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# Mercury Contamination in Tigertooth croaker, *Otolithes ruber* (Teleostei, Sciaenidae), Fish of the Northwestern Persian Gulf with an Emphasis on Human Health Risk

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**ABSTRACT**

**Aims:** This research aims to determine the mercury (Hg) in the muscle and liver tissues of *Otolithes ruber* species and its human health risk assessment due to its consumption.
**Material & Methods:** In this study, thirty fish samples were taken from the Imam Khomeini port northwest of the Persian Gulf in July. Then, the total mercury was measured by the Mercury Advanced Analyzer (254 AMA manufactured by Leco).
**Findings:** The mean concentrations of Hg in the muscle of *O. ruber* species were 0.112± 0.015 $\mu g.g^{-1}$ d.w were below the limits for fish proposed by WHO, FAO, USEPA, FDA, and MAFF, and the mean concentrations of Hg in the liver tissues were 0.714± 0.113. $\mu g.g^{-1}$ d.w. The muscle/liver ratio was about 0.16, which revealed high contamination of the region with the mercury element. EDI and EWI lower than PTDI and PTWI and THQ<1.00 showed that the consumption of the mentioned fish will not pose an acute risk to the consumers' health. Based on CRlim and CRmm in the studied fish for different human groups, a potential human health risk was identified for children.
**Conclusion:** In general, this work's main conclusion showed that there is no severe warning or prohibition against consuming this fish by adults. However, it should be mentioned that the risk assessment caused by the presence of other heavy elements and organic pollutants in *O. ruber* fish can impact the permissible limit of consumption of this species.

**Keywords:** Fish Liver; Fish Muscle; Non-carcinogenic Indicators; Water Pollution.

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## Introduction

Along with the increase in demand for marine products, the pollution of marine environments has seriously increased [1], which could cause a decrease in the quality of these valuable food sources [2]. In the meantime, the Persian Gulf, with an area of 237473 Km$^2$, which is considered one of the most critical closed water ecosystems in the world, has been affected by the increase in population and the industrialization of its border countries and has become a worrying situation because due to the closed water of the Persian Gulf basin, the pollution entered, concentrated there and entered the bodies of aquatic organisms. According to previous research [3], the two main industries causing pollution in this region are the petrochemical and oil sectors. According to the findings obtained by the Regional Organization for the Protection of the Marine Environment (ROPME), the oil and petrochemical sectors provide a significant risk of mercury pollution in some regions of the Persian Gulf [4]. There have been reports regarding a mercury crisis in Iran's southern areas, particularly the Imam Khomeini Port. Some fish taken from the Persian Gulf have been found to contain more mercury than the 0.5 mg.kg$^{-1}$ WHO guideline [5]. Additionally, Azimi et al. [6] demonstrated mercury pollution in this aquatic ecosystem because the mercury level in sediments in the northwest Persian Gulf is higher than international norms. According to the Iranian Fisheries Organization statistics, Iran's per capita fish consumption was 14.1 kg in 2022. Hence, people who consume much seafood in the Persian Gulf coastal cities of Iran are at a higher risk of mercury exposure because fish is a staple food and the primary source of animal protein for these communities [7]. Therefore, despite the benefits of consuming fish today, its consumption faces some risks due to pollutants, including mercury, in aquatic ecosystems. This risk is significant for vulnerable groups such as pregnant women and children because fish consumption is the most important way of entering mercury into the human body [8]**.** Due to the long biological half-life of methylmercury, it can have long-term adverse effects on the human body and health, especially on the nervous system, which include mental disorders, reduced hearing and vision, loss of body control and general weakness, nervousness, impact on the fetus, and so on [9]. Therefore, the risks of its consumption should be evaluated through scientific methods.

