Beneficial yet Risky

Evaluate Risks of Fish Diet of Mercury Exposure to Consumers in Sweden

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Abstract:

For a long time, fish is regarded as an important food source beneficial for human health. But there’s nowadays an increasing concern of fish consumption for increasing existence of mercury (Hg) and methylmercury (MeHg), which can be accumulated upon fish intake and pose health threats to human. It is suggested that children and pregnant women are more vulnerable to effects due to accumulation of Hg. There have been continuous efforts done by governments and researchers all over the world, e.g. publishing national and regional advisories on fish consumption, in order to inform public related risks aroused by excess fish consumption. Sweden, as one of the earliest countries abandons the use of Hg (Regeringskansliet, http://www.sweden.gov.se), has published a national advisory on fish consumption for pregnant and breastfeeding women (Swedish National Food Agency, SLV, http://www.slv.se/). Hg level in edible fish organs is also limited for safe consumption. In order to picture a better image of this, we investigated existed databases in Sweden on Hg levels in fish, fishery statistics, consumption data, and observed Hg level in human in recent decades for human exposure to Hg in Sweden. Though mercury emission decreased, the exposure to mercury via fish consumption is still high. We believe there’s a potential risk for Swedish inhabitants, especially pregnant women and women in breastfeeding, as well as young children. It is strongly recommended a safer limit of Hg in fish products for consumption in Sweden.

We hope for more synthesized knowledge of safe fish consumption that benefit for the public and promote regional/national policy in having an up-to-date fish consumption advisory in Sweden.

Keywords: methylmercury, fish consumption, environmental health
Table of Contents

1. Introduction ................................................................. 1
2. Background ................................................................. 2
   2.1. Fish for Human Health ............................................... 2
   2.2. Hg and its toxic effects. ............................................ 2
   2.3. Mercury is still a problem in Sweden. ............................ 3
3. Results. ........................................................................... 4
   3.1. Total Hg and MeHg in fish. ........................................... 4
   3.2. Fish consumption and exposure. ..................................... 6
4. Discussion. ................................................................. 8
   4.1. Mercury level in fish: still safe? ................................... 8
   4.2. Bioaccumulation: from fish to human hair and blood. .......... 9
   4.3. Exposure limits. ......................................................... 9
   4.4. How to balance benefits and risks? ................................. 12
5. Conclusions ................................................................. 13
6. Acknowledgement .......................................................... 14
7. References. ................................................................. 15
8. Appendix. ................................................................. 19
1. Introduction

The production and extensive usage of mercury (Hg) has lasted for a long time in human history, but the knowledge of its risk to human health is less known. Hg emitted from related industry production and waste incineration activities, are released to soil and water, leaching from landfills and by spreading sewage sludge (Hylander & Herbert 2008; Hylander 2011). Production and usage of mercury have ceased significantly during these years, but the deposition of Hg in the environment does not cease (Johansson et al., 2001; Bishop et al., 2009). Contamination of freshwater fish and seafish by Hg and its organic form, methylmercury (MeHg), is gaining increasing concerns as an environmental problem. Environmental air mercury deposition and levels of methylmercury in fish is well documented (Simon & Boudou, 2001; Chan et al., 2003; Yi et al., 2011). Fish from several Swedish lakes are found containing too high Hg levels to be suitable for fish consumption (Lindeström, 2001). We thus investigated data from the Swedish Environmental Research Institute (IVL) database for the information of total Hg and MeHg level in freshwater fish and seafish, We also looked into Swedish National Fishery Agency (Fiskeriverket, http://www.havochvatten.se/) and Statistics Sweden (SCB, http://www.scb.se/) for recent commercial fishing catch and recreational fishing data. A calculated MeHg exposure to Swedish population based on collected information was then compared to existed EU Tolerable (TDI) and US Reference Dose (RfD) on fish consumption. It is strongly suggested that more guidance to public awareness of fish consumption in via regional advisory or physicians to balance the risks and benefits of fish diet.
2. Background

