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Health risk assessment for consuming rice, bread, and vegetables in Hoveyzeh city

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ABSTRACT

Introduction: People are continuously exposed to contamination, which mainly consists of heavy metals (HMs) and organic compounds. Several metals can get into grains, veggies, and bread through various methods. We estimated the health risk of HM exposure from the consumption of bread, veggies, and rice, considering the per capita amounts of these foods in the Iranian food basket, especially in Hoveyzeh and Azadegan Plain.

Material and method: The food products analyzed for the assessment of HMs include different veggies, rice, and bread. The health risk assessment was done with the Hazard Quotient and cancer risk formulae. The buying of vegetables, rice, and bread was done in random order during the fall and wintertime seasons.

Result: Tarom rice has the maximum reported levels of Cd (0.55 mg/kg), but Pakistani rice has the lowest level (0.18 mg/kg). Radish shows the highest concentrations of As, Pb, Cr, and Ni among vegetation, while Cress shows the lowest level. The study findings showed that Lavash bread had the highest levels of As (1.31 mg/kg), Cd (0.2 mg/kg), and Ni (1.2 mg/kg), whereas it indicated the lowest level of Cr (0.056 mg/kg). While the non-carcinogenic risk of HMs was evaluated between two groups of adults and children, both groups' HI and HQ levels were less than 1. The maximum HQ and HI scores for children were associated with Arsenic (As), specifically 0.0127 and 0.0137 for Tarom rice, respectively. Nevertheless, the highest HQ and HI scores for adults were associated with As, namely 0.0059 and 0.0064 for Tarom rice, respectively.

Conclusion: The evaluation of the carcinogenic risk caused by HM exposure in kids and adults showed that both groups' accumulated lifetime CRs and ILCRs were lower than 1*10–6. Hence, the consumption of veggies, rice, and bread within the study's area does not show an association with the occurrence of chronic diseases resulting from hazardous HMs.

1. Introduction

Contamination is something people are continually exposed to. The contaminants include mainly HMs and organic compounds, which come from human as well as natural activities [1]. Metals having several atoms higher than 50 and a specific gravity of higher than 6 g per cubic centimeter are known as HMs. Strength, toxicity, weight, density, and a high atomic number are a few of these metals' primary characteristics [2,3]. Lead (Pb), Nickel (Ni), Cadmium (Cd), and Arsenic(As) are extremely toxic HMs that pose serious threats to the body, even at low levels. Due to their toxic effects as well as their capacity for accumulation in tissues, they can enter the body with food, drink, air, and other sources and do irreversible damage [4,5]. Grains may have been contaminated with HMs, which are subsequently transferred to bread in different ways. HMs may contaminate flour-producing industries, too. Water-containing HMs in the process of making bread dough can be considered a type of contamination [6,7]. The kind of fuel utilized by bakeries influences how HMs accumulate in bread. The nearness of bakers to both urban centers and industrial regions is a critical factor that causes contamination [8]. As bread is one of the primary staples and food and water that are contaminated are major sources of HMs transfer, monitoring the HMs in bread enables one to

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find out whether these factors exist and whether they surpass the limit [9].

Rice is a popular staple throughout the world, especially in Asian nations. The mean average consumption of rice in Iran, Asia, and worldwide is about 41, 85, and 65 kg per year, respectively [10]. Because of the increasing population of Iran, there has been an increasing need for rice every day. Growing rice in a polluted setting may cause adverse effects on human health. Crops cultivated in such sites may absorb potential contaminants from the soils used for agriculture [11,12]. Rice has been known to absorb HMs and other toxic compounds from polluted soil and even from the air with its roots [13]. Several factors lead to the absorption of HMs in crops, especially rice. Additionally, human behavior, like industrial and crop cultivation, such as the excessive usage of pesticides, insect-control agents, and also insufficient pollution control regulations can result in the contamination of food with HMs [14].

