

FISH CONSUMPTION TO PROMOTE GOOD HEALTH AND MINIMIZE CONTAMINANTS

A Quick Reference Guide for Clinicians®

PSR®

PHYSICIANS FOR SOCIAL RESPONSIBILITY™



Association of
Reproductive
Health
Professionals

Contents

Introduction	1
Scientific Evidence on Fish Contaminants	4
Translating the Evidence into Fish Consumption Guidelines	8
Summary of ARHP/PSR Fish Consumption Guidelines	12
Web-based Resources	14
References	15

CLINICAL ADVISORY COMMITTEE

Andrew Helfgott, MD

Director, Maternal Fetal Medicine
Sacred Heart Women's Hospital
Pensacola, FL

Lillie Rizack, CNM, MSN

Midwife, Chestnut Hill Hospital
Faculty, The Midwifery Institute of Philadelphia University
Philadelphia, PA

Anne Robin, MD

Clinical Assistant Professor, Family Medicine
University of Illinois at Urbana-Champaign
Champaign, IL

Katherine M. Shea, MD, MPH, chair

Consultant, Physicians for Social Responsibility
Adjunct Faculty, Duke University Medical Center
Chapel Hill, NC

William B. Weil, MD

Professor Emeritus, Department of Pediatrics and Human Development
Michigan State University, College of Human Medicine
East Lansing, MI

ARHP STAFF

Katherine Lacy, MA, RN
Writer/Consultant

Wayne C. Shields
President and CEO

Amy M. Swann
Director of Education

PSR STAFF

Karen Perry, MPA
Deputy Director
Environment and Health Program
Washington, DC

Maria Valenti
Program Director
Greater Boston PSR
Boston, MA

ACKNOWLEDGMENTS

This publication is based on guidelines originally developed by Jill Stein, MD, and Ted Schettler, MD, MPH, at Greater Boston Physicians for Social Responsibility, and David Wallinga, MD, MPA, in conjunction with the national office of Physicians for Social Responsibility.

This publication has been made possible by unrestricted educational grants from the Homeland Foundation, The John Merck Fund, and Clear the Air.

FISH CONSUMPTION TO PROMOTE GOOD HEALTH AND MINIMIZE CONTAMINANTS

A Quick Reference Guide for Clinicians

INTRODUCTION

The health benefits of fish and seafood have been well documented and widely promoted in recent years. Fish is low in saturated fat and is a healthy alternative to red meat. It provides the body with essential vitamins and minerals, including iron; zinc (from shellfish); vitamins A, B and D; and, of course, protein. Omega-3 fatty acids found in fish are also beneficial, particularly in terms of cardiovascular health. Preliminary evidence suggests that early exposure to omega-3 fats may enhance brain development as well.¹⁻⁷ At the same time, fish are also vulnerable to contamination by toxic industrial pollutants, such as mercury, as well as polychlorinated biphenyls (PCBs), dioxins, flame retardants, and other lipophilic chemicals. These pollutants accumulate in fish flesh (mercury) or fatty tissue (PCBs), exposing people who eat them.

Health care providers are confronted with the need to offer useful dietary guidance to patients in the presence of these conflicting facts about the risks and benefits of consuming fish and seafood. This *Quick Reference Guide*, developed jointly by the Association of Reproductive Health Professionals (ARHP) and Physicians for Social Responsibility (PSR), reviews the scientific evidence on toxic fish contaminants and offers guidelines to assist the clinician in communicating with patients about the risks and benefits of eating fish. The guidelines also provide concrete suggestions for day-to-day consumption of fish and other seafood. These guidelines take into account those recently issued jointly by the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA)⁸ on mercury levels in fish and shellfish. The ARHP/PSR guidelines also address the health risks posed by lipophilic contaminants, using PCBs as an example.