2.1. Fish for human health

Keeping a habit of eating fish will do a lot of good to human health. As a quality food, fish had been long time regarded as important source of protein, long chain n-3 fatty acids, and many other beneficial minerals for human health. Mozaffarian & Rimm (2006) illustrated the scientific base fish consumption benefits by showing a modest consumption of fish (e.g. 1-2 fish meals/week), especially species higher in the n-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Fish has traditionally been an important part of the diet in Sweden due to the geographical advantage of long coastline and many lakes and rivers (von Rein & Hylander, 2000). Inlagd sill (pickled herring), fiskbullar (fishballs), kräftskiva (crayfish party) and surströmming (fermented Baltic fish) from typical Swedish menu perfectly outlined Swedes’ passion for fish products. Not only the pleasure of cuisine with fish or cooking, the recreational fishing and angling mean a lot for local culture and family activities as well. Many Swedes, including native Saami people in the northern part of Sweden, still enjoy summer fishing in the lakes in the forests or mountains. These activities are integrated parts of Swedes’ lives and become one of the special features of Swedish life.

2.2. Hg and its toxic effects

Mercury (Hg) as a ubiquitous environmental toxin can cause great numbers of adverse health effects in living organisms. Mercury exists in elemental, inorganic, or organic forms, and each has its own profile of toxicity. Methylmercury (MeHg) is the most toxic form of mercury to human.

Human exposure to MeHg occurs primarily through the diet, with fish and fish products as the dominant source (EPA, 1999). The tragedy in Minamata Bay, Japan, during 1950s and 1960s was well documented and keeps reminding us the disastrous consequences of mercury toxicity in human. The risk is determined by the likelihood of exposure, the form of mercury present (some forms are more toxic than others), and the geochemical and ecological factors that influence how mercury moves and changes form in the environment (Schroeder et al., 1998; Lu et al., 2001; Selin, 2009).
According to EPA (1997a), toxic effects of mercury vary depending on its chemical form and the route of exposure: MeHg is particularly damaging to developing embryos, which are five to ten times more sensitive than adults, it affects the immune system, alters genetic and enzyme systems, and damages the nervous system, including coordination and the senses of touch, taste, and sight; Elemental mercury (Hg⁰) is less toxic than MeHg, once ingested, it is absorbed relatively slowly and may pass through the digestive system without causing damage.

2.3. Mercury is still a problem in Sweden

Hg concentration in Swedish forests’ soil top layer still increases due to long range and historical Hg deposition (Johansson et al., 2001), though efforts have been done in restricting the emission. This deposition may be due to long-range air transport of atmospheric mercury from the rest of Europe and other parts of the world (KEMI, 2011). On the other hand, Johansson et al. (2001) reported observed reductions in deposition, and during the 1990’s a general decrease of about 20% has been observed in mercury concentrations in fish in Sweden. Nevertheless, Åkerblom et al. (2008, 2012) specified a significant temporal change of increased mercury level in pike muscle from 1994–1998 to 2001–2005. The increase of total organic carbon (TOC) in lake water during the decades may have contributed to the significantly elevated fish mercury. Anthropogenic impacts, e.g. clear-cutting of forests, or natural events like flooding and draughts, could have resulted in the fluctuation of fish mercury over the year (Bishop et al., 2009).

Today, because of high mercury contents in the fish, detailed recommendations for the consumption are given. Sweden adopts EU commission’s recommendation that a general limit of mercury in fishery products as 0.5 mg/kg, with the exception of certain listed fish species applies 1.0 mg/kg (HEAL, 2006; EC, 2004 and 2008a). Stricter limits are applied to fish supplements, as low as 0.1 mg/kg (EC 2008a). Another limit, 0.02 mg/kg of mercury, is set for achieving better surface water status to protect ecological values (EC, 2008b). SLV (2012) recommends women who are planning to become pregnant, during pregnancy, or in breast-feeding, to eat limited amount of fish (2-3 times per week of normal fish; certain fish species--Atlantic halibut, burbot, perch, pike, pikeperch, ray, shark, swordfish, fresh/frozen tuna, are suggested to eat 2-3 times per year, and avoid taking some species at all) in order to avoid effects to fetus and newborn children.
3. Results