Vegetables have an essential role in maintaining a healthy diet. Food, especially vegetables, is the main route of HM absorption into the body [15]. Considering the increasing use of wastewater irrigation, it has the potential to risk public health if guidelines are not met, especially regarding products that are consumed raw [16,17]. Since veggies are an important source of carbohydrates, proteins, and vitamins, it is essential to keep in mind that their high absorb rate of HMs might possibly threaten human health and cause problems for humanity. With the use of pesticides and chemical fertilizers, growers add to the increase of these metals in both the soil and crops [18].

We decided to look into the risk of HMs having been detected in the food of the residents of Hoveyzeh and Susangerd due to the amount of bread, veggies, and rice that every Iranian has on a per-person basis and the chance that these foods may be contamination in the urban areas of Hoveyzeh and Susangerd (probably due to of the consumption of low-quality salt, the variety of water supplies utilized, the kind of fuel utilized by each bakery for making bread, the utilize of chemical fertilizers containing phosphates during grain farming, and the position of bakeries in the city close to industrial centers and heavy traffic, among other environmental factors).

2. Material and method

2.1. Study area

Susangerd city is the center of the Azadegan Plain, one of the cities in the region of Khuzestan. 48.17 degrees east and 31.55 degrees north are its geographic coordinates. The town is located at a height of 15 m above the level of the sea. The Azadegan Plain is in the northwestern region of Ahvaz, about 55 kilometers from the city. Hoveyzeh is in the southwest region of Susangerd, while Bostan is located in the northeast region of Susangerd. Furthermore, the Karkhe River traverses this area. The residents of this city mainly communicate in Arabic and participate mainly in farming. There are 51,431 residents who live in this city. Bostan, Abu Hamizah, and Kot Sayednaim were a few of the other cities in the Azadegan plain [19].

Having a population of 30,750, Hoveyzeh city is one of the towns in the province of Khuzestan. Hoveyzeh and Rafi were the two towns that made up this city. Hoveyzeh city has a region called Nissan, as well as two villages named Bani Saleh and Nissan. Most of the individuals in this city are of Arab descent and communicate mainly using the Arabic language. Geographically, this region is situated at 31.46 degrees north and 48.07 degrees east. The total area of the land is 370,000 ha [20].

2.2. Sampling and preparation of samples

Veggie samples were obtained from street vendors in Hoveyzeh and Azadegan plains for evaluation. The vegetables consumed in both cities came completely from farms in Hamidieh city. During the wintertime and autumn, a random veggie sample was collected. The vegetable samples included basil, radish, Cress, and Chive. Subsequently, a sample of each weight of approximately one kilogram was collected. During the step of washing the samples with purified water, we continued to dry them using an oven that was set at a temperature of 105 degrees Celsius for a duration of 24 hours. Afterward, we determined their weight. During the final stage, we take every sample to acid digestion, inject them into the ICP-OES device, and then carry out an analysis of the concentration.

The rice samples studied in this research were collected from the shops of Dasht Azadegan and Hoveyzeh cities. To determine the risk assessment of rice eating for HMs, five different types of rice were selected. Samples were selected in a random way. The rice types studied were Anbar, Tarom, Pakistani, Indian, and black tail rice. To determine the concentration of the HMs in the sample, the first step is to wash one kilogram of it with purified water and then apply it to the process of drying in an oven at a temperature of 105°C for a period of 48 hours. A little piece of dry rice, approximately 0.5 g, is crushed up and subsequently acid-dissolved. The sample, after digestion, is eventually injected into the ICP-OES devices, and the concentration is reported.

The bread was selected at random from city bakeries. The bread types studied included Barbari, Lavash, and Sangak. To quantifying the level of HMs, we first collect a sample of a kilogram of bread at each bakery. Afterward, we then desiccated them in the oven at a temperature of 105 degrees Celsius and subsequently divided them into separate components. We digestion 25 g of all kinds of bread with nitric acid, then inject the digested samples into the ICP device to find out each of their concentrations.

The HMs that were evaluated in this study included Pb, Ni, Cr, Cd, and As.