*Otolithes ruber* (Tigertooth croaker) is a neritic fish of the Persian Gulf and the Oman Sea with a dominant diet of carnivores and valuable species in fisheries that are captured in coastal waters by bottom trawl, gill net, and hook, and that is significant to the fishing economy in the study area [10]. They do not live in rocky regions but over muddy and sandy substrata [11]. *O. ruber* is found throughout the Indo-West Pacific [10], the Persian Gulf and Oman Sea, and the Iranian coasts, probably exposed to various types of pollution in water and sediments [12]. *O. ruber* has been extensively investigated due to its high abundance and global range, and a significant quantity of knowledge about its biology for the Northwest Persian Gulf is already accessible [13-15]**.** However, few studies have been conducted to evaluate the risk of consumption of aquatic organisms [16], especially high-consumption fish, in terms of heavy metals (especially mercury) in the Persian Gulf, and most of them have only investigated heavy metals in different tissues of fish and also the relationship of metal accumulation with biometric indicators [3, 17-20]. In most of these studies, only the accumulation of metals has been examined, and there needs to be more literature on the health risk assessment of Hg for consumers in this area. So, in addition to obtaining



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essential and valuable information about the amount of mercury in the studied species, the present research provides the necessary confidence and trust for the consumption of the mentioned species. The objectives of our study are to determine the mercury (Hg) in the muscle and liver tissues of *O. ruber* species commonly consumed by the residents of the regions and to evaluate Hg level in terms of public health and toxic risk levels for investigating the food safety of the fish belonging to the area. We do not use the liver of this fish; Hg was measured to evaluate muscle/liver index.

## Materials & Methods

### Sampling and sample preparation

Thirty fish samples, weighing an average of 385.74 ± 43.39 g and length of 29.22 ± 4.40 cm, were caught from the Imam Khomeini port in July 2021 (Figure 1). The fish samples were wrapped carefully in polyethylene bags and brought to the lab in an ice box as soon as possible. The fish samples were dissected in the lab, and the muscle and liver tissues were collected and then stored at -20˚C until the primary analysis started [21].

Fish muscle and liver tissue samples were prepared and dried for Hg analysis. The muscle and liver tissues were dried in a freeze dryer (DORSAtech, Iran) for 24 hours to gain constant weight. After grinding, 0.03 to 0.05 g of the dry tissue was weighed to measure the mercury in the Mercury Advanced Analyzer (254 AMA manufactured by Leco). The detection limit of this device is 5 $\mu g.kg^{-1}$ to 5 $mg.kg^{-1}$. For sufficient accuracy, three repetitions were made from each sample. Using the technique outlined by Al-majed and Preston [22], Standard Reference Materials (SRM) 1633b were utilized to evaluate the quality control of observed Hg concentrations. In order to do this, the National Institute of Standards and Technology (NIST, SRM 2976) recommended using fish muscle tissue in three replications as one of the standards. The recovery rate was then reported at 96 to 101%, ensuring the measurement's consistency and dependability.

### Muscle/Liver Ratio

The amount of muscle mercury concentration compared to the amounts accumulated in the liver (Muscle/Liver) is a reliable indicator of the level of mercury pollution in the environment. If the index value is in the range of 0.5, it