3.1. Total Hg and MeHg in fish

We investigated data from The Swedish Environmental Research Institute (IVL) database that integrates related researches from 1967 to 2011 with mercury levels detected in fish from Swedish environment. Data files containing mercury levels in fish sampled from 2142 lakes, 42 sea sites, and 61 river sites. Mean values of mercury level over the year are shown (Figure 1). MeHg in lake fishes kept at an alarming level, sometimes intriguingly higher than total Hg levels, but no continuous record in the database after 1991. Mean values of total Hg of several fish species in recent years are also of our concern that exceeded 0.5 mg/kg ww (Figure 2). Seafishes have relatively low total Hg level changes over time, usually below 0.5 mg/kg (Table 1 and Figure 2).

Table 1. Mean values of data from IVL database in Sweden from 1967 to 2011. T-Hg: Total Hg level. Unit: mg/kg ww. Concentrations marked in red font indicate if they are over the general limit of 0.5 mg/kg. English names of fishes can be referred from Appendix. “-”: missing data

<table>
<thead>
<tr>
<th>Species</th>
<th>Counts (n=) (Hg/MeHg)</th>
<th>Length (cm)</th>
<th>Weight (g)</th>
<th>T-Hg (mg/kg)</th>
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</thead>
<tbody>
<tr>
<td><strong>Lakes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbore</td>
<td>8944/197</td>
<td>14.30</td>
<td>66.33</td>
<td>0.25</td>
</tr>
<tr>
<td>Gädda</td>
<td>24153/3310</td>
<td>57.11</td>
<td>1015.78</td>
<td>0.74</td>
</tr>
<tr>
<td>Mört</td>
<td>162/4</td>
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<td>94.95</td>
<td>0.29</td>
</tr>
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<td>Öring</td>
<td>22/-</td>
<td>72.64</td>
<td>4211.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Röding</td>
<td>513/34</td>
<td>29.24</td>
<td>316.05</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>River</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbore</td>
<td>109/21</td>
<td>23.07</td>
<td>257.58</td>
<td>0.53</td>
</tr>
<tr>
<td>Gädda</td>
<td>612/176</td>
<td>48.61</td>
<td>1241.10</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>Sea</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abbore</td>
<td>475/-</td>
<td>18.11</td>
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<td>Sill/strömmning</td>
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<td>18.27</td>
<td>43.20</td>
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<tr>
<td>Scrubbskädd</td>
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<td>346/-</td>
<td>21.57</td>
<td>38.96</td>
<td>0.07</td>
</tr>
<tr>
<td>Torsk</td>
<td>977/-</td>
<td>33.03</td>
<td>384.79</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Figure 1. a) Total Hg levels in fish muscle of fishes in lakes of Sweden over time from 1967 to 2011. b) MeHg levels in fish muscle of fishes in lakes of Sweden over time from 1967 to 1991. c) Total Hg and MeHg levels in fish muscle of fishes in rivers of Sweden over time from 1967 to 2011. Unit: mg/kg wet weight (ww)
Figure 2. a) Total Hg level in fish muscle of different species in lakes of Sweden. b) Total Hg level in fish muscle of different seafishes in Sweden. Data collected from IVL database from 2006 onwards. English names of fishes can be referred from Appendix

3.2. Fish consumption and mercury exposure

Commercial and recreational fishing data in Sweden from Fiskeriverket & SCB (2008) was collected. Statistics concerning fish products from other countries were not included, although it was acknowledged that Sweden periodically import large amounts of fresh fishes and other fish products from neighboring countries, e.g. Norway. According to FAO (2010), around 80% of the world fish production allocated to human consumption. People in recreational fishing usually throw some of the caught fish back to the water, and the kept part used for food is approximately 60% by total catch (Fiskeriverket & SCB, 2008). We calculated the MeHg exposure via fish consumption (Table 2) based on data obtained from IVL and statements from European Commission (EC, 2008c) that “Methylmercury… can make up more than 90% of the total mercury in fish and seafood”.