2.3. Average daily dose

The ADDs (average daily doses) of HMs from eating bread, veggies, and rice are obtained with Eq. 1 and are expressed in milligrams per kilogram daily [21]. Table 1 also shows the parameters for calculating ADDs.

$$\mathrm{ADD} = \frac{C * IR * EF * ED}{At * BW}\left(\frac{mg}{Kg}.day\right) \quad (1)$$

2.4. Non-carcinogenic risks

Actually, the expression of the non-toxic effect (Eq. 2) uses HQ, which refers to the ratio of being exposed to HMs to their reference dose (RfD). The RfD depends on the specific contaminant. As an example, the quantity of As, Cd, Ni, and Pb consumed by digesting are 0.0003, 0.001, 0.046, and 0.02, respectively. The hazard index (HI) comes from the total of HQ (Eq. 3). There is no non-carcinogenic risk if this quantity is less than 1, but when it is higher than 1, there will be a non-carcinogenic risk [22].

$$\mathrm{HQ} = \frac{ADD}{RfD} \quad (2)$$

$$\mathrm{HI} = \sum\nolimits_{1}^{i} HQ_s \quad (3)$$

Table 1
ADDs calculation parameters.

Concentration	C	mg	Adults	Children
Ingestion Rate	IR	(mg/day)	82	25
Exposure Frequency	EF	(day)	365	365
duration of human exposure	ED	(year)	60	6
Averaging time of human exposure	*At*	(day)	10,950	2190
Body Weight	*BW*	(kg)	70	15

2.5. Carcinogenic risks

The carcinogenic risk (CR) of any carcinogen has been determined by dividing the ADD by the slope factor (SF) based on Eq. 4. The SF values for As, Cd, Ni, and Pb have been 1.5, 0.38, 1.7, and 0.0085, respectively. The sum of all carcinogenic risks is used for determining the incremental lifetime cancer risk (ILCR) [23]. (Eq. 5)

$$CR = ADD * SF \quad (4)$$

CR: Carcinogenic or cancer risksSF: slope factor

$$ILCR = \sum_{1}^{i} CR \quad (5)$$

ILCR<$1*10^{-6}$: There is an extremely low potential of getting cancer. ILCR>$1*10^{-4}$: There is the potential of getting cancer.$1*10^{-6}$< ILCR<$1*10^{-4}$: Acceptable level of risk.

3. Result

3.1. Heavy metal concentration

Five HMs (Ni, Pb, Cr, Cd, and As) have been identified in food samples, including bread, veggies, and rice. The common kinds of rice eaten in Hoveyzeh and Azadegan plains are Anbar, Domsiah, Tarom, Indian, and Pakistani. Additionally, many of the individuals under investigation eat Anbar rice. Table 2 shows the metal level present in foods. Based on this data, the concentrations of As in five various kinds of rice that are consumed are higher than the accepted limit set by the National Standard Council of Iran, which is 0.15 mg/kg [24]. Skin, pulmonary, urinary system, and bladder cancer risk have been increased by even minute levels (0.05 mg/kg) of As exposure from eating food or exposure to the skin [25,26]. The increased concentrations of As in rice may have been due to the usage of irrigating crops with water originating from wells [27]. The following shows a report of the level of As in rice eaten: Tarom > Domsiah > Anbar > Indian > Pakistani. There had been no rice consumed that had more Cd than permitted allowed. The Iranian national standard suggests that 0.6 mg/kg of Cd can be consumed in rice [28]. Tarom rice has the maximum reported levels of Cd (0.55 mg/kg), but Pakistani rice has the lowest level (0.18 mg/kg). Cd poisoning, anemia, as well as increased blood pressure may come from the metal's entry into the dietary chain [29]. Rice is an agricultural crop that has been able to effectively absorb Cd through its roots. This process of absorption happens when it has a higher level of reduction and oxidation potential, and the Cd is in the form of a divalent cadmium [30]. The levels of Ni and Cr throughout every one of the consumed rice types weren't higher than the acceptable limit set by the Iranian national standard, which is 10 mg/kg. Cr is essential for human health in its trivalent form, but its hexavalent form is very poisonous and hazardous [31]. Ni, a toxic HM, affects cellular processes, hinders growth, reduces hematopoiesis, and interferes with iron intake [32]. Ni metabolites can cause dermatitis and CVD. Ni can also have mutagenic and congenital effects [33]. Nevertheless, the concentrations of Pb in all rice eaten, except for Indian rice, exceeded the permissible limit. Iranian food safety organizations have recommended strict limits on the level of Pb (0.15 mg/kg) in rice to ensure its safety [34]. The level of Pb was maximum in Anbar rice, but Indian rice had a minimal level. Pb is a common HM that appears in high levels in wheat and rice. Several investigations have shown how common it is in crops. There are differences in species of plants in their ability to accumulate, absorb, and tolerate HMs [35]. Pb contamination can be attributed to factors such as the usage of sewage sludge and fertilizers containing phosphates on farmland, as well as the residue from the burning of fossil fuels and the irrigation of crops with sewer [36]. The trend of decreasing Pb levels in consumed rice is as follows: Anbar>Domsiah>Tarom>Pakistani> Indian.