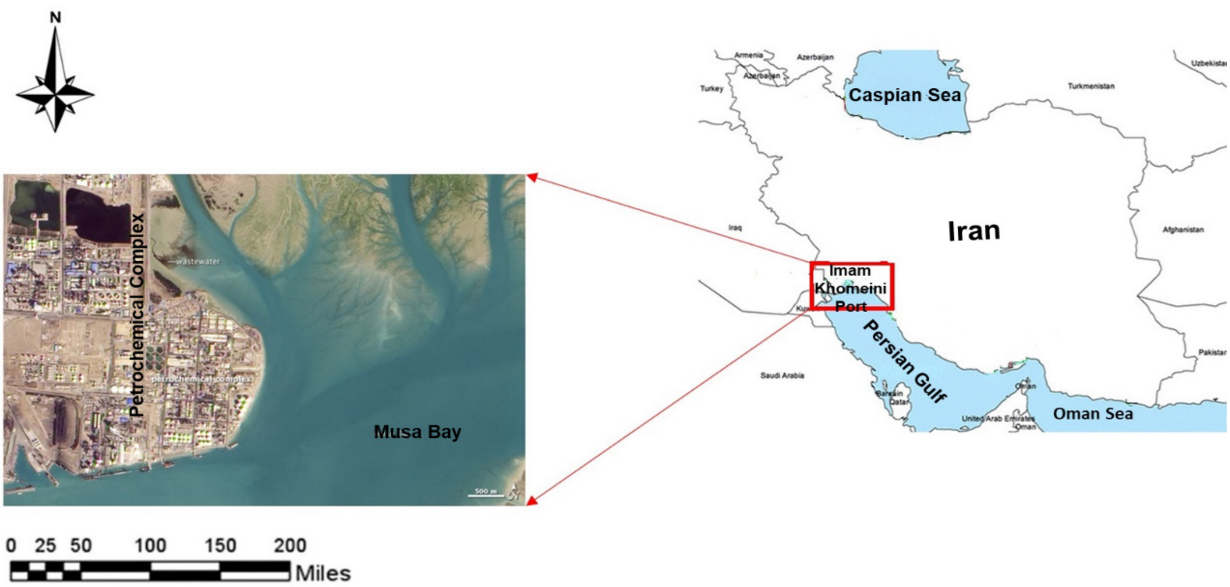


**Figure 1)** Map of the study area where the study fish were sampled..


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indicates stable environmental conditions, and if it is in the range of 1.4, it specifies that the environment is improving [18].

## Human health risk assessment

### Non-carcinogenic indicators

The Estimated Daily Intake (EDI) was computed by considering the concentration of Potentially Toxic Elements (PTEs) in the edible tissues of the *O. ruber*. EDI can be computed to estimate the daily input of each analyzed PTE in the human body (Eq. (1)) [23].

$$EDI\ (\mu g.kg^{-1}\ day^{-1}) = \frac{IR \times C}{WAB} \qquad \text{Eq. (1)}$$

where IR is Ingestion Rate (38 g.day$^{-1}$ for Iranian adults, and 16 g.day$^{-1}$ for children), C is metal concentration in fish muscle (µg.g$^{-1}$), WAB is average body weight (70kg, men; 60kg, women, and 16 kg, children aged 4-6 years) [24].

Additionally, the Target Hazard Quotient (THQ) was computed as the ratio of Hg exposure (concentration in edible tissues) to the tolerable level (reference dose) of the same element that has no adverse effects. This ratio estimates the health risk PTE-contaminated fish and seafood pose to human consumers. EF is the exposure frequency (365 days.year$^{-1}$), ED is Exposure Duration (children = 6 years, and adults = 26 years), IR is the Ingestion Rate (38 g.day$^{-1}$ for Iranian adults and 16 g.day$^{-1}$ for children), CF is the conversion factor (0.20) to convert fresh weight to dry weight if the data is reported in fresh weight, C is the fish heavy metal concentration (mg.kg$^{1}$d.w.), WAB is the average body weight (70kg, men; 60kg, women, and 16 kg, children aged 4-6 years), ATn (Averaging Time for non-carcinogenic risk) is EF × ED (children = 2100 days, and adults = 9100 days), and RfD is Oral Reference Dose (0.0003 mg.kg $^{-1}$.day$^{-1}$ for Hg). Values for THQ greater than 1 signify a moderate to high risk within the exposed population [24]. The THQ can be calculated as equation2 [25-26]:

$$THQ = \frac{EF \times ED \times IR \times CF \times C}{WAB \times ATn \times RfD} \times 10^{-3} \qquad \text{Eq. (2)}$$

where THQ is the Target hazard quotient (THQ ≤ 1.00 is an acceptable risk level, and THQ >1.00 indicates a potential risk level).

### Daily consumption rate ($CR_{lim}$) and monthly consumption rate ($CR_{mm}$)

The daily consumption rate ($CR_{lim}$) was determined using Eq. (3). This formula calculates the maximum amount of fish muscle consumed daily from spoiled fish. In addition, equation 4, related to the allowable monthly consumption of fish muscle, was used to calculate the monthly consumption rate ($CR_{mm}$).

$$THQ = \frac{EF \times ED \times IR \times CF \times C}{WAB \times ATn \times RfD} \times 10^{-3} \qquad \text{Eq. (3)}$$

$$CR_{mm} = \frac{CRlim \times AT}{MS} \qquad \text{Eq. (4)}$$

where $CR_{lim}$ is the daily consumption rate (kg.day$^{-1}$), RFD is the oral reference dose for Hg (0.0003 mg.kg$^{-1}$day$^{-1}$), BW is the average body weight (70kg, men; 60kg, women, and 16 kg, children aged 4-6 years) and Cm is the heavy metal concentration (µg.g$^{-1}$ d.w). Moreover, $CR_{mm}$ is the monthly consumption rate (meals.month$^{-1}$), AT is the average time in a month, which in this study is assumed as 30.44, and MS refers to the amount of each meal (kg.meal$^{-1}$), 0.227 and 0.114 kg for adults and children, respectively [23].