The actual exposure can be higher than the calculated range given in Table 1. We selected only several major fish species with a total commercial capture of 116,979 tonnes, recreational catch of 10,614 tonnes, in 2006, which was less than half of the annual capture of 292,134 tonnes in the same year. Recreational fishing caught
approximately 18,100 tonnes, in which about 50% from inland waters. Recreational fishing exposure was calculated based on the survey results that a total of 1.0 million Swedes went fishing in 2006 (Fiskeriverket, 2009). Population of Sweden in 2006 obtained from SCB (2012) is 9,113,257 and it is used to calculate exposure to MeHg via commercial fishing.

Table 2. Fish catch and the least MeHg exposure via fish consumption based on commercial fishing and recreational fishing data in 2006 from Fiskeriverket & SCB (2008). Commercial fishing (CF), Recreational fishing (RF). English names of fishes can be referred from Appendix. Total consumption calculated irrespectively of fish species.

<table>
<thead>
<tr>
<th></th>
<th>Fishing catches (Live weight in tonnes)</th>
<th>Total Hg level in 2006</th>
<th>Exposure to MeHg (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial fishing(CF)</td>
<td>Recreational fishing(RF)</td>
<td>(mg/kg)/no. of sampling</td>
</tr>
<tr>
<td>Abborre</td>
<td>230</td>
<td>3084</td>
<td>0.18 (n=710)</td>
</tr>
<tr>
<td>Gädda</td>
<td>168</td>
<td>3524</td>
<td>0.62 (n=248)</td>
</tr>
<tr>
<td>Mörte</td>
<td>3</td>
<td>938</td>
<td>0.14 (n=16)</td>
</tr>
<tr>
<td>Röding</td>
<td>9</td>
<td>395</td>
<td>0.08 (n=9)</td>
</tr>
<tr>
<td>Sill/Strömming</td>
<td>103323</td>
<td>1779</td>
<td>0.04 (n=84)</td>
</tr>
<tr>
<td>Torsk</td>
<td>13246</td>
<td>894</td>
<td>0.06 (n=20)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposure to MeHg via fish</th>
<th>Total (g)</th>
<th>Per capita (mg/year)</th>
<th>Per capita (µg/week)</th>
<th>Per capita (µg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>105.62/1567.58/1673.20</td>
<td>0.01/1.67/0.17</td>
<td>0.22/32.18/3.31</td>
<td>0.03/4.58/0.47</td>
</tr>
<tr>
<td></td>
<td>3547.93/67.39/3615.32</td>
<td>0.39/0.07/0.40</td>
<td>7.49/1.30/7.63</td>
<td>1.07/0.18/1.09</td>
</tr>
</tbody>
</table>
4. Discussion

4.1. Mercury level in fish: still safe?

Figure 3. Total Hg (mg/kg ww) in 1-kg pike (taken from Munthe et al., 2004).

Munthe et al. (2004) did a data investigation of Hg level in fish in Sweden. It is shown in Figure 3 that the total Hg level in 1-kg pike exceeds the EU limit of 0.5 mg/kg in almost half of Sweden’s inland water, which covers central Sweden, as well as coastal area adjacent to Kattegat, Baltic Sea, and Gulf of Bothnia. This may be due to the historic background of mercury content in freshwater or atmospheric deposition from foreign countries (Lindqvist et al., 1991).

Another effort made in investigating data of fish mercury (from 1967 to 2004) was calculating the mercury level for a "standard fish" (1-kg pike, 0.3-kg perch, 3.2-kg trout or 1.4-kg char, for they have similar mercury level in this form of weight standardization), the median Hg concentration in Swedish freshwater fish was 0.71 mg/kg (Munthe et al., 2007). This value exceeded the EU limit of 0.5 mg/kg by 42%, of the highest among Nordic countries. We followed the same methodology to look into IVL database (from 1967 to 2011) for mercury level of 1-kg pike (Wet weight range 0.75~1.25 kg). A median Hg concentration of 0.68 mg/kg was obtained. It is slightly lower than 7 years ago, but still 36% higher than EU limit of 0.5 mg/kg.

For Sweden, there will be a lot to be done to achieve the goal set by EU Under the Priority Substances Directive (EC, 2008b), which set the limit for good chemical
status of surface water be as low as 0.02 mg/kg of mercury and its compounds per kilogram wet weight in fish or other aquatic biota, to protect aquatic environment in accordance with Water Framework Directive (EC, 2000).