Developing fetuses are particularly vulnerable to common fish contaminants, and infants and children remain vulnerable due to rapid brain growth and development. The guidelines provided here are most important for pregnant and breastfeeding women and for young children. Because these pollutants build up in the body over time, a woman's dietary habits throughout her early life profoundly influence the exposures of her future children.⁹ A woman who is contemplating pregnancy in the future can lower her blood mercury level by careful eating for 6 to 12 months before becoming pregnant, but PCBs accumulate over time, and lifelong vigilance is required to minimize maternal body burden. All women of childbearing age—even adolescent girls—should follow the recommendations summarized on page 12 of this *Quick Reference Guide*. It is also important to acknowledge that, since there are as yet limited data on which to base recommendations, these guidelines should be viewed as provisional and subject to revision as more is learned or as effective measures are taken to eliminate toxic pollutants from our environment.

ARHP/PSR Guideline on Fish Consumption

How and Why the ARHP/PSR Guideline Differs from the March 2004 FDA/EPA Advisory

The March 2004 fish consumption advisory—issued jointly by the FDA and the EPA—recommends limiting consumption of fish and shellfish to 12 ounces per week to minimize exposure to mercury (<http://www.cfsan.fda.gov/~dms/admehg3.html>). For women of childbearing age and adolescent girls, the guidelines in this *Quick Reference Guide* call for a limit of no more than 6 ounces a week if the fish consumed contains “moderate” rather than “lower” mercury levels. (See the chart on page 6.)

ARHP and PSR believe that women who might become pregnant should strive to keep their blood mercury levels at or below 5.8 µg of methylmercury per liter of blood. This level correlates with intake at the EPA reference dose of 0.1 µg of methylmercury per kilogram of body weight per day. The National Research Council (NRC) has endorsed the EPA reference dose as appropriate to protect the developing fetus. Based on the best information available on mercury content in fish, it is estimated that as many as 6 to 7 percent of women following the advisory issued by FDA in March 2004 are likely to be exposed above this “safe” level. Recent analysis suggests this level may need revision due to evidence that cord blood mercury levels may be significantly higher than maternal blood levels.¹⁰

FDA officials have reasoned that the EPA/NRC reference dose for methylmercury should be viewed as a guideline rather than a so-called “bright line.” ARHP and PSR disagree. The 5.8-µg/L level intentionally incorporates a 10-fold uncertainty factor to account for biological variability and mercury database insufficiencies. Thus, as the most prudent approach to protecting the developing fetus, women of childbearing ages should be advised to consume fish in a manner and amount that will ensure that their exposure remains below this level.

Until there are larger and regularly updated surveys of mercury content in fish, and until more complete consumer information is provided to purchasers of both fresh and processed fish, it is important to be cautious and to limit consumption sufficiently to ensure that all women maintain safe levels.

ARHP and PSR also believe that the evidence for health risks from exposure to PCBs in fatty fish is sufficient to warrant a recommendation for limiting consumption of these fish to one or two times per month.

SCIENTIFIC EVIDENCE ON FISH CONTAMINANTS

Mercury and persistent organic pollutants (POPs) such as PCBs are common contaminants of freshwater as well as ocean fish. These pollutants have been released to the environment in large quantities by industrial activities, and fish from more than half of inland lakes and rivers in the United States contain detectable levels of these or other chemicals. Many are contaminated at or near levels of concern. These contaminants can travel beyond national borders, persist for long periods in the global environment, and accumulate to toxic levels in aquatic ecosystems and fish. Many are potent neurotoxicants, and the developing brains of fetuses, infants, and young children are most sensitive to the effects of exposure. When these pollutants are ingested, their concentrations also build up in the body over time. As a result, past as well as current dietary habits influence the body burden of these contaminants, particularly in the case of POPs.

Mercury. Mercury is a persistent heavy metal that occurs in elemental form as well as various organic and inorganic forms.¹¹ Most of the human-caused mercury pollution in our environment is emitted from industrial smokestacks.¹² The EPA has concluded that coal-fired power plants are the nation's largest source of unregulated mercury emissions attributable to human activity. Other major sources include mining, smelting, and waste incineration.¹³

Mercury that is released into the atmosphere from various industrial activities can be deposited onto soil or into waterways.¹⁴ Biological processes then convert it to organic forms, such as methylmercury, which bio-accumulates through the food chain. Consequently, mercury concentrations are highest in large, long-lived predatory fish. In 2002, mercury contamination led 45 states to issue more than 2,100 fish consumption advisories for rivers, lakes, and coastal areas.¹⁵ The chart on the page 6 shows the mean mercury levels measured in various species of fish and shellfish, as determined by the EPA and FDA from a variety of data sources.¹⁶ In the absence of a single "official" standard, ARHP and PSR selected the breakpoints

between lower, moderate, and highest mercury levels that are used to categorize the species in the chart.

