Healthy fish consumption and reduced mercury exposure

Counseling women in their reproductive years

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Abstract

Objective To provide family physicians with a practical, evidence-based approach to counseling women about healthy fish eating.

Sources of information MEDLINE was searched for articles published between 1999 and 2008. Most studies described in this article provide level II or III evidence.

Main message Fish is an important component of a healthy diet for women in their reproductive years owing to the beneficial effects of omega-3 fatty acids on the neurologic development of the fetus. However, some fish species contain considerable methylmercury, which crosses the placenta and has harmful effects on neurobehavioural development. As many jurisdictions have issued fish consumption advisories, which can be confusing, women would benefit from individualized assistance from a trusted source, their family physicians, to clarify the risks and benefits of eating fish.

Conclusion We recommend that family physicians counsel women in their reproductive years about healthy choices regarding fish in their diet, and provide appropriate resources.

Résumé

Objectif Proposer au médecin de famille une méthode fondée sur des preuves pour conseiller les femmes au sujet d'une consommation saine de poisson.

Sources de l'information On a cherché dans MEDLINE les articles publiés entre 1999 et 2008. La plupart des études décrites dans cet article possédaient des preuves de niveaux II et III.

Principal message Le poisson est une composante importante d'une alimentation saine pour les femmes en âge de procréer, en raison des effets bénéfiques des acides gras oméga-3 sur le développement neurologique du fœtus. Toutefois, certains poissons contiennent des quantités considérable de mercure, lequel traverse la barrière placentaire et a des effets nocifs sur le développement neurocomportemental. Comme plusieurs organismes ont émis des avertissements au sujet de la consommation de poisson, créant ainsi une certaine confusion, il serait avantageux que les femmes bénéficient d'une assistance individualisée de la part d'une source fiable comme leurs médecins de famille afin de mieux comprendre les risques et avantages de la consommation de poisson.

Conclusion Nous sommes d'avis que le médecin de famille doit conseiller les femmes en âge de procréer sur les choix sains concernant leur consommation de poisson en plus de leur fournir les ressources appropriées.

KEY POINTS Women should be encouraged to eat at least 2 servings a week of high–omega-3, low-mercury fish. Family physicians can play an important role in counseling women in their reproductive years about healthy consumption of fish, and they can provide appropriate resources. A patient handout is provided, which offers accessible advice on what fish can be eaten how often and high-mercury species to avoid or eat rarely. Because of the benefits of fish consumption, family physicians need to support individual awareness and behaviour shifts so benefits and risks are balanced.

POINTS DE REPÈRE On devrait encourager les femmes à manger au moins 2 portions par semaine de poisson riche en oméga-3 et pauvre en mercure. Le médecin de famille peut jouer un rôle important pour conseiller les femmes en âge de procréer au sujet d'une consommation saine de poisson et pour leur fournir des ressources appropriées. Il existe un document à distribuer aux patients, qui offre des avis à la portée de tous sur les poissons qu'on peut consommer et à quelle fréquence, et sur les espèces à haute teneur en mercure qu'il faut éviter ou manger rarement.. Parce qu'il y a avantage à consommer du poisson, le médecin de famille doit être un agent de prise de conscience individuelle et de changements de comportement afin de trouver un équilibre entre les avantages et les risques.

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Case description

At her annual physical examination, a 28-year-old university student says that she is to be married next year, when she wants to go off the pill and try to conceive. She lives at home with her parents, immigrants to Canada from Hong Kong. She eats a tuna submarine sandwich for lunch at least 3 days a week at school and has sushi once a week. She also eats fish with her family approximately 3 times a week. She has read an article suggesting that she might be eating too much fish. How would you counsel her about fish eating and pregnancy?

Fish is a healthy dietary choice for women in their reproductive years, with health benefits for their future children, but there is concern that mercury in some fish species could harm a developing fetus. Preconception and prenatal visits offer effective opportunities for family physicians to improve maternal and child health.[1] It is a challenge to offer clear, practical advice on the benefits and risks of fish consumption, as the evidence is complex and at times uncertain. To ensure that this advice is useful and not detrimental, it must be individualized, especially in ethnically diverse urban Canada.