Table 2
Concentration of heavy metals in food (mg/kg).

Food	Type	As	Cd	Cr	Ni	Pb
Rice	Anbar	1.67	0.36	0.37	0.001	0.95
	Domsiah	2.53	0.48	0.24	0.014	0.35
	Tarom	2.73	0.55	0.13	0.008	0.24
	Hendi	1.5	0.22	0.005	0.004	0.012
	Pakistani	1.4	0.18	0.019	0.061	0.2
Vegetable	Cress	2.4	0.199	0.457	0.78	0.163
	Chive	4.61	0.16	0.998	1.09	0.321
	Basil	3.15	0.13	1.22	1.13	0.256
	Radish	5.369	0.254	1.36	2.5	0.361
Bread	Barbari	0.16	0.13	1.44	0.8	0.054
	Sangak	0.11	0.15	1.12	0.61	0.36
	Lavash	1.31	0.2	0.056	1.2	0.28

Four vegetable varieties—cress, chive, basil, and radish—that are frequently eaten by the study region's people have been selected as examples for the current research. The concentrations of As, Cd, and Pb in each of the four kinds of veggies exceeded the standard limit. As for the recommendations set by the WHO and the Food and Agriculture Organization (FAO), the acceptable levels of As, Cd, and Pb in veggies ought to be lower than 0.7, 0.05, and 0.1 mg/kg, respectively. Chemical fertilizers may release a mean of 0.0008–0.93 mg of Pb and 0.0005–0.5 mg of Cd per kilogram of soil. These elements can be absorbed by crops and vegetables over some time [37]. Radish shows the highest concentrations of As, Pb, Cr, and Ni among vegetation, while Cress shows the lowest level. The decreasing distribution of As and Pb is as follows. Radish (5.36)>Chive (4.61)>Basil (3.15)>Cress (2.4). The overuse of fungicides, insecticides, and herbicides is a major contributor to the increasing levels of HMs in veggies. These toxic substances are taken in by vegetables through their leaves, stems, and origins [38]. A study done by Cheng et al. published "Utilizing wastewater and its effect on HM accumulation in soil" showed an important association between levels of HMs in soil and tissues of plants [39].

These studies indicate that the soil or water used to plant rice, veggies, or wheat has high levels of HMs and does not meet irrigation and planting criteria [40].

Three types of bread, including Barbari, Sangak, and Lavash, have been collected in the present study. The study findings showed that Lavash bread had the highest levels of As (1.31 mg/kg), Cd (0.2 mg/kg), and Ni (1.2 mg/kg), whereas it indicated the lowest level of Cr (0.056 mg/kg). The acceptable levels for As, Cd, Pb, and Ni in bread recommended for eating are 0.15, 0.15, 0.15, and 10 mg/kg, respectively. The highest concentration of Cr (1.44 mg/kg) and the lowest concentration of Pb (0.054 mg/kg) were observed in Barbari bread. The concentrations of As in Barbari and Lavash bread, the concentrations of Cd in Lavash bread, and the levels of Pb in all breads (except Barbari) are above the acceptable limits set by WHO. The contamination of agricultural products with HMs is a danger because of the accumulating and adverse effects that they have on communities, and also the possible danger that they present to food safety [41]. Soil contamination can happen when the concentration of Cd, As, and Pb elements exceeds the acceptable level. This can be due to geological factors, overuse of chemical fertilizers (especially phosphate fertilizers), pesticide use, land irrigating with urban wastewater, and vehicle traffic near grown wheat crops[42]. Based on research done to evaluate the level of HMs in Hamadan bread, the breakdown of bakery equipment has increased average levels of Cd, Pb, and Ni[43].

