the primary sources of cobalt in soil and water [34].

The results of Pearson method showed that heavy metals in Weiss farms were not significantly correlated ($P>0.05$). However, positive and significant correlation was observed between iron and cadmium ($R=0.414$; $P<0.05$), iron and zinc ($R=0.426$; $P<0.05$), zinc and lead

Table 4. Comparison of heavy metals (mg/Kg) of agricultural fields in the Weiss and Arab Assad regions

Heavy Metals	Mean±SD	
	Weiss	Arab Assad
Cadmium	1.14±0.07[a]	1.15±0.10[a]
Lead	5.61±0.39[a]	5.04±0.40[a]
Nickel	6.18±0.42[a]	5.42±0.21[a]
Chromium	1.07±0.15[a]	1.14±0.07[a]
Copper	3.58±0.68a	3.27±0.36[a]
Zinc	15.44±1.75[a]	12.86±1.15[b]
Cobalt	6.30±0.68[a]	1.35±.72[b]
Iron	58.17±8.12[a]	58.42±7/41[a]
Manganese	27.88±3.98[a]	20.68±1.97[a]

a and b show a significant difference (P<0.05).

Table 5. Pearson correlation of heavy metal concentrations in wheat of Weiss farms

Heavy Metals								
Cadmium	Lead	Nickel	Chromium	Copper	Zinc	Cobalt	Manganese	Iron
1	0.270	0.351	-0.169	0.070	0.455	0.028	0.196	0.414
0.270	1	0.417	0.027	-0.015	0.457	-0.283	0.053	-0.030
0.351	0.417	1	0.470	-0.091	0.208	0.014	-0.065	0.091
-0.169	0.027	0.470	1	-0.309	-0.179	-0.049	-0.030	0.007
0.070	-0.015	-0.091	-0.309	1	0.448	-0.249	-0.217	0.199
0.455	0.457	0.208	-0.179	0.448	1	-0.169	0.053	0.426
0.028	-0.283	0.014	-0.049	-0.249	-0.169	1	-0.015	-0.050
0.414	-0.030	0.091	0.007	0.199	0.426	-0.050	-0.136	1
0.196	0.053	-0.065	-0.030	-0.217	0.053	-0.015	1	-0.136

* Pearson correlation was assessed at 95 confidence level (a=0.05).

(R=0.457; P<0.05), zinc and copper (R=0.448; P<0.05), nickel and lead (R=0.417; P<0.05) and zinc and cadmium (R=0.455; P<0.05) (Table 5). Also, the Pearson method showed that the amounts of heavy metals in wheat farms in the Arab Assad region were not significantly correlated (P>0.05). Meanwhile, significant correlation was observed between lead and cadmium (R=0.635; P<0.05), iron and lead (R=0.443; P<0.05), copper and zinc (R=0.408; P<0.05) and manganese and lead (R=0.318; P<0.05) (Table 6). According to the results, there was no positive and significant correlation between the amounts of heavy metals in the wheat cultivated in the Weiss and Arab Assad regions (P>0.05). The negative correlation between heavy metals indicates that metals have multiple and independent sources, but the correlation between lead and chromium indicates that they are somewhat common and originate from human activity sources. There was a robust positive correlation between the amount of each element of lead and cadmium in wheat samples and irrigation water, which con-

Table 6. Pearson correlation of heavy metal concentrations in wheat of agricultural fields in Arab Assad region

Heavy Metals								
Cadmium	Lead	Nickel	Chromium	Copper	Zinc	Cobalt	Iron	Manganese
1	0.635	0.340	-0.049	-0.316	0.027	-0.089	0.218	0.264
0.635	1	0.264	-0.088	-0.367	0.003	-0.189	0.443	0.318
0.340	0.264	1	0.162	0.298	0.298	-0.393	-0.076	-0.046
-0.049	-0.088	0.162	1	0.075	0.022	0.067	-0.066	-0.206
-0.316	-0.367	0.298	0.075	1	0.408	0.085	-0.395	-0.353
0.027	0.003	0.298	0.022	0.408	1	0.019	-0.269	-0. 409
-0.089	-0.189	-0.393	0.067	0.085	0.019	1	-0.075	0.143
0.218	0.443	-0.076	-0.066	-0.395	-0.269	-0.075	1	0.218
0.264	0.318	-0.046	-0.206	-0.353	-0.409	0.143	0.218	1

*Pearson correlation was evaluated at 95 confidence level (a=0.05).