Two streams of evidence inform this debate. The first concerns the fetal health and developmental benefits of omega-3 fatty acids from maternal fish consumption. The second concerns the neurotoxicity to the fetal brain of mercury found in some commonly eaten fish species.

Sources of information

MEDLINE was searched using terms relevant to each section of the article. Search terms included *fish consumption, methylmercury, prenatal exposure, neurotoxicology, child development, developmental outcomes,* and *omega-3 fatty acids.* Articles published between January 1999 and October 2008 were reviewed. Most studies provided level II (cohort or case-controlled epidemiologic studies) or III (expert opinion and consensus statements) evidence. Government websites were searched for relevant material on fish advisories and toxicologic profiles. We recommend a resource developed by Toronto Public Health, in consultation with other public health units in southern Ontario, based on a 2006 technical report that extensively reviewed the relevant evidence.[2]

Main message

Health benefits of eating fish. The health benefits of eating fish are related to the presence in fish of 2 long-chain omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Besides being obtained directly from fish, both DHA and EPA can be derived from a plant-based omega-3 fatty acid, α-linolenic acid (ALA); ALA is an essential fatty acid that cannot be synthesized by the body, so dietary sources are required. Fish in the mother's diet is thought to provide the optimal source of DHA and EPA, as the fetus and infant appear to have limited ability to synthesize DHA from dietary ALA.[3]

Health benefits for pregnancy. Docosahexaenoic acid is incorporated into the brain and retinal tissues during fetal development and into the developing human brain for the first 2 years of life. Randomized controlled trials of DHA-enriched infant formula demonstrate a modest positive effect on intelligence quotient, which is more pronounced in premature infants (level I evidence).[4] The relationship between maternal fish consumption during pregnancy and the child's long-term cognitive development has recently been studied in cohorts in the United States and United Kingdom.[5,6] In general, beneficial effects on child cognitive development were found when mothers ate fish for more than 2 meals per week.

Prenatal dietary requirement for DHA. There has been much debate in the literature concerning the prenatal dietary requirement for DHA.[7,8] A recent consensus statement confirms the importance of DHA in the maternal diet, and recommends that pregnant and lactating women consume at least 200 mg of DHA daily.[9] Citing a lack of intervention studies and conflicting results from observational studies, Motherisk concluded in 2007 that until evidence accumulated, clinicians should not encourage women to take omega-3 fatty acid supplements during pregnancy.[10] In recently released prenatal nutrition guidelines, Health Canada states that fish oil supplements should not be considered equivalent to eating fish, and recommends that a food-based approach should be emphasized for women who do not eat fish.[11]

Mercury in fish and its health effects. Fish consumption is the main source of exposure to methylmercury, which is bound to protein in the muscle of the fish.[12,13] It is almost completely absorbed from the gastrointestinal tract, accumulates in the mother's body, and is transferred across the placenta and the fetal blood-brain barrier.[14] Levels in cord blood are approximately 1.7 times higher than in maternal blood,[15,16] and levels in the fetal brain are higher than in the mother.[17] Levels in breast milk, on the other hand, are substantially lower than in maternal blood.

At high doses, methylmercury is neurotoxic to adults. Evidence of the effects on the developing fetal brain of lower doses of methylmercury (from fish in the maternal diet or from maternal body stores) comes from both animal and human studies.[17] Animal models of in utero exposure indicate dose-related deficits in sensory, motor, and cognitive neurodevelopment in exposed offspring. Evidence in humans derives mainly from 3 longitudinal cohort studies of fish-eating populations, studies that reached conflicting results (**Table 1**).[17-23] These divergent findings have been variously explained in terms of

Table 1. Main studies exploring health effects of low-dose prenatal mercury exposure

STUDY LOCATION	DETAILS	ASSOCIATIONS WITH PRENATAL MERCURY EXPOSURE
Faroe Islands[18,19]	More than 900 mother-child pairs; diet included PCB exposure (whale meat), but analyses controlled for PCBs	Memory, language, and attention deficits at age 7; fine motor, attention, visual-spatial, and verbal skill deficits at age 14
New Zealand[20]	237 mother-infant pairs; varying fish consumption patterns during pregnancy (low to high)	Reduced performance in scholastic and psychological tests during early school years
Seychelles Islands[21,22]	779 mother-infant pairs; approximately 12 fish meals a week on average during pregnancy	Pilot study showed lower Denver Developmental Screening Test scores; main study showed no delays in developmental milestones or deficits in neurodevelopmental tests