Methylmercury readily crosses the placenta and enters the fetal brain, where it impairs normal development. Recent epidemiological studies suggest that prenatal exposure to even low levels of mercury may result in subtle deficiencies in motor skills, attention, language skills, learning capacity, and memory, as well as other symptoms of neurological damage in children.¹⁷⁻²⁰ These effects of prenatal exposure have been shown to persist into adolescence, suggesting that at least some neurotoxic effects of intrauterine exposure to methylmercury are irreversible.²¹ The NRC has estimated that neurobehavioral effects in the fetus could occur at methylmercury levels of as low as 58 parts per billion in cord blood. The NRC cautions that children of women who consume large amounts of fish and seafood during pregnancy are at particular risk. Mercury also passes through breast milk, which is an additional reason for breastfeeding mothers to minimize consumption.

Data from the 1999–2000 National Health and Nutrition Examination Survey (NHANES), reported in the Center for Disease Control and Prevention’s second National Exposure Report, indicated that measures of methylmercury exposure fell below “levels of concern” in all tested children between ages 1 and 5 and in most women of childbearing age. Eight percent of these women, however, had concentrations higher than the EPA recommended level of 5.8 µg/L.^{22,23}

Mercury Levels in Commercial Fish and Shellfish

Adapted from EPA/FDA, 2004:[http:// www.cfsan.fda.gov/~frf/sea-mehg.html](http://www.cfsan.fda.gov/~frf/sea-mehg.html)

SPECIES	MEAN MERCURY LEVEL (parts per million [ppm])
Lower Mean Mercury Levels (None detected [ND] to 0.29 ppm)	
Bass (saltwater; includes sea bass/striped bass/rockfish)	0.27
Catfish	0.05
Clams ^a	ND
Cod ^b	0.11
Crab (blue, king, and snow)	0.06
Crawfish	0.03
Flatfish (includes flounder and sole)	0.05
Haddock	0.03
Halibut	0.26
Herring ^c	0.04
Lobster (spiny)	0.09
Mackerel (Atlantic)	0.05
Mackerel chub (Pacific)	0.09
Mackerel, Spanish (South Atlantic)	0.18
Monkfish ^b	0.18
Oysters	ND
Perch (freshwater)	0.14
Pollock	0.06
Salmon (fresh/frozen) ^c	0.01
Sardines ^c	0.02
Scallops	0.05
Shad (American)	0.07
Shrimp	ND
Skate	0.14
Snapper ^b	0.19
Squid	0.07
Tilapia	0.01
Trout (freshwater)	0.03
Tuna (canned chunk light)	0.12
Weakfish (sea trout)	0.25
Moderate Mean Mercury Levels (0.3 to 0.59 ppm)	
Bluefish ^c	0.31
Grouper ^b	0.55
Lobster (Northern/American)	0.31
Mackerel, Spanish (Gulf of Mexico)	0.45
Marlin	0.49
Orange roughy ^b	0.54
Tuna (canned, white albacore)	0.35
Tuna (fresh/frozen)	0.38
Highest Mean Mercury Levels (≥ 0.6 ppm): Avoid Eating	
Mackerel-King (Atlantic & Gulf of Mexico)	0.73
Shark ^b	0.99
Swordfish ^b	0.97
Tilefish (Gulf of Mexico) ^b	1.45

a) FDA testing has been extremely limited (<10 samples tested) and may not reflect actual contamination levels. b) Some species have been overfished in recent years, and thus may not be good choices for those concerned about fisheries sustainability. Visit <http://www.mbayaq.org> for more information. c) These fatty fish may be low in mercury but high in PCBs or other persistent organic pollutants.