3.2. Non-carcinogenic risk assessment

The results of the research regarding non-carcinogenic risk are shown in Table 3. The evaluation of the non-carcinogenic risk associated with HMs in two groups, adults, and kids, showed that the HI and HQ were both below 1 for both groups. Therefore, the eating of foods such as rice, veggies, and breads in the region under investigation is not

Table 3
Non-carcinogenic risk results.

HQs (Kids)							HI
Food	Type	As	Cd	Cr	Ni	Pb	
Rice	Anbar	0.0078	0.0005	0.0001	$7*10^{-7}$	0.0003	0.0088
	Domsiah	0.0118	0.0006	0.0001	$9.8*10^{-6}$	0.0001	0.0127
	Tarom	0.0127	0.0007	$6*10^{-5}$	$5.6*10^{-6}$	$9.6*10^{-5}$	0.0137
	Hendi	0.0070	0.0003	$2.3*10^{-6}$	$2.8*10^{-6}$	$4.8*10^{-6}$	0.0073
	Pakistani	0.0065	0.0002	$8.9*10^{-6}$	$4.2*10^{-6}$	$8*10^{-5}$	0.0069
Vegetable	Cress	0.0020	$5.09*10^{-5}$	$3.9*10^{-5}$	$9.9*10^{-6}$	$1.1*10^{-5}$	0.0021
	Chive	0.0039	$4.09*10^{-5}$	$8.5*10^{-5}$	$1.3*10^{-5}$	$2.3*10^{-5}$	0.0040
	Basil	0.0026	$3.32*10^{-5}$	0.0001	$1.4*10^{-5}$	$1.8*10^{-5}$	0.0028
	Radish	0.0045	$6.49*10^{-5}$	0.0001	$3.1*10^{-5}$	$2.6*10^{-5}$	0.0048
Bread	Barbari	0.0007	0.0001	0.0006	$5.6*10^{-5}$	$2.1*10^{-5}$	0.0016
	Sangak	0.0005	0.0002	0.0005	$4.2*10^{-5}$	0.0001	0.0014
	Lavash	0.0061	0.0002	$2.6*10^{-5}$	$8.4*10^{-5}$	0.0001	0.0006
HQs (Adult)							HI
Food	Type	As	Cd	Cr	Ni	Pb	
Rice	Anbar	0.0036	0.0002	$8.1*10^{-5}$	$3.2*10^{-7}$	0.0001	0.0041
	Domsiah	0.0055	0.0003	$5.2*10^{-5}$	$4.6*10^{-6}$	$6.5*10^{-5}$	0.0059
	Tarom	0.0059	0.0003	$2.8*10^{-5}$	$2.6*10^{-6}$	$4.5*10^{-5}$	0.0064
	Hendi	0.0032	0.0001	$1*10^{-5}$	$1.3*10^{-6}$	$2.2*10^{-6}$	0.0034
	Pakistani	0.0030	0.0001	$4.1*10^{-6}$	$2*10^{-6}$	$3.7*10^{-5}$	0.0032
Vegetable	Cress	0.0007	$1.9*10^{-5}$	$1.5*10^{-5}$	$3.8*10^{-6}$	$4.5*10^{-6}$	0.0008
	Chive	0.0015	$1.5*10^{-5}$	$3.2*10^{-5}$	$5.3*10^{-6}$	$9*10^{-6}$	0.0015
	Basil	0.0010	$1.2*10^{-5}$	$4*10^{-5}$	$5.5*10^{-6}$	$7.2*10^{-6}$	0.0011
	Radish	0.0017	$2.5*10^{-5}$	$4.4*10^{-5}$	$1.2*10^{-5}$	$1*10^{-6}$	0.0018
Bread	Barbari	0.0003	$8.5*10^{-5}$	0.0003	$2.6*10^{-5}$	$1*10^{-5}$	0.0007
	Sangak	0.0002	$9.8*10^{-5}$	0.0002	$2*10^{-5}$	$6.7*10^{-5}$	0.0006
	Lavash	0.0028	0.0001	$1.2*10^{-5}$	$3.9*10^{-5}$	$5.2*10^{-5}$	0.0031

