

Risk-Benefit Assessment of Commonly Consumed Fish Species From East Sea, Yellow Sea, Bohai Sea, and South Sea in China - Based on Methylmercury and DHA, EPA (Overview)

Marine fish is a good source of dietary nutrients and rich in high-quality protein, trace elements, unsaturated fatty acids, and many other beneficial nutrients. However, with the accelerated industrialization and urbanization, the pollution of the marine environment has been aggravated, and the safety of marine fish has become a concern. Among the many pollutants, methylmercury is of wide concern because of its potential to cause persistent and severe damage to the human nervous system. The results of the national food safety risk monitoring and assessment in 2012 showed that the exposure to methylmercury was high in high consumers of aquatic foods, suggesting that there is a certain risk of dietary exposure to methylmercury among Chinese residents. With the increasing consumption of marine fish in China in recent years, it is necessary to carry out a risk-benefit assessment of marine fish to provide a scientific basis for dietary guidance of marine fish.

1. Assessment Data and Methods

In this assessment, the consumption data on marine fish for women of childbearing age (15-49 years old) are mainly from the Chinese Resident Food Consumption Survey in 2014, and the data on fatty acid and methylmercury content of marine fish are from special surveys on common marine fish in four major marine areas, including the Bohai Sea, Yellow Sea, East Sea and South Sea. This report uses the quantitative risk-benefit quantitative assessment model proposed by FAO/WHO, which was developed based on the results of studies on the neurodevelopmental effects of DHA and methylmercury on neonates/infants and used the effect of marine

fish intake on IQ as an evaluation index. A comprehensive study of the effects of marine fish intake by pregnant women or lactating mothers on neurodevelopment in infants and children was conducted weighing the health risks against the nutritional benefits.

2. Assessment Results

2.1 Risk-benefit assessment of neurodevelopment in newborns and infants

There are 77 species of common marine fish on the market from the four major marine areas. Based on the content of methylmercury and fatty acids (DHA, EPA) in marine fish, the risks and benefits of marine fish intake by pregnant women or lactating mothers on the neurodevelopment of infants and children were assessed using the consumption data on marine fish for all women of childbearing age (15-49 years) and for the consumers that were included in the China Resident Food Consumption Survey in 2014.

The average consumption of marine fish for the general population of women of childbearing age was 14.77 g/d, with a high consumption (P95) of 83.33 g/d. At the average consumption level, the daily DHA+EPA intake of the total population, depending on consumed fish species, ranged from 5.60 mg to 363.08 mg, the average weekly exposure to methylmercury ranged from 0.02 $\mu\text{g}/\text{kg}$ BW to 0.29 $\mu\text{g}/\text{kg}$ BW, and the net increase effect of marine fish consumption by pregnant women or lactating mothers on IQ values of newborns and infants ranged from 0.03 to 5.60. At the P95 consumption level, the daily DHA+EPA intake, depending on consumed fish species, ranged from 31.58 mg to 2048.42 mg, and the weekly exposure to methylmercury ranged from 0.09 $\mu\text{g}/\text{kg}$ BW to 1.62 $\mu\text{g}/\text{kg}$ BW, where the weekly exposure to methylmercury from one marine fish species (sharp-headed scalloped

shark) exceeded the PTWI (1.6 µg/kg BW). The net increase effect of marine fish consumption by pregnant or lactating mothers at P95 consumption level on IQ values of newborns and infants ranged from 0.18 to 5.72.

For the women of childbearing age consuming marine fish, the average consumption was 52.0 g/d and P95 of consumption was 133.33 g/d. The average daily DHA+EPA intake of the consumers ranged from 19.71 mg to 1278.26 mg depending on different fish species, and the average weekly exposure to methylmercury ranged from 0.05 µg/kg BW to 1.01 µg/kg BW. The net increase effect of marine fish consumption by pregnant women or lactating mothers on IQ values of newborns and infants ranged from 0.11 to 5.75. At the P95 consumption level, the daily DHA+EPA intake corresponding to the consumption of different fish species ranged from 50.53 mg to 3277.52 mg, and the weekly exposure to methylmercury ranged from 0.14 µg/kg BW to 2.59 µg/kg BW, where methylmercury exposure exceeded the PTWI value by consumption of seven species of marine fish, and the net increase effect of marine fish consumption by pregnant women or lactating mothers at this P95 consumption level on IQ values of newborns and infants ranged from 0.28 to 5.67.