PCBs. PCBs are a large group of fat-soluble chemicals that were produced from the 1920s to the 1970s for use as lubricants and insulators in electrical equipment. Although production has now been banned in the United States, an estimated two-thirds of the total amount produced has not yet been released into the environment.²⁴ PCBs are highly toxic; they accumulate in fatty fish, such as salmon and bluefish, as well as beef and dairy products; and they can cause a number of different health effects, depending on the extent of exposure and individual sensitivity.^{25,26} They are representative of the lipophilic POPs that can produce negative health effects ranging from subtle biochemical and cellular changes to more serious long-term effects, such as cancer and delays in childhood development. Developing fetuses as well as infants and young children may be particularly vulnerable to the adverse effects of these chemicals, because their bodies are immature and rapidly growing.²⁷ Early life exposure to PCBs can cause harmful neurological effects, leading to learning deficits, poor memory, and behavioral problems.

In 2002, 38 states issued consumption advisories for PCBs in freshwater and coastal fish.²⁸ PCBs and related chemicals tend to accumulate and persist, especially in deep, coldwater bodies such as the Great Lakes and the northern oceans. Although wild salmon from Alaska and elsewhere is contaminated with PCBs, data recently published in *Science* indicate that farmed salmon contained significantly higher concentrations of these contaminants,²⁹ probably as a result of contaminants in fish feed.

TRANSLATING THE EVIDENCE INTO FISH CONSUMPTION GUIDELINES

Health care providers offering advice about eating fish should carefully consider the health impacts of fish contamination by mercury, PCBs, and other toxicants. A key challenge in formulating advice to patients is to strike an appropriate balance between reducing risks from fish contaminants and preserving the overall health benefits of eating fish. Though little comprehensive testing of fish for contaminants occurs in the United States, guidelines based on currently available information should inform decision making about what fish to eat, how much, and how often. In addition, because contaminant levels vary among bodies of water in different geographic areas, guidelines should be tailored to reflect state and regional advisories.³⁰

State and Regional Fish Consumption Advisories

U.S. states, territories, tribal organizations, and certain regional governmental authorities issue fish consumption advisories for their jurisdictions. A comprehensive listing can be found at:

<http://www.epa.gov/waterscience/fish/states.htm>

Representative examples include:

Illinois

<http://www.idph.state.il.us/envhealth/fishadv/fishadvisory04.htm>

Maine

<http://www.maine.gov/dhs/ehu/fish/2KFCA.shtml>

Michigan

http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Minnesota

<http://www.health.state.mn.us/divs/eh/fish/eating/safeeating.html>

North Carolina

<http://www.epi.state.nc.us/epi/fish/mercuryadvice.html>

Oregon

<http://www.ohd.hr.state.or.us/esc/fishadv.cfm>

Washington

http://www.doh.wa.gov/ehp/oehas/EHA_fish_adv.htm

The good news. Emphasis should be placed on the health benefits of fish consumption and the identification of those species thought to be relatively low in contaminants and therefore safe to eat.

For example, fish such as cod, haddock, and pollock are low in fat and mercury (averaging 0.1 parts per million [ppm]), and two servings (12 ounces) per week of these species can be safely consumed (assuming there is no other fish consumption and no advisories to restrict consumption of fish from local sources).

Consistent with the current EPA/FDA advisory, patients should also be advised to eat a wide variety of fish and that it is acceptable to make tradeoffs occasionally if the recommended consumption level is exceeded (e.g., when fish is served at a dinner party or is prominent on a restaurant menu in a vacation spot).

Minimizing mercury exposure. Women of childbearing age and children should avoid eating any swordfish, shark, king mackerel, and tilefish. These large species eat other fish and can accumulate mercury over their long lifetimes at levels approaching or exceeding 1 ppm, the EPA maximum recommended level.^{31,32} This level of contamination is sufficient to pose a risk to the developing brain of the fetus, infant, or child, even with infrequent fish consumption. All men and women, regardless of age, should limit their consumption of these fish, because their levels of mercury contamination can cause illnesses in adults.³³⁻³⁵

A total of only 6 ounces of fish should be consumed per week, if the fish consumed contains “moderate” levels of mercury. Many state and regional advisories also recommend against eating fish with mercury levels of 0.5 ppm or greater, such as grouper and orange roughy. Depending on the state, other species may also exceed this level. Women who are contemplating pregnancy at some point in the future should be counseled that avoiding consumption of mercury-containing fish for 6 to 12 months before becoming pregnant will lower the risk of fetal contamination from this particular food source to a negligible level.