associated with a non-carcinogenic risk of toxic HMs. The highest HQ values for kids were found to be associated with As, measuring 0.0127, 0.0045, and 0.0061 for Tarom rice, radish, and Lavash bread, respectively. The maximum HI values for kids were associated with As, measuring 0.0137, 0.0048, and 0.0016 for Tarom rice, radish, and Barbari bread, respectively. The highest HQ for adults was associated with As, with values of 0.0059, 0.0017, and 0.0028 for Tarom rice, radish, and Lavash bread, respectively. As had the highest HI value among adults, with respective values of 0.0064, 0.0018, and 0.0031 for Tarom rice, radish, and Lavash bread.

The non-carcinogenic risk for kids is as follows: Tarom (0.0127) > Domsiah (0.0118) > Anbar (0.0078) > Indian (0.0070) > Pakistani (0.0065).

The non-carcinogenic risk for adults is as follows: Tarom (0.0059) >Domsiah (0.0055) >Anbar (0.0036) >Indian (0.0032) >Pakistani (0.0030).

Following the criteria set by the USEPA, the non-carcinogenic risk to the health of consumers is not a concern, as the HI value for different veggies, grains, and bread is lower than one[44]. Since every veggie studied in Qureshi et al.'s research had levels of HMs below acceptable levels, the low absorption of HMs by veggies in this study indicates that the risks to human health are the minimum [45]. Furthermore, Woldetsadik et al.'s study showed that all types of vegetables had HM levels that were lower than the acceptable limits. inversely, the levels of Pb amount surpassed the recommended threshold, as a result of irrigating veggies with wastewater [46]. The research done by Roba et al. indicated that the THQ values for elements such as Zn, Cu, Pb, and Cd were higher than one. This indicates that consumers could encounter possible health risks [47].

According to the study done by Mousavi et al., the HQ of Cd, Pb, and Ni in rice cultivated in the Khuzestan province exceeded 1. These results show eating rice grown in the area can cause non-carcinogenic health risks [48]. Pb, Ni, and Cd have HQs of 2.29, 0.045, and 0.216 in rice from China's Hunan area, respectively, and Cd has a non-carcinogenic risk potential for people [49]. A study has been done on the potential of HM contamination of rice, vegetation, and soil along India's eastern coastline. The HI scores for adults (1.561) and kids (1.360) show an adverse effect on their health in the period to come [50].

3.3. *Carcinogenic risk assessment*

The results of the research on the risk of causing cancer are shown in Table 4. The evaluation of the carcinogenic risk caused by HMs in both groups, adults, and kids, showed that the CRs and Incremental Lifetime Cancer Risks (ILCR) for both groups have been determined to be lower than 1*10–6. Therefore, the consumption of rice, veggies, and bread in the study's area is not associated with CR from dangerous HMs. As had the highest CRs for kids, with values of 4.1*10–7, 1.4*10–7, and 1.9*10–7 for Tarom rice, radish, and Lavash bread, respectively. As had the greatest ILCR values for kids, with levels of 4.5*10–7, 2.3*10–7, and 4.1*10–7 for Tarom rice, radish, and Lavash bread, respectively. As had the greatest CRs for adults, with levels of 9.6*10–7, 2.8*10–7, and 4.6*10–7 for Tarom rice, radish, and Lavash bread, respectively. The maximum ILCR value for adults was associated with As, with levels of 1.1*10–6, 4.6*10–7, and 9.6*10–7 for Tarom rice, radish, and Pakistani bread, respectively. The probability of getting cancer in kids is as the following:

Tarom ($4.1*10^{-7}$) > Domsiah ($3.8*10^{-7}$) > Anbar ($2.5*10^{-7}$) > Indian ($2.2*10^{-7}$) > Pakistani ($2.1*10^{-7}$).