4.2. Bioaccumulation: from fish to human hair and blood

Human hair and blood mercury concentrations were reported to be directly related to the amount of fish consumed (Mahaffey et al., 2004). Not only this, hair mercury is also significantly correlated to blood mercury (Ask et al., 2002). Thus Total Hg in hair has been used as an indicator to monitor mercury exposure (Björnberg et al., 2003; Johnsson et al., 2004). Institute of Environmental Medicine, IMM, of Karolinska Institutet, has been monitoring national and regional data of mercury in human hair (IMM, 2012) and blood (Sundkvist et al., 2011) for long term analysis as well. Although Swedish pregnant women have increased their fish consumption in last decade, there is no clear trend of their hair mercury increase coherently (Figure 4). We assume consumers’ might have increased intake of seafish with lower Hg level, partly due to easy access to these products for inland habitants. A monitoring project leaded by Barregård & Sällsten (2006) in West Götland region confirmed that urine mercury level has decreased in the last decade, mainly due to the decrease usage of mercury in dental amalgam.

Figure 4. Plotted data with regression lines of median total mercury level in hair of Swedish first time mothers from 1996 to 2010 and their median fish consumption frequency per month. Data from IMM 2012.

4.3. Exposure limits

US EPA initiated RfD of MeHg for least deleterious effect in human calculated from the Benchmark Dose Limit (BMDL) (US EPA, 1997b). The BMDL is
the 95% lower confidence limit on the maternal hair concentration corresponding to a 10% extra risk level (Shipp et al., 2000). The daily intake of MeHg is calculated to be 1.1 μg/kg bw and with an uncertainty factor of at least 10 for conversion, a daily RfD for methylmercury, 0.1 μg/kg bw, was calculated (Hansen & Gilman, 2005).

European Food Safety Authority (EFSA) in 2004 accepted both guidelines of the US EPA RfD and the JECFA Provisional Tolerable Weekly Intake (PTWI) from WHO of 1.6 μg/kg bw (corresponding to a daily intake of 0.23 μg/kg bw) (JECFA, 2004).

The exposure range calculated in Table 2 seems to be pretty safe: Per capita exposed to lowest freshwater fish mercury at 0.03 μg or seafish mercury at 1.07 μg per day from commercial fishing. If we compare it with EU TDI of methylmercury, 0.23 μg/kg bw/day, e.g. for a female Swede with an average weight 64.7 kg, she is expected to take MeHg no more than 14.88 μg/day for health concern, and 18.54 μg/day for a male Swede weighted at average level of 80.6 kg (Nordstjernan, 2012). Thus the average exposure from fish is too little to be noticed per capita from commercial fishing. It is even lower than US RfD, 0.1 μg/kg bw/day. Nevertheless, it should not be neglected that recreational fishing people are under high MeHg exposure from Table 2, with several folds higher exposure amount than average level. Considering people who caught fish for themselves would have shared them with other family members, the actual exposure amount can be lower. Based on average number of residents per Swedish household, 1.99 (SCB 2012), with recreational fishing of freshwater fish MeHg per capita exposure 4.58 μg/day, we thus calculated the exposure per capita in a typical Swedish household is 2.29 μg/day. When considering fish diet for mothers with fetus or breastfeeding, and young children, this is quite risky (e.g. for fetus and young children with body weight less than 5 kg, the safe MeHg intake should be very low). It is also noticed that although people caught much more pike and perch during their recreational fishing, seafish are largely consumed in commercial fishing part (Table 2). This means people have higher chances becoming exposed to MeHg via seafish if they are used to seafood diet.