Cooking Salmon and Other Fatty Fish

Encourage patients to prepare fatty fish such as salmon with cooking methods that minimize the risk from fat-soluble contaminants such as PCBs. (Note: This does not remove mercury, which is found in fish muscle rather than in fat.) The suggestions below are adapted from a guide for expectant mothers, published by the Illinois Department of Natural Resources.

- Trim away fatty areas such as the belly, top of the back, and dark meat along the side.
- Remove or puncture the skin before cooking to allow the fat to drain off.
- Broil, grill, roast, or steam the fish on a rack to allow fat to drain away.
- Do not fry large, fatty types of fish such as salmon and bluefish.
- Throw away fatty drippings; don't use them in other cooking.

PCBs and omega-3 fatty acids. Fatty fish such as salmon, herring, sardines, and bluefish contain elevated levels of beneficial fats (long-chain omega-3 fatty acids). The net benefit of eating fish species higher in omega-3 fats, however, may be compromised by toxic threats from PCBs and other lipophilic contaminants. The study of organic contaminants in salmon reported in *Science* in January 2004 concluded that, based on the presence of elevated PCB levels, no more than one meal of farmed salmon should be consumed per month.³⁶ Such reports set up competing concerns: losing the potential health benefits of omega-3 fats derived from fish or risking exposure to toxic pollutants. A strategy between these two extremes may be reasonable: Fatty fish consumption should be limited to one to two meals per month and the loss of marine omega-3 fats can be compensated for through basic lifestyle changes to help ensure cardiovascular health.

Strategies for Enhancing Cardiovascular Health

- *Change lifestyle*—Cardiac health can be enhanced by many dietary and lifestyle factors, including exercise, eating a diet low in saturated fat and cholesterol, preventing obesity, and refraining from cigarette smoking.³⁷⁻³⁹
- *Eat fish containing omega-3 fats, in accordance with ARHP/PSR guidelines for eating fatty fish*—See guidelines on page 12.
- *Increase consumption of plant-derived omega-3 fats*—Some evidence suggests that plant-derived omega-3 fats may also have cardiovascular benefits; plant sources include soy and canola oils, tofu, soybeans, walnuts, and flax seeds/oil.
- *Reduce overall consumption of other animal fats.*

What about children's consumption?

For everyone, it is best to eat a wide variety of fish and seafood in order to decrease the risk of over-exposure to either mercury or PCBs and related toxicants. This is particularly true for small children, who often tend to eat a limited diet with strong preferences for certain foods. To reduce the risk of high exposure to pollutants from over-consumption of any one fish, parents should be advised to teach children from an early age to enjoy a variety of low-mercury, low-PCB fish and shellfish. They should eat these fish or shellfish as often as is recommended for women of childbearing age, but serving sizes should be smaller and proportional to body weight, for example, one to two ounces for a toddler and two to three ounces for older and larger children.

Shrimp and canned tuna are the most commonly eaten seafood, and they tend to be popular with children. Recent surveys show that shrimp is unlikely to contain mercury but may contain some PCBs. Tuna does contain mercury, but levels in most cans of chunk light tuna tested by FDA in 2003 were low enough to be safe for children as part of a varied fish and shellfish diet. Fish sticks and fast-food fish sandwiches, also frequently eaten by children, are typically made from fish that are low in pollutants.

SUMMARY OF ARHP/PSR FISH CONSUMPTION GUIDELINES

Fish can be an important part of a healthy diet. Following the guidelines below will help ensure that you enjoy the health benefits of eating fish while minimizing any safety problems related to environmental contaminants in fish and shellfish.