### Statistical analyses

The analysis of Hg in fish muscle and liver samples was performed considering triplicates. Hg concentrations were reported as Mean ± SD. Independent Samples t-Test was used to assess variation between tissues. The variables were normally distributed throughout the Kolmogorov-Smirnov test. Statistical analyses were performed by applying a significance level of 0.05. All data analyses were performed in SPSS 26.0.





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## Results and Discussions

### Hg accumulation in the muscle and liver tissues of fish

The mean concentrations of Hg in the muscle and liver tissues of *O. ruber* species are summarized in Table 1. Based on the results, the Hg distribution in fish's muscle and liver tissues followed the order of liver>muscle. A significant difference was observed between Hg concentrations in the two tissues (p<0.05). Liver tissue generally accumulates high amounts of mercury due to its detoxification activity [27-28]. Muscle tissue can be considered one of the primary target tissues for mercury due to the presence of proteins rich in cysteine and methionine and the high affinity of mercury for their sulfhydryl groups [27, 29]. Accumulation of mercury in muscle tissue is considered a protective mechanism in fish because stopping mercury in muscle tissue reduces the exposure of the central nervous system to this metal [30]. The binding of mercury to sulfhydryl groups leads to the formation of water-soluble complexes that can easily move in the aqueous phase of the cell. Therefore, the high water content of liver and muscle tissues can be essential in increasing mercury concentration in these tissues [27,31]. In addition, since the circulatory system is responsible for the distribution of mercury in the body [27, 29, 32], tissues with many blood vessels have more mercury than other tissues. For this reason, mercury accumulation in liver tissue is more than in muscle [33]. Liver and muscle tissues have always been considered the primary target tissues for mercury accumulation. Of course, despite the high accumulation of mercury in these two tissues, it can be seen that the liver has the highest amount of mercury in some of the studied species [7, 34-36].

Different superscript letters in each column indicate significant differences (p < 0.05) as follows: a, b Significant differences among tissues.

WHO stands for World Health Organization; FAO stands for Food and Agriculture Organization; USEPA stands for United States Environmental Protection Agency; FDA stands for Food and Drug Administration; and MAFF stands for Ministry of Agriculture, Fisheries and Food.

Examination of the results of comparing the mean Hg concentration obtained in the present study with international standards revealed that the Hg concentration in the muscle tissue of *O. ruber* is below the limits for fish proposed by WHO, FAO, USEPA, FDA, and MAFF (Table 2). The values specified by the mentioned organizations are those above, and the effects of mercury entering the human body will be determined. However, mercury may have unspecified effects on health, even in amounts below these limits [4, 45]. Also, in similar studies, Sahebi and Emtyazjoo [38], Askary Sary and Mohammadi [5], and Pourkhabbaz et al. [39], the concentration of mercury in fish muscle tissue is lower than the limit set by international standards. The lower mercury concentration compared to the standards does not mean they are safe. Even though there is less mercury in muscle tissue than international standards, there is a need for closer monitoring due to mercury's extreme toxicity and its possible contamination risks, especially for children and pregnant women. According to the substantial evidence presented by Guallar et al. [47], people who eat a diet high in seafood are among the most vulnerable to mercury exposure. Therefore, additional parameters have also been studied to provide a more precise evaluation, including the risk index and the daily mercury absorption.