The probability of getting cancer in adult is as the following:

Tarom ($9.6*10^{-7}$) > Domsiah ($8.9*10^{-7}$) > Anbar ($5.8*10^{-7}$) > Indian ($5.2*10^{-7}$) > Pakistani ($4.9*10^{-7}$).

The research done in Thailand showed that veggies grown in landfills have both carcinogenic and non-carcinogenic risks. Among these risks, a highly significant carcinogenic risk correlates with a high level of As and Pb metals [51]. The research done by Sultana et al. showed that the area of Bangladesh is not recommended for growing veggies because of the existence of high levels of HMs, which pose a risk to food safety. Cd is the HM that poses the highest risk of cancer; Mn, Pb, and Fe components are the least carcinogenic [52]. A variety of rice cultivated in Khuzestan province (Iran) showed a carcinogenic risk higher than 10–4 caused by a high level of Cd, Pb, and Ni. These results indicate that eating rice from this province poses a possible carcinogenic risk [53]. The CR of Cd and Ni metals in rice from the Hunan region in China has been determined to be 0.0343 and 0.0039, respectively, which is above an acceptable level of 10–4. Therefore, consumption of this rice had a chance to cause cancer in humans [54].

Table 4
Carcinogenesis risk results.

CRs (Kids)							**ILCR**
Food	Type	As	Cd	Cr	Ni	Pb	
Rice	Anbar	$2.5*10^{-7}$	$1.3*10^{-8}$	$1.8*10^{-8}$	$1.7*10^{-9}$	$8.1*10^{-10}$	$2.8*10^{-7}$
	Domsiah	$3.8*10^{-7}$	$1.8*10^{-8}$	$1.2*10^{-8}$	$2.3*10^{-8}$	$2.9*10^{-10}$	$4.3*10^{-7}$
	Tarom	$4.1*10^{-7}$	$2.1*10^{-8}$	$6.5*10^{-9}$	$1.3*10^{-8}$	$2*10^{-10}$	$4.5*10^{-7}$
	Hendi	$2.2*10^{-7}$	$8.3*10^{-9}$	$2.5*10^{-10}$	$6.8*10^{-9}$	$1*10^{-11}$	$2.4*10^{-7}$
	Pakistani	$2.1*10^{-7}$	$6.8*10^{-9}$	$9.5*10^{-10}$	$1*10^{-8}$	$1.7*10^{-10}$	$2.3*10^{-7}$
Vegetable	Cress	$6.5*10^{-8}$	$1.3*10^{-9}$	$4.1*10^{-9}$	$2.4*10^{-8}$	$2.5*10^{-11}$	$9.5*10^{-8}$
	Chive	$1.2*10^{-7}$	$1.1*10^{-9}$	$9.1*10^{-9}$	$3.3*10^{-8}$	$4.9*10^{-11}$	$1.7*10^{-7}$
	Basil	$8.6*10^{-8}$	$9*10^{-10}$	$1.1*10^{-8}$	$3.5*10^{-8}$	$3.9*10^{-11}$	$1.3*10^{-7}$
	Radish	$1.4*10^{-7}$	$1.7*10^{-9}$	$1.2*10^{-8}$	$7.7*10^{-8}$	$5.6*10^{-11}$	$2.3*10^{-7}$
Bread	Barbari	$2.4*10^{-8}$	$4.9*10^{-9}$	$7.2*10^{-8}$	$1.3*10^{-7}$	$4.6*10^{-11}$	$2.3*10^{-7}$
	Sangak	$1.6*10^{-8}$	$5.7*10^{-9}$	$5.6*10^{-8}$	$1*10^{-7}$	$3*10^{-10}$	$1.8*10^{-7}$
	Lavash	$1.9*10^{-7}$	$7.6*10^{-9}$	$2.8*10^{-9}$	$2*10^{-7}$	$2.3*10^{-10}$	$4.1*10^{-7}$
CRs (Adult)							**ILCR**
Food	Type	As	Cd	Cr	Ni	Pb	
Rice	Anbar	$5.8*10^{-7}$	$3.2*10^{-8}$	$4.3*10^{-8}$	$3.9*10^{-9}$	$1.8*10^{-9}$	s
	Domsiah	$8.9*10^{-7}$	$4.2*10^{-8}$	$2.8*10^{-8}$	$5.5*10^{-8}$	$6.9*10^{-10}$	$1.1*10^{-6}$
	Tarom	$9.6*10^{-7}$	$4.9*10^{-8}$	$1.5*10^{-8}$	$3.1*10^{-8}$	$4.7*10^{-10}$	$1.05*10^{-6}$
	Hendi	$5.2*10^{-7}$	$1.9*10^{-8}$	$5.8*10^{-10}$	$1.5*10^{-8}$	$2.3*10^{-11}$	$5.6*10^{-7}$
	Pakistani	$4.9*10^{-7}$	$1.6*10^{-8}$	$2.2*10^{-9}$	$2.4*10^{-8}$	$3.9*10^{-10}$	$5.3*10^{-7}$
Vegetable	Cress	$1.2*10^{-7}$	$2.6*10^{-9}$	$8*10^{-9}$	$4.6*10^{-8}$	$4.8*10^{-11}$	$1.8*10^{-7}$
	Chive	$2.4*10^{-7}$	$2.1*10^{-9}$	$1.7*10^{-8}$	$6.5*10^{-8}$	$9.6*10^{-11}$	$3.2*10^{-7}$
	Basil	$1.6*10^{-7}$	$1.7*10^{-9}$	$2.1*10^{-8}$	$6.7*10^{-8}$	$7.6*10^{-11}$	$2.5*10^{-7}$
	Radish	$2.8*10^{-7}$	$3.4*10^{-9}$	$2.3*10^{-8}$	$1.4*10^{-7}$	$1*10^{-10}$	$4.6*10^{-7}$
Bread	Barbari	$5.6*10^{-8}$	$1.1*10^{-8}$	$1.6*10^{-7}$	$3.1*10^{-7}$	$1*10^{-10}$	$5.5*10^{-7}$
	Sangak	$3.8*10^{-8}$	$1.3*10^{-8}$	$1.3*10^{-7}$	$2.4*10^{-7}$	$7.1*10^{-10}$	$4.2*10^{-7}$
	Lavash	$4.6*10^{-7}$	$1.7*10^{-8}$	$6.5*10^{-9}$	$4.7*10^{-7}$	$5.5*10^{-10}$	$9.6*10^{-7}$