For women of childbearing age and adolescent girls:

- **Eat up to 12 ounces per week (two servings) of fish low in mercury and low in fat.** Cod, haddock, pollock, shrimp, tilapia and chunk light canned tuna are among the low-fat, low-mercury choices.
- **Eat a variety of fish and seafood.**
- **Follow local, state, and federal fish advisories.**
- **Eat no more than 6 ounces of fish per week (one serving) if you eat canned albacore tuna or other fish that are moderately contaminated with mercury.** Examples: bluefish, grouper, orange roughy, marlin, and fresh tuna
- **Do not eat any fish high in mercury.** Examples: swordfish, shark, king mackerel, and tilefish
- **Eat fatty fish no more than one to two times per month.** Fatty fish, such as salmon, herring, and sardines, are low in mercury but may carry relatively high quantities of other contaminants. Use cooking methods that allow the fat to drain away.

For children under the age of 15:

- **Serve children a variety of fish and seafood that are low in mercury and other contaminants:** Cod, haddock, pollock, tilapia, chunk light tuna, and shrimp are among the low-fat, low-mercury choices. Fish sticks are usually made from fish that are low in pollutants.
- **Limit how *frequently* children eat fish and seafood in accordance with the guidelines for women of childbearing age.**
- **Limit the *amount* of each child's serving based on age and body weight.** For example, a toddler might eat a serving of 1 to 2 ounces, whereas an older and larger child may be served 2 to 3 ounces of low-mercury fish. Toddlers and small children should probably not be offered fish moderately contaminated with mercury, such as canned white albacore tuna, because—even at reduced serving sizes—they may get too much mercury for their weight.

WEB-BASED RESOURCES (Accessed May 26, 2004)

American Dietetics Association. Daily Nutrition Tips. Omega-3s can help prevent disease.

<http://www.eatright.com/erm/erm121202.html>

Agency for Toxic Substances and Disease Registry. *Toxicological Profiles*. Agency for Toxic Substances and Disease Registry, Atlanta, GA.

<http://www.atsdr.cdc.gov/toxpro2.html>

Association of Reproductive Health Professionals.

<http://www.arhp.org>

Centers for Disease Control and Prevention. *National Report on Human Exposure to Environmental Chemicals*.

<http://www.cdc.gov/exposurereport>

Environmental Defense. Sustainable Fishing and Seafood.

<http://www.environmentaldefense.org/tool.cfm?tool=seafood>

Environmental Protection Agency. Mercury website.

<http://www.epa.gov/mercury>

Environmental Protection Agency. Office of Water. Fish Advisories Website (includes updated listing of national fish and wildlife advisories).

<http://www.epa.gov/ost/fish>

Environmental Protection Agency. Persistent Bioaccumulative and Toxic (PBT) Chemical Program.

<http://www.epa.gov/opptintr/pbt/>

Environmental Protection Agency. Toxics Release Inventory (TRI) Program.

<http://www.epa.gov/tri/tridata/index.htm>

Environmental Working Group. Mercury in Seafood.

<http://www.ewg.org/issues/mercury/index.php>

Food and Drug Administration. What You Need to Know About Mercury in Fish and Shellfish.

<http://www.cfsan.fda.gov/~dms/admehg3.html>

Institute for Agriculture and Trade Policy. Online Smart Fish Calculator.

<http://www.iatp.org/foodandhealth/home.cfm>

Monterey Bay Aquarium. Seafood Watch.

<http://www.mbayaq.org/cr/seafoodwatch.asp>

Physicians for Social Responsibility.

<http://www.mercuryaction.org>, <http://www.envirohealthaction.org>

United Nations Environment Programme. Mercury Programme.