### Muscle/Liver Ratio

A good way to estimate environmental mercury pollution is to examine the ratio of muscle concentration to liver accumulation



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(muscle/iver). When the value of the index is around 0.50, it indicates stable environmental conditions, and if it is within 1/40, it indicates that the environment is improving [33]. In this study, the numerical value of the muscle index, liver, is about 0.16, which shows that the pollution situation in Imam Khomeini port is improving and far from stable conditions. Some researchers believe that the distribution of mercury in fish tissues is affected by the intensity of pollution and changes in ecosystems with different pollution [48-49]. Havelková et al. [29] examined 1117 pieces of fish caught from 13 stations in the Elbe River of the Czech Republic during five years. They used the ratio between the amount of mercury accumulated in muscle and liver as an indicator. Their study showed that the ratio of mercury in the muscle to the liver decreases in the more polluted stations. In other words, mercury accumulation in the liver tissue is higher in environments with high pollution, and the target tissue for these areas is the liver. In the present study, the muscle/liver ratio results indicated high contamination of the region with the mercury element, and the target organ for this element was the liver.

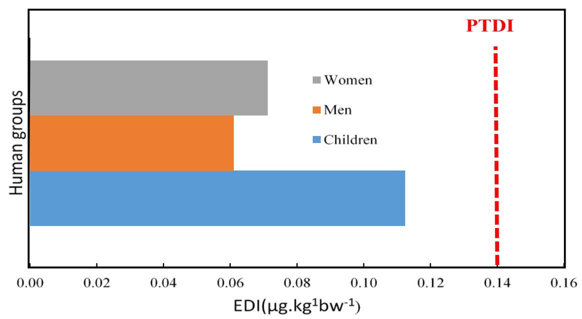


**Figure 2)** Estimated Daily Intake (EDI) for human groups.

## Human health risk assessment

Usually, fish muscle is one of the most important tissues in which the concentration of heavy metals is measured because this part is edible and affects human health. The path of heavy metals entering the human body is different, but eating contaminated fish is one of the ways through which the heavy metals enter the body. Therefore, this study considered muscle tissue an edible part of human nutrition, and the risk assessment of mercury-contaminated fish consumption was investigated. Since, in this study, the samples were taken from fish with acceptable weights consumed as food, the relationship between length and weight index and the rate of metal accumulation was not noticed in the fish. Due to the toxicity of heavy metals, regulatory bodies worldwide have specified acceptable limits for these pollutants in some food items such as fish. The standards of critical regulatory bodies, such as USEPA and EFSA Panel on Contaminants in the Food Chain (CONTAM), were used in the risk assessment of fish consumption in the studied region.

The results of the daily intake of mercury metals in children, women, and men are presented in Figure 2. Based on the results, it was found that the highest amount of daily mercury absorption was in children, and the lowest amount was in men. Daily mercury intake for children, men, and women was 0.11, 0.06, and 0.07 $\mu g.kg^{1}bw^{-1}$, respectively (Figure 2). Also, EWI values in children, men, and women were 0.77, 0.42, and 0.49 $\mu g.kg^{1}bw^{-1}$, respectively. Based on the findings, children were evaluated as the most sensitive group against mercury accumulated in muscle tissue. Andrew et al. [50] claimed that children and pregnant women are vulnerable groups to accumulated mercury in the food tissue of *Oreochromis niloticus* and *Labeo niloticus* as freshwater fish species. The Provisional Tolerable Daily Intake (PTDI) and Provisional Tolerable Weekly Intake (PTWI) of mercury as recommended by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) [50] is 0.14 and 1.00 $\mu g.kg^{-1}$


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**Table 1)** Mean Hg concentration ($\mu g.g^{-1}$ d.w) ± SD in tissues of *Otolithes ruber.*

| Common Name | Scientific Name | Muscle | Liver |
|---|---|---|---|
| Tigertooth croaker | *Otolithes ruber* | 0.112± 0.015[a] | 0.714± 0.113[b] |

body weight, respectively. EDI for all studied groups was lower than PTDI and PTWI in this study. Additionally, for every participant in this trial, the provisional tolerated daily intake (PTDI) and Provisional Tolerable Weekly Intake (PTWI) remained within the normal limits recommended by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the European Food Safety Authority (EFSA). These results were consistent with those published by Majlesi et al. [51], who presented that according to the PTDI and PTWI index, the amount of mercury deposited in tropical fish did not constitute a health risk to consumers. The PTDI and PTWI have the highest pollution levels, and an individual is safe if exposed on a given day. According to Mortazavi and Norozi Fard [502], eating fish species taken from the Dez River had PTDI and PTWI values lower than FAO and WHO guidelines, meaning that eating them poses no health risk to locals. Also, Parang et al. [53] revealed that PTDI and PTWI did not exceed the permissible values in all fish species and human groups. However, due to the higher PTDI and PTWI rates in children and women than in men, these two groups receive more risks. Ritonga et al. [54] in their study indicated that the total mercury in Barracuda (*Sphyraena putnamae*) muscle from the Gulf of Thailand was lower than the maximum allowance value presented by the European Union and Thailand's Ministry of Public Health and EDI value in all samples of Barracuda were lower than the PTDI guideline.