Table 7. Health risk assessment of heavy metals of wheat in agricultural fields of Weiss and Arab Assad regions in children

Heavy Metals	Arab Assad				Weiss			
	Daily Absorption Rate (mg/Kg/day)	HQ	Consumption Limit (mg/Kg/day)	Carcinogenicity Index	Daily Absorption Rate (mg/Kg/day)	HQ	Consumption Limit (mg/Kg/day)	Carcinogenicity Index
Cadmium	0.007	7.80	0.028	0.117	0.007	7.73	0.028	0.116
Lead	0.034	8.55	0.025	0.029	0.038	9.52	0.023	0.032
Nickel	0.036	1.83	0.120	0.033	0.041	2.09	0.105	0.038
Chromium	0.007	2.57	0.086	0.003	0.007	2.42	0.091	0.003
Copper	0.022	0.55	0.40	-	0.024	0.60	0.365	-
Zinc	0.087	0.29	0.762	-	0.104	0.34	0.635	-
Cobalt	0.009	0.21	1.041	-	0.042	0.99	0.223	-
Iron	0.396	0.56	0.391	-	0.394	0.56	0.393	-
Manganese	0.140	10.02	0.022	-	0.189	13.51	0.016	-

firms the results of this study. Numerous chemical reactions can occur that may increase or decrease the toxicity of the pollutant. The effective reactions on heavy metals are adsorption, precipitation, dissolution. These reactions have often been ignored by scientists and engineers involved in environmental regeneration.

The highest hazard quotient (HQ) of heavy metals in the wheat for children was related to manganese (13.51). The lowest value of HQ for wheat consumption in children was related to cobalt (0.21) (Table 7). In adults, the highest and lowest carcinogenicity index of heavy metals was related to manganese (11.05) and cobalt (0.17), respectively (Table 8). The highest risk of carcinogenicity index of cadmium in children and adults were 0.117 and 0.095, respectively. Heavy metal health risk assessment analysis in wheat samples of agricultural fields in the Weiss and Arab Assad regions showed that the HQ of cadmium, lead, nickel, chromium and manganese for children and adults was higher than 1, though, the HQ of zinc, iron and cobalt was lower than 1. Carcinogenic index of the cadmium, lead, nickel and chromium in Arab Assad and Weiss regions showed that their values were higher than 10^{-4}. According to the results, the consumption of wheat with high level of manganese is dangerous for the health of different age groups. Manganese is essential for growth, skeletal formation, and reproductive function in humans and animals, and its deficiency can lead to diabetes, bone disorders, growth retardation in infants and children, and nervous system instability. Meanwhile, it can lead to arthritis in adults [35]. Manganese is also considered essential for metabolic processes in plants [36]. In Pakistan, the concentration of manganese in wheat grain and wheat flour was 4.9 and 38.1 mg/Kg, respectively. In India, its range was 11.40-19.57 mg/Kg [37-39], which is consistent with the results of the

Table 8. Health risk assessment of heavy metals of wheat in farms of Weiss and Arab Assad regions in adults

Heavy Metals	Arab Assad				Weiss			
	Daily Absorption Rate (mg/Kg/day)	HQ	Consumption Limit (mg/Kg/day)	Carcinogenicity Index	Daily Absorption Rate (mg/Kg/day)	HQ	Consumption Limit (mg/Kg/day)	Carcinogenicity Index
Cadmium	0.006	6.38	0.052	0.095	0.006	6.32	0.052	0.094
Lead	0.027	6.99	0.047	0.023	0.031	7.78	0.042	0.026
Nickel	0.030	1.50	0.221	0.027	0.034	1.71	0.194	0.031
Chromium	0.006	2.10	0.157	0.003	0.005	1.97	0.168	0.002
Copper	0.018	0.45	0.733	-	0.019	0.49	0.670	-
Zinc	0.071	0.23	1.399	-	0.085	0.28	1.165	-
Cobalt	0.007	0.17	1.911	-	0.034	0.81	0.409	-
Iron	0.324	0.46	0.718	-	0.322	0.44	0.722	-
Manganese	0.114	8.19	0.040	-	0.154	11.05	0.030	-

present study. In a research on rice samples in India, the manganese's hazard index was higher than 1 [36] which confirms the results of this study.