<http://www.chem.unep.ch/mercury>

REFERENCES

1. Makrides M, Neumann MA, Gibson RA. Is dietary docosahexaenoic acid essential for term infants? *Lipids* 1996;31:115–9.
2. Birch EE, Garfield S, Hoffman DR, Uauy R, Birch DG. A randomized controlled trial of early dietary supply of long-chain polyunsaturated fatty acids and mental development in term infants. *Dev Med Child Neurol* 2000;42:174–81.
3. O'Keefe JH, Jr., Harris WS. From Inuit to implementation: omega-3 fatty acids come of age. *Mayo Clin Proc* 2000;75:604–14.
4. Oomen CM, Feskens EJ, Rasanen L, et al. Fish consumption and coronary heart disease mortality in Finland, Italy, and the Netherlands. *Am J Epidemiol* 2000;151:999–1006.
5. Harris WS, Isley WL. Clinical trial evidence for the cardioprotective effects of omega-3 fatty acids. *Curr Atheroscler Rep* 2001;3:174–9.
6. Iso H, Rexrode KM, Stampfer MJ, et al. Intake of fish and omega-3 fatty acids and risk of stroke in women. *JAMA* 2001;285:304–12.
7. Hu FB, Bronner L, Willett WC, et al. Fish and omega-3 fatty acid intake and risk of coronary heart disease in women. *JAMA* 2002;287(14):1815–21.
8. Food and Drug Administration. What You Need to Know About Mercury in Fish and Shellfish. Available at: <http://www.cfsan.fda.gov/~dms/admeHg3.html>. Accessed May 26, 2004.
9. Chapter 29. In: Etzel RA, Balk SJ, (eds). *Pediatric Environmental Health*. 2nd ed. Elk Grove Village, IL: American Academy of Pediatrics, 2003:443–58.
10. Mahaffey KR, Clickner RP, Bodurow CC. Blood organic mercury and dietary mercury intake: national health and nutrition examination survey, 1999 and 2000. *Environ Health Perspect* 2004;112(5):562-70.
11. Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Mercury* 1999. Available at: <http://www.atsdr.cdc.gov/toxprofiles/tp46.html>. Accessed May 26, 2004.
12. United Nations Environment Programme. Global Mercury Assessment. Chapter 6 : Sources and cycling of mercury to the global environment. Available at : <http://www.chem.unep.ch/mercury/report/chapter6.htm>. Accessed May 26, 2004.
13. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Office of Research and Development. Mercury Study Report to Congress. Volume V: Health Effects of Mercury and Mercury Compounds. December 1997. Available at: <http://www.epa.gov/ttn/oarpg/t3/reports/merover.pdf>. Accessed May 26, 2004.

14. U.S. Environmental Protection Agency, Office of Environmental Information. Toxics Release Inventory (TRI) Public Data Release Report 2000. EPA-260-R-02-003. Available at: <http://www.epa.gov/tri/tridata/tri00/pdr/index.htm>. Accessed May 26, 2004.
15. Environmental Protection Agency. Available at <http://www.epa.gov/waterscience/fish/states.htm>. Accessed May 26, 2004.
16. Food and Drug Administration. *Mercury Levels in Commercial Fish and Shellfish*. Available at: <http://www.cfsan.fda.gov/~frf/sea-mehg.html>. Accessed May 26, 2004.
17. Grandjean P, Weihe P, White RF, et al. Cognitive deficits in 7-year-old children with prenatal exposure to methylmercury. *Neurotoxicol Teratol* 1997;19(6):417–28.
18. National Academy of Sciences, National Research Council. *Toxicological Effects of Methylmercury* 2000. Available at: <http://books.nap.edu/catalog/9899.html>. Accessed May 26, 2004.
19. Steuerwald U, Weihe P, Jorgensen PJ, et al. Maternal seafood diet, methylmercury exposure, and neonatal neurologic function. *J Pediatr* 2000;136(5):599–605.
20. Murata K, Weihe P, Budtz-Jorgensen E, Jorgensen PJ, Grandjean P. Delayed brainstem auditory evoked potential latencies in 14-year-old children exposed to methylmercury. *J Pediatr* 2004;144:177–83.
21. Murata K, et al. *J Pediatr* 2004;144:177–83.
22. Schober SE, Sinks TH, Jones RL, et al. Blood mercury levels in US children and women of childbearing age, 1999–2000. *JAMA* 2003;289(13):1667–74.
23. Mahaffey KR, Clickner RP, Bodurow CC. Blood organic mercury and dietary mercury intake: national health and nutrition examination survey, 1999 and 2000. *Environ Health Perspect* 2004;112(5):562–70.
24. DeVoogt P, Brinkman UAT. Production, properties and usage of polychlorinated biphenyls. In: Kimbrough RD, Jensen A (eds). *Halogenated Biphenyls, Terphenyls, Naphthalenes, Dibenzodioxins and Related Products*. 2nd ed. Amsterdam: Elsevier, 1989:3–46.
25. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorinated Dibenzo-p-dioxins (CDDs). 1998. Available at: <http://www.atsdr.cdc.gov/toxprofiles/tp104.html>. Accessed May 26, 2004.
26. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polychlorinated Biphenyls (PCBs). 2000. Available at: <http://www.atsdr.cdc.gov/toxprofiles/tp17.html>. Accessed May 26, 2004.