In addition, the risks caused by the consumption of Tigertooth croaker fish were evaluated by the Target Hazard Quotient (THQ), and considering that the mean THQ for this species for all human groups was lower than the alarming level

**Table 2)** Comparison of the mean concentration of Hg in muscle tissues of *O. ruber* of the Imam Khomeini port with different studies and standards.

| Locations/Standards | Species | Unit | Hg | References |
|---|---|---|---|---|
| Imam Khomeini Port (Iran) | *O. ruber* | $\mu g.g^{-1}$ w.w | 0.03 | Present study |
| Khuzestan Shore (Iran) | *O. ruber* | $\mu g.g^{-1}$ w.w | 0.31 | [37] |
| Mahshahr Port (Iran) | O. ruber | $\mu g.g^{-1}$ w.w | 0.04 | [38] |
| Mahshahr Seaport (Iran) | *O. ruber* | $\mu g.g^{-1}$ w.w | 0.05 | [5] |
| Oman Sea (Iran) | *O. ruber* | $\mu g.g^{-1}$ d.w | 0.01 | [39] |
| WHO | | $\mu g.g^{-1}$ | 0.50 | [40] |
| FAO | | $\mu g.g^{-1}$ | 2.00 | [41] |
| USEPA | | $\mu g.g^{-1}$ | 2.00 | [42] |
| FDA | | $\mu g.g^{-1}$ | 0.40 | [43] |
| MAFF | | $\mu g.g^{-1}$ | 0.30 | [44] |



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(THQ<1.00), the consumption of these fish would not endanger human health, but their consumption must be managed (Table 3). In this context, an assessment of mercury and cadmium via seafood consumption in Italy by Barone et al. [55] showed that THQ < 1.00 fell within the acceptable bounds. They stated that seafood consumption would not appear to pose any significant dangers. However, levels of mercury exposure should be regularly monitored as they have occasionally approached safety limits. Also, assessing risks to human health resulting from mercury levels in sardines (Sardinella brasiliensis) by Porto et al. [56] demostrated that THQ ranged from 0.027 to 0.086 (<1.00), showing that the consumption of this food would not pose a health risk to the resident population. The study by Cheraghi et al. [57] showed that although the amount of mercury in the muscle of all the studied fish of the Karun River is less than the international standard, the amount of HQ is higher than 1.00, so the consumption of the mentioned fish would pose risks to the health of the consumers. Sobhanardakani et al. [58] indicate that the concentration of Hg in the different tissues of the studied marine organisms was significantly lower than the permissible levels for these toxic metals. Therefore, they stated that some considerations should be taken when consuming the number of servings of these fish, especially for sensitive groups such as pregnant women and children.

Since the amount of HQ for the fish of *O. ruber* was calculated to be less than 1, consuming the mentioned fish would not pose an acute risk to the consumers' health. However, due to the characteristic of mercury accumulation in the body, its optimal consumption should be calculated. In other words, knowledge of the amounts of fish that can be safely consumed over a specific period without causing adverse effects is necessary to assess better and delineate the potential risks to human health with the exposure assessment. The Permissible daily intake (CRlim) of *O. ruber* for children, men, and women were 0.043, 0.187, and 0.160 kg.day$^{-1}$, respectively (Table 3). CRlim was lower and higher for people weighing more and less than 16, 70, and 60 kg, respectively, for children, men, and women. The proposed equation, considering the pollutant concentration in fish and marine products by reducing its consumption, allows for reducing the amount of pollutants entering and absorbing the body to the standard level in each region. The risk assessment caused by the presence of other heavy elements and organic pollutants in fish can effectively determine this species' permissible limit of consumption. The US EPA has suggested that the safe monthly consumption rate or CRmm (meals/month) should be measured to lower the risk for fish consumers and avoid long-term systemic impacts. The USEPA [23] states that a meal is safe if its CRmm exceeds 16 meals per month. Adults can eat more than 16 meals of these species if they follow these rules, depending on the quantities of mercury. According to the results of this study, the number of fish meals allowed per month for men and women was 25 and 21, respectively. In contrast, the number of meals allowed per month for Children was 11, identifying a potential human health risk for children. In a similar study, mercury, methylmercury, and selenium levels in fish were measured. The CRmm was determined, suggesting that high-risk groups in children should consume fish in moderation, as high consumption of these fish, particularly swordfish and tuna, may be a health concern [55]. Restrictions on the general public's consumption of fish and other aquatic species, particularly for vulnerable subpopulations like children and pregnant women, can help minimize mercury exposure while allowing for these foods' nutritional advantages.