PCB—polychlorinated biphenyl.

differences in dietary composition as it relates to fish species, patterns of neurotoxicant intake, dietary intakes of "protective" omega-3 fatty acids and selenium, and possible genetic differences among the different populations studied.[17,24]

The Harvard Center for Risk Analysis[23] estimated that prenatal mercury exposure that raises maternal hair mercury measured at birth by 1 µg/g reduces intelligence quotient by 0.7 points in the exposed child. This finding, although not clinically observable in individual patients, would have considerable societal effects at the population level.[25]

"Safer" levels of mercury: intake and tissue levels. There are no consistent guidelines for an "acceptable" or "tolerable" level of mercury for the developing brain.[12] Health Canada has recently developed a provisional interim blood guidance value of 8 µg/L based on the existing provisional tolerable daily intake of 0.2 µg/kg daily for children, pregnant women, and women of childbearing age.[26] Brodkin et al[14] recommend that at blood mercury levels of 10 µg/L (50 nmol/L), the source of exposure to mercury should be assessed and reduced. The US Environmental Protection Agency (US EPA)[27] set the reference dose (RfD) at 0.1 µg/kg daily, equivalent to a maternal blood mercury level of 5.8 µg/L (29 nmol/L).[17] Mergler and colleagues point out, however, that in the risk assessment upon which the US EPA's RfD is based, the US National Research Council used cord blood mercury measures and did not account for the bioconcentration of methylmercury across the placenta when determining a maternal reference blood mercury level.[16] Mahaffey and colleagues suggest, therefore, that maternal blood mercury levels exceeding the range of values from 3.5 µg/L (15 nmol/L) to 5.8 µg/L (29 nmol/L) should be the reference point for preventing fetal neurotoxicity.[28] A recent Motherisk systematic review of the literature identified 0.3 µg/g of hair mercury to be the lowest observable adverse effect level for adverse effects on child neurodevelopment resulting from fetal exposure.[29] Motherisk advises that hair analysis of high fish-consuming populations might be warranted before pregnancy, as dietary modifications can decrease body burden of mercury.[30]

Mercury in fish. Mercury in the environment can come from natural sources, but anthropogenic emissions have increased environmental mercury by a factor of 2 to 4.[31] Atmospheric mercury is converted by bacteria in lakes into organic methylmercury, which is taken up by microorganisms, such as plankton, in water. It is then biomagnified, being found at highest concentrations in longer-living and larger predatory fish species at the top of the aquatic food chain,[31] including tuna, shark, swordfish, marlin, orange roughy, and escolar.[32] Mercury levels also vary with the age and size of fish, the water body from which they originate, and even the season of capture. Species such as salmon, herring, sardines, Arctic char, Atlantic mackerel, and rainbow trout are lower in mercury and high in omega-3 fatty acids.[33]

Health Canada has set a regulatory limit, banning the sale of fish containing more than 0.5 ppm of total mercury, except for the predatory high-mercury fish listed above, for which a new limit of 1 ppm has recently been set.[32] In a survey of fish from retail outlets in Vancouver, BC, Toronto, Ont, and Halifax, NS, mercury was found in all samples; the highest concentrations were found in swordfish, followed by shark, fresh tuna, and marlin.[34]

Table 2. Tuna as a source of mercury

FOOD SOURCE	SPECIES	MERCURY CONTENT
Fresh or frozen tuna, including sushi tuna and tuna steaks	Larger species	Higher
Canned white tuna	Albacore species	Intermediate
Canned light tuna	Smaller species such as skipjack, yellowfin, and tongol	Lower

Tuna deserves special mention, as it is so widely available and it is an economical protein source (**Table 2**).