Sweden is one of the countries that consume the highest amounts of fish per capita on an annually basis in the world, 20~30 kg/year (FAO, 2010). On the other hand, it was addressed that capita consumption of fish and related products in Sweden in 2008 was 21.28 kg (Food For Thought, 2009), which corresponds to 196,975 tonnes per year (Population of Sweden in 2008 is 9,256,347 according to SCB 2012). If we apply 0.5 mg/kg the current EU limit of mercury content in fish products, a
minimum exposure of 21.86 μg per day to MeHg may be allocated per capita. That is an enormous high level of MeHg exposure even for a bulky adult if he consumes mainly the freshwater fish of high MeHg content, although the real condition can have great variation in consumption categories. Or if we can use the Standard portion size per fish meal, typically 125 g/portion, to calculate the daily intake of fish. General fish dietary recommendation is 3 fish meals/week, where one of one meal of oily fish. It is based on previous dietary surveys, one of which was carried out by the Swedish NFA (Glynn et al., 2006; Ström et al., 2011). In order to qualify for the weekly MeHg dose, 1.6 μg/kg bw, from fish diet, the MeHg level in fish muscle has to be lowered down to 0.256 mg/kg ww for a 60 kg adult, and even lower for pregnant women or children.

Exposure to MeHg via freshwater fish varies greatly comparing to seafish (Table 2), due to the different capture of pike and perch in commercial fishing and recreational one. Fiskeriverket & SCB (2008) summarized that for about 1 million people who chose recreational fishing in 2006, 50% of their total catch is from inland waters, in which 80% are pike and perch and weight up to 10 kg. Considering higher observed mercury level in pike and perch from freshwater (Table 1), it is concerned for people who fish for themselves by inland waters might get accumulated MeHg in a short period of time.

Vegetarians in Sweden might have affected fish consumption as well, in which case their “quota” is allocated to other people that makes the distribution uneven. Considering people have different habits of eating fish, we have reasons to believe that some families may have fish meals more frequently than others, indicating those groups of people are under higher amount of exposure. During the summers (July and August), some Swedes, e.g. Saami people in the north (Beach H, personal interview) or families on a vacation, have a habit of going fishing in the mountains or by the sea for personal or family food consumption (Fiskeriverket, 2009). In Arctic region, where ecosystems are easily influenced by severe climate change, Hg from atmosphere transportation incorporates local food chain easily via rain and snow precipitation (Lu et al., 2001), related to detected high MeHg level in local habitants in Greenland (Johansen et al., 2007). So we assume that exposure amount in certain periods of the year in some regions may exceed the tolerable dose.
4.4. How to balance benefits and risks?

Still food fish is a great importance for our health. Petersson-Grawè et al. (2007) stressed the role of seafood consumption as it contributes to 80% of the total long chain 3 polyunsaturated fatty acids (LC n-3 PUFA) intake, thus a daily intake of 4 mg/kg bw is considered to be sufficient (Extension needed). Regular fish consumption with adequate amount is able to achieve a reduced risk of coronary death by 36% less and total mortality decreased by 17%, and other clinical effects may also be favorably affected (Mozaffarian & Rimm, 2006; Kris-Etherton et al., 2002). A suggested intake for EPA and DHA for sufficient EPA and DHA is 250 mg/day for primary prevention from the American Heart Association. DHA appears beneficial for, nevertheless, low-level methylmercury, may adversely affect, early neurodevelopment (Egeland et al., 1997; Becker et al., 2007).

Countries in the Arctic receive MeHg exposure mainly through the consumption of fish and meat (muscle and organs) from marine mammals (Griesbauer, 2007; Hansen & Gilman, 2005). US and Canada give special attention to these seafood consumption. Except using the RfD as the guidance for safe fish consumption, US EPA & FDA (2004) have also issued advice for women who might become pregnant, who are pregnant, nursing mothers and young children. They are advised not to eat shark, swordfish, king mackerel or tilefish. The amount of fish meal for intake is suggested to be up to two average meals (12 oz) per week of species known to be lower in mercury. Special cases given to some fishes that only one meal (6 oz) is advised, e.g. albacore “white” tuna. There is information for physicians conducted by academia scientists for the purpose of letting public better aware of the problem about overexposure to MeHg (Silbernagel et al., 2011). Health Canada (2002) advises the general population a maximum weekly intake of 150 g for following fishes: fresh/frozen tuna, shark, swordfish, marlin, orange roughly, and escolar. This amount applies to women who are pregnant, may become pregnant or are breastfeeding but only as a monthly intake. They also advice an intake of 125 g of these fish per month for children aged 5-10 years, and 75 g per month for children aged 1-4 years. However, they are encouraged to eat other fish, e.g. canned light tuna, which are low in mercury, to compensate the LC n-3 PUFA intake for health benefit.