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**Table 3)** Target Hazard Quotient (THQ), Permissible daily intake (CRlim), and monthly meals (CRmm) of studied fish for human groups.

| Fish species | THQ | | | CRlim ($kg.day^{-1}$) | | | CRmm ($meals.month^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Children | Men | Women | Children | Men | Women | Children | Men | Women |
| *O. ruber* | 0.078 | 0.042 | 0.049 | 0.043 | 0.187 | 0.160 | 11.41 | 25.07 | 21.49 |

## Conclusion

Overall, the results from this study and published data support the conclusion that the Hg distribution in the muscle and liver tissues of *O. rubber* fish followed the order of liver>muscle. Although liver and muscle tissues have always been considered the two primary target tissues for mercury accumulation, in environments with high pollution, mercury accumulation in the liver tissue is higher, and the target tissue for these areas is the liver. The amount of muscle mercury concentration compared to the amounts accumulated in the liver (muscle/liver) is a reliable indicator for determining the level of mercury pollution in the environment. In this study, the numerical value of the muscle index, liver, was about 0.16, which showed that the pollution situation in Imam Khomeini port is not only not improving, but it is also far from stable conditions. Typically, fish muscle is one of the most critical tissues in which the concentration of heavy metals is measured because this part is edible and affects human health. Examination of the results of comparing the mean Hg concentration obtained in the present study with international standards revealed that the Hg concentration in the muscle tissue of *O. ruber* was below the limits for fish proposed by WHO, FAO, USEPA, FDA, and MAFF. The lower mercury concentration compared to the standards does not mean they are safe. Therefore, additional parameters have also been studied to provide a more precise evaluation, including the risk index and the daily mercury absorption. Daily mercury intake for children, men, and women were 0.11, 0.06, and 0.07 $\mu g.kg^{1}bw^{-1}$, respectively. Based on the findings, children were evaluated as the most sensitive group against mercury accumulated in muscle tissue. The Provisional Tolerable Daily Intake (PTDI) and Provisional Tolerable Weekly Intake (PTWI) of mercury, as recommended by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 2003, are 0.14 and 1 $\mu g.kg^{-1}$ of body weight, respectively in this study, EDI for all studied group were lower than PTDI and PTWI. In addition, the risks caused by the consumption of Tigertooth croaker fish were evaluated by the Target Hazard Quotient (THQ), and considering that the mean THQ for this species for all human groups was lower than the alarming level (THQ<1.00), the consumption of these fish would not endanger human health, but their consumption must be managed. Since the amount of HQ for the fish of *O. ruber* was calculated to be less than 1, consuming the mentioned fish would not pose an acute risk to the consumers' health. However, due to the characteristic of mercury accumulation in the body, its optimal consumption should be calculated. According to the Permissible daily intake (CRlim) and monthly meals (CRmm) of studied fish for human groups, the number of fish meals allowed per month for men and women was 25 and 21, respectively. However, the number of meals allowed per month for Children was 11, identifying a potential human health risk for children. The main conclusion of this work is that there is no severe warning or



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prohibition against consuming this fish by adults. However, it should be mentioned that the risk assessment caused by the presence of other heavy elements and organic pollutants in *O. ruber* fish can impact determining the permissible limit of consumption of this species. Also, it is recommended that this research be carried out in other regions of the Persian Gulf and other consumed aquatic products.


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