27. Environmental Protection Agency, Office of Research and Development. Draft Dioxin Reassessment 2001. Available at: <http://cfpub.epa.gov/ncea/cfm/dioxreass.cfm>. Accessed May 26, 2004.
28. Food and Drug Administration. <http://www.epa.gov/waterscience/fish/states.htm>. Accessed May 26, 2004.
29. Hites RA, Foran JA, Carpenter DO, Hamilton MC, Knuth BA, Schwager J. Global assessment of organic contaminants in farmed salmon. *Science* 2004;303:226–9.
30. Environmental Protection Agency. Fish Advisories. Available at: <http://www.epa.gov/ost/fish/>. Accessed May 26, 2004.
31. Environmental Protection Agency. Mercury Study Report to Congress Volume IV: An Assessment of Exposure to Mercury in the United States. 1997. Available at: <http://www.epa.gov/oar/mercury.html>. Accessed May 26, 2004.
32. National Academy of Sciences, National Research Council. Toxicological Effects of Methylmercury. 2000. Available at: <http://books.nap.edu/catalog/9899.html>. Accessed May 26, 2004.
33. Salonen JT, Seppanen K, Nyyssonen K, et al. Intake of mercury from fish, lipid peroxidation, and the risk of myocardial infarction and coronary, cardiovascular, and any death in Eastern Finnish men. *Circulation* 1995;91:645–55.
34. Guallar E, Sanz-Gallardo MI, van't Veer P, et al., for the Heavy Metals and Myocardial Infarction Study Group. Mercury, Fish Oils, and the Risk of Myocardial Infarction. *N Engl J Med* 2002;347:1747–54.
35. Hightower JM, Moore D. Mercury levels in high-end consumers of fish. *Envir Health Perspect* 2003;111(4):604–8.
36. Hites RA, Foran JA, Carpenter DO, Hamilton MC, Knuth BA, Schwager J. Global assessment of organic contaminants in farmed salmon. *Science* 2004;303:226–9.
37. Ascherio A, Rimm EB, Giovannucci EL, Spiegelman D, Stampfer MJ, Willett WC. Dietary fat and risk of coronary heart disease in men: cohort follow up study in the United States. *Br Med J* 1996;313:94–0.
38. de Lorgeril M, Renaud S, Mamelle N, et al. Mediterranean alpha-linolenic acid-rich diet in secondary prevention of coronary heart disease. *Lancet* 1994;343:1454–9.
39. Stone NJ. Fish consumption, fish oil, lipids, and coronary heart disease (Statement of the American Heart Association). *Circulation* 1996;94:2337–40.

Association of Reproductive Health Professionals (ARHP)

2401 Pennsylvania Avenue, NW, Suite 350
Washington, DC 20037
Telephone: (202) 466-3825
Fax: (202) 466-3826
E-Mail: arhp@arhp.org
Web: www.arhp.org

ARHP is a non-profit 501(c)(3) educational organization that has been educating front-line health care providers and their patients since 1963. The organization fosters research and advocacy to improve reproductive health.

Physicians for Social Responsibility (PSR)

1875 Connecticut Avenue, NW, Suite 1012
Washington, DC 20009
Telephone: (202) 667-4260
Fax: (202) 667-4201
E-mail: psrnatl@psr.org
Web: www.psr.org

Physicians for Social Responsibility is a leading public policy organization with 30,000 members representing the medical and public health professions and concerned citizens. PSR is committed to the elimination of nuclear and other weapons of mass destruction, the achievement of a sustainable environment, and the reduction of violence and its causes.

Additional copies of this guide may be ordered by calling (202) 466-3825 or visiting <http://www.arhp.org>. The guide may also be downloaded in PDF format at <http://www.arhp.org/guide/> or <http://www.mercuryaction.org>