4. Conclusion

The purpose of this study was to investigate the concentration of heavy metals and the carcinogenic and non-carcinogenic risks caused by the consumption of food (such as rice, vegetables, and bread) in the population of Hoveyzeh and Azadegan plains. The evaluation of the carcinogenic risk caused by HM exposure in kids and adults showed that both groups' accumulated lifetime CRs and ILCRs were lower than 1*10–6. Hence, the consumption of veggies, rice, and bread within the study's area does not show an association with the occurrence of chronic diseases resulting from hazardous HMs. HI and HQ were lower than 1 for both adults and kids in the non-carcinogenic risk assessment of HMs. There's no non-carcinogenic risk of toxic HMs from eating veggies, rice, and bread in the studied area. to reduce food contamination, the following suggestions are provided:

- Training farmers in the field of correct irrigation and fertilization.
- Teaching farmers and people about the harmful effect of heavy metals on the body and ways to control and reduce it.
- Substitute vegetables with lower absorption of heavy metals.
- Identifying sources of pollution and controlling its reduction.
- Inspection and maintenance of water and soil resources used for planting vegetables by health and environmental officials.

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CRediT authorship contribution statement

Farhadi Majid: Conceptualization, Data curation, Formal analysis, Funding acquisition. **Ahmadi Angali Kambiz:** Resources, Software, Supervision. **Sepahvand Arefeh:** Validation, Visualization, Writing – original draft. **Neisi Abdolkazem:** Investigation, Methodology, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data was used for the research described in the article.

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Declaration of Competing Interest

The authors declare no conflict of interest.

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