Lorestani and Hazavei investigated heavy metals contamination in the rain-fed and irrigated wheat crop in some agricultural farms in Hamadan. The results of the study showed that due to high value of the risk index of cadmium and lead (more than 1), the two elements were considered as risk factors for human health in the study area [40]. Heavy risk index values in most of the edible crops in Hamadan province were significantly more than 1 in all age groups. It indicates that children and adults in the study area may have a potential noncancerous risk due to intake the heavy metals through consumption of wheat, potatoes and corn. Consumption of edible plants, especially wheat, is the most critical human exposure to heavy elements. Also, the potential non-cancer risk of chromium, manganese, iron, cadmium, zinc, nickel and copper is less than 1 [41]. Bayissa et al. also reported that the risk index of cadmium and lead metals in different wheat cultivars was 1.82 for children and 1.60 for adults. It indicates that children absorb more heavy metals than adults. They are more vulnerable to the side effects of these metals [42]. The mentioned results of these researchers are consistent with the results of the present study. In general, the results of this study showed that although the consumption of this product does not have an acute harmful effect on the consumers health, but given the high amount of these elements in the wheat crop of this region and consumption of contaminated foods, they can lead to an increased risk of public health. Therefore, environmental factors must be properly addressed [43]. Risk assessment of the heavy metals such as chromium, nickel, copper, zinc, cadmium and lead in wheat in China showed that there was a non-carcinogenic index in adults and children in the wheat consumed in the study area. No carcinogenic risk has been identified in the study area [44], which confirms the results of this research.

In this study, the concentrations of heavy metals including cadmium, lead and chromium in the wheat of the Weiss and Arab Assad regions were higher than standard of WHO, FAO and Iran (i.e. the values of cadmium, lead and chromium were 0.05, 0.1 and 0.1 mg/Kg, respectively). Also, amount of nickel, copper and zinc in the wheat of the regions were higher than WHO/FAO standard (i.e. the values were 66.70, 40 and 60 mg/Kg, respectively) [45-47]. Manganese levels in the wheat were also higher than the WHO/FAO standard (2.3 mg/Kg) [48]. In addition, the concentration of iron in the wheat cultivated in this study was higher than the CAC standard (15 mg/Kg) [49] (Table 9).

4. Conclusion

The wheat is one of the most important cereals and strategic crops globally, which is of great importance due to its use in a diet with a wide variety of bread. Heavy metal health risk assessment analysis in the wheat samples of agricultural fields in the Weiss and Arab Assad regions showed that the HQ of cadmium, lead, nickel, chromium and manganese for children and adults were higher than 1. The HQ of zinc, iron and cobalt was lower than 1. Carcinogenic index of the toxic metals such as cadmium, lead, nickel and chromium in the wheat samples selected from farms in the Arab Assad and Weiss regions was higher than 10^{-4}. According to the results, consumption of the manganese in wheat is dangerous for human health at different age groups. In general, the results of the health risk assessment of heavy metals in the wheat samples showed that

Table 9. Comparison of heavy metal concentrations in the wheat samples with international standards [45-49]

Heavy Metals	WHO/FAO	CAC Standard	Iranian National Standard	Chin [44]	Iran [50]	Pakistan [19]	This Study (wheat)
Cadmium	0.05	-	0.05	0.012	0.018	0.810	1.14-1.15
Lead	0.1	-	0.1	0.03	0.713	0.451	5.04-5.61
Nickel	66.70	-	66.70	0.07	0.663	-	5.42-6.18
Chromium	0.1	-	0.1	0.09	0.85	0.476	1.07-1.14
Copper	40	-	40	4.41	5.012	2.134	3.27-3.58
Zinc	60	-	60	24.19	25.75	9.15	12.86-15.44
Iron	-	15	-	-	-	16.73	1.35-6.30
Manganese	2.3	-	-	-	45.25	-	58.17-58.42

the consumption of this product can have an acute adverse effect on consumer's health.

Ethical Considerations

Compliance with ethical guidelines

In this article, all ethical considerations have been addressed.

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Authors' contributions

All authors equally participated in the research process.

Conflict of interest

The authors declare no conflict of interest.

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