2.2 Food value of common commercially available marine fish in four major marine areas

This assessment takes into account the availability of food consumption, the dietary habits of Chinese residents and the need for dietary balance and provides an evaluative classification of the food value of marine fish. The results are as follows:

Class	Species	Consumption recommendation
Class I (35 species)	Embiotoca jacksoni, mackerel, scomber japonicus, conger myriaster, blackhead seabream, large yellow croaker,	Priority recommendation. Rationale: Consumption of these fish species by pregnant women and lactating mothers in a balanced dietary regimen has a significant

Class	Species	Consumption recommendation
	<p>plectorhinchus cinctus, Japanese sardinella Alepocephaliformes, goldlined seabream, Chinese herring, epinephelinae, small yellow croaker, dotted gizzard shad, salmon, lanterneye fish, Pampus chinensis, striped beakfish, miichthys miiuy, flatfish, sea ruffe, willow leaf fish, hering, beltfish, Japanese sea bass, red drum, livingston's cichlid, turbot, barbeled grunter, pacific halibut, Spanish mackerel, hexagrammos, bluefin gurnard, silver pomfret</p>	<p>benefit on IQ growth in newborns and infants with a low risk of methylmercury exposure.</p>
<p>Class II (42 species)</p>	<p>Frigate tuna, daggertooth pike conger, fourfinger threadfin, flathead grey mullet, barracuda, yellow drum, Decapterus, cynoglossus robustus, silver pomfret, sea catfish, sardine, bigeye, golden threadfin bream, zebra, orange-spotted spinefoot, striped eel catfish, sand lance, meager, mottled spinefoot, stone flounde, collichthys lucidus, Bombay duck, longfin mojarra, red seabream, black scraper, Alaska pollock, mangrove red snapper, greater lizardfish, anglerfish, Raja porosa, yellowtail, Protosalanx chinensis, silver whiting, Cynoglossus semilaevis, yellowfin seabream, ridged-eye flounder, olive flounder, common dab, yellowtail scad, Chinese sleeper, spadenose shark, bartail flathead</p>	<p>General recommendation Reason: ① It is only by consuming more than the recommended amount in the Chinese Dietary Guidelines that highest IQ growth benefits can be obtained, and moderate consumption can also provide high quality protein, multivitamins and minerals; ② Methylmercury exposure poses certain health risks, and it is recommended to avoid long-term, high volume consumption to reduce the risk.</p>
<p>Class III (0 species)</p>	<p>No such species were included in the current assessment</p>	<p>Not recommended. Rationale: Methylmercury exposure may pose a health risk when consumption is within the recommended amount in the Chinese Dietary Guidelines.</p>

3. Conclusions and Recommendations

By average consumption of marine fish in women of childbearing age (healthy women aged 15-49 years) and average consumption of other consumers, methylmercury exposures of all 77 fish species evaluated in this study did not exceed the PTWI, suggesting low health risks; moreover, a certain net IQ increase effect could be obtained for newborns and infants. However, the net IQ increase benefits of consuming different fish species for newborns and infants were not the same, and there were large differences in nutritional benefits.

Among the fish species evaluated in this study, 35 species can be recommended to pregnant women and lactating mothers as a priority because they can provide the highest IQ increase benefit to newborns and infants with low risk of methylmercury exposure when they follow a balanced dietary pattern.

The average consumption of marine fish in women of childbearing age in China is much lower than the recommended intake in the Chinese Dietary Guidelines (2016). It is recommended to further strengthen publicity and education, improve national nutrition and health awareness, and advocate pregnant women and lactating mothers to choose marine fish species with lower methylmercury contamination under a balanced dietary consumption level, so that marine fish intake during pregnancy and lactation can bring greater benefits for IQ increase of newborns and infants.

This project only analyzed the common marine fish on the market from the four major marine areas of China, which does not cover all marine fish supplied in Chinese market at different times throughout the year, nor does it cover imported marine fish, thus bringing some limitations to the results of the risk-benefit analysis and food value recommendations for marine fish.