In Sweden, advisory of risky fishes contain also freshwater fish, e.g. perch and pike. Women who are considering having children, during pregnancy, or in breast-breeding period, are suggested to have fish meals 2-3 times per week for “safe” fishes.
listed by SLV, while limiting intake of selected “risky” species that may contain mercury, dioxins and PCB at 2-3 times per year (SLV, 2012). Kris-Etherton et al. (2002) suggested for Swedish consumers, especially specified women (pregnant women and breastfeeding mothers), to consume certain variety of seafood, but to decrease fish consumption for certain species highest in mercury levels and a moderate intake frequency of 3 fish meals/week.

5. Conclusions

Unlike Arctic countries in generally having seafood high in mercury, Swedes are facing risks of MeHg exposure from freshwater fish as well. Risky exposure quantity of mercury have been focused and monitored for long, and studies on negative impact of mercury pollution in the society and economy, e.g. loss of IQ because of brain impairment caused by MeHg toxicity (Pacyna et al., 2008). Fish mercury over the decades has changed greatly, which could possibly result in human for certain consequences as methylmercury bioaccumulates along trophic cascades. Monitoring of fish mercury as well as mercury level in human thus offers a great variety of information for further studies, which require continuous and rigorous work. Regional advisories can be further developed regarding more stringent mercury limit for areas with higher mercury background. National advisories should be addressed with an approximate amount of consumption per meal for better guidance in the public. It is also encouraged that physicians and pediatricians get related information to their patients directly. If more guidance can be developed based on current advisory for young children with age specifications, they can be better protected from possible neurodevelopment disorders.
6. Acknowledgement

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Cover image was retrieved from following webpage, http://media.onsugar.com/files/2010/02/05/2/192/1922729/094be07116014917_fish.j pg, on 29 March 2012.
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# 8. Appendix.

List of fish species names in Swedish, English and Latin

<table>
<thead>
<tr>
<th>Swedish</th>
<th>English</th>
<th>Latin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abborre</td>
<td>Perch</td>
<td><em>Perca fluviatilis</em></td>
</tr>
<tr>
<td>Flodkräf hybrids</td>
<td>European Crayfish</td>
<td><em>Astacus astacus</em></td>
</tr>
<tr>
<td>Gädda</td>
<td>Pike</td>
<td><em>Esox lucius</em></td>
</tr>
<tr>
<td>Gös</td>
<td>Pike-Perch</td>
<td><em>Sander lucioperca</em></td>
</tr>
<tr>
<td>Lake</td>
<td>Burbot</td>
<td><em>Lota lota</em></td>
</tr>
<tr>
<td>Mört</td>
<td>Roach</td>
<td><em>Rutilus rutillus</em></td>
</tr>
<tr>
<td>Öring</td>
<td>Trout</td>
<td><em>Salmor trutta</em></td>
</tr>
<tr>
<td>Röding</td>
<td>Char</td>
<td><em>Salvenius alpinus</em></td>
</tr>
<tr>
<td>Sandskädda</td>
<td>Common Dab</td>
<td><em>Limanda limanda</em></td>
</tr>
<tr>
<td>Signalkräf hybrids</td>
<td>Signal Crayfish</td>
<td><em>Pacifastacus leniusculus</em></td>
</tr>
<tr>
<td>Släkta</td>
<td>Vendance</td>
<td><em>Coregonus albula</em></td>
</tr>
<tr>
<td>Sill/strömmming</td>
<td>Herring</td>
<td><em>Clupea harengus</em></td>
</tr>
<tr>
<td>Skrubbskädda</td>
<td>European Flounder</td>
<td><em>Platichthys flesus</em></td>
</tr>
<tr>
<td>Tånglake</td>
<td>Viviparous Eelpout</td>
<td><em>Zoarces viviparatus</em></td>
</tr>
<tr>
<td>Torsk</td>
<td>Atlantic Cod</td>
<td><em>Gadus morhua</em></td>
</tr>
</tbody>
</table>