Exposure from eating fish: groups at higher risk. Average levels of mercury in the diet of a representative sample of Canadian adults and children were found to be low and below Health Canada guideline levels.[35] The dietary intake estimates, however, were based on data from a 1977 Nutrition Canada survey, and consumption practices have likely changed over the past 3 decades. Other Canadian studies have documented higher methylmercury exposure in subgroups with higher fish consumption, such as anglers fishing in the Great Lakes in Ontario (with levels higher in Asian Canadians than in Canadians of European descent),[36] Chinese-Canadian schoolchildren in Vancouver,[37] and residents of the Canadian Arctic, where 3% of Inuit maternal blood and 56% of umbilical cord blood samples contained methylmercury levels above the 5.8 µg/L (29 nmol/L) reference level.[38]

Preliminary data from the 2007 to 2008 Canadian Health Measures Survey[39] indicate that Canadian blood mercury levels might be slightly higher or about the same as those of the American general population. Data are not currently available for the upper percentiles, which would provide an estimate of blood mercury for those who consume large amounts of fish. Recent data from the US National Health and Nutrition Examination Survey[40] indicated that blood mercury levels and fish consumption were higher in women living within 40 to 80 km of the Great Lakes, Asian women, and higher-income women, with more than 3 million American women (4.7%) estimated to have blood mercury levels exceeding 5.8 µg/L (29 nmol/L).[28] The average mercury levels of adult women in New York City, NY, were more than 3 times those found in a national study. New Yorkers of Asian descent had higher blood mercury than did other racial or ethnic groups.[41]

Fish consumption advisories and advice. Fish consumption advice and advisories have been issued in many jurisdictions.[32,42-44] The fish consumption advice issued by Toronto Public Health[33] (summarized in a patient handout available from **CFPlus***) deserves highlighting for 2 reasons. First, the risk calculations are based on the US EPA RfD,[27] a more conservative measure than Health Canada's provisional tolerable daily intake.[26] We consider this caution appropriate in a country with diverse population groups, many of which consume large amounts of fish for cultural reasons.

Second, it identifies what fish species are the best choices and how often and in what quantity they can be eaten, rather than simply advising vulnerable groups to limit high-mercury fish. This is important, in light of research demonstrating that pregnant women might respond to fish advisories warning about the intake of high-mercury fish by reducing or eliminating fish intake.[45]

The Toronto Public Health resource[33] lists more than 80 species of fish commonly found in stores or fish markets in Canada and recommends eating a variety of fish. It also lists species caught or raised in environmentally unsustainable ways and provides a list of fish species that can be safely eaten every day, which is helpful for providing guidance to those subpopulations that consume large amounts of fish.

Environment Canada provides a listing of provincial and territorial advisories[46] for anglers who catch and eat their own freshwater sport fish. These fish could contain higher levels of mercury and other contaminants such as polychlorinated biphenyls.

Resources. The fish consumption resources detailed in the handout* give accessible advice on what fish can be eaten how often, the number of servings per week for each age group, and the species of fish to avoid or eat rarely. A summary in the form of a wallet card is also available from Toronto Public Health.[33] Referral to a registered dietitian is recommended if there are more detailed dietary issues. Families who catch and eat their own fish should be directed to sport fishing advisories.[46]

Case resolution

Women who eat fewer than 2 servings of fish a week, as recommended by Canada's Food Guide,[47] should be encouraged to eat at least 2 servings a week of high–omega-3, low-mercury fish. The woman in our case ate approximately 7 servings of fish a week. She was encouraged to continue to eat fish but counseled on shifting to a variety of high–omega-3, low-mercury fish (see patient handout*), bearing in mind the family's cultural dietary practices.

Should her blood mercury level be tested?

A blood mercury test is unnecessary in the clinical management of this case. The half-life of methylmercury in the blood averages approximately 70 days,[14] so even if her level is elevated, with dietary changes for approximately 3 months her blood level and risk would be expected to drop accordingly. There are no guidelines as to when to test or what is an "acceptable" blood mercury level. However, we suggest that 5.8 µg/L (29 nmol/L) be considered the level to guide discussions for counseling women in their reproductive years who consume large amounts of fish.

Conclusion

Although the ultimate "upstream" societal solution should be to reduce mercury discharges into the environment, family physicians can play an important

CFPlus GO

*A patient handout is available at **www.cfp.ca**. Go to the full text of the article online, then click on **CFPlus** in the menu at the top right of the page.

role in counseling women in their reproductive years about healthy choices for fish consumption, and they can provide appropriate resources. Because of the benefits associated with fish consumption, we need to support individual awareness and a behaviour shift such that benefits and risks are better balanced.

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Contributors

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Competing interests

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