Assessment of fish species and dosage of fish-fatty-acid supplements for pregnant women

No. 2021/26-A6e, The Hague, June 22, 2021

Background document to:
Dietary recommendations for pregnant women
No. 2021/26, The Hague, June 22, 2021

Health Council of the Netherlands

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evaluating fish species for pregnant women

The committee recommends that pregnant women eat two servings of fish a week, including one serving of fatty fish and one serving of lean fish. It is particularly important to pay attention to which species of fish one eats, as some contain more harmful substances than others. The relevant substances are methylmercury, dioxins, and PFAS. In this section, the committee outlines how it evaluated fish species based on the levels of these contaminants.

1.1 The approach

The committee evaluated fish species based on the measured levels of methylmercury, dioxins, and PFAS and the Tolerable Weekly Intakes (TWI) of these substances. The TWI of a harmful substance is based on the so-called “critical effect”: i.e. the first adverse effect of the substance that occurs with increasing exposure. At all levels above the TWI, there is an increased risk of the critical effect occurring. The risk of the occurence of the critical effect or any other adverse effect of the substance, increases as exposure levels that exceed the TWI increase further.

The committee recommends that pregnant women eat two servings of fish a week, including one serving of fatty fish and one serving of lean fish. Therefore, the evaluation of fish species was based on the consumption of two servings per week. However, higher levels of dioxins occur mainly in fatty fish, and the committee recommends eating only one serving of fatty fish per week. Therefore, the evaluation of dioxin levels was based on a consumption of two servings per week, as well as a consumption of one serving per week.

For methylmercury, the committee evaluated the exposure from fish based on both the average and the highest levels reported, whereas the evaluations for dioxins and PFAS were only based on the average levels reported. This was done for the following reasons:

- The critical effect of methylmercury consists of an adverse effect on the development of the nervous system in offspring. As such, the critical effect of methylmercury emerges during pregnancy. Pregnancy is the relevant period of exposure for this critical effect.[1]
- The critical effect of dioxins consists of an adverse effect on the sperm quality of boys and men, and the critical effect of dioxins therefore emerges after pregnancy. As such, child exposure prior to and after birth are both relevant for this effect. The child’s exposure to dioxins as a foetus (via their mother) and their exposure after birth (via food) are both relevant, as the breakdown and excretion of dioxins in the body are very limited. Foetal exposure via the mother depends on the mother’s exposure during and prior to pregnancy because dioxins accumulate in the body’s fatty tissue.[2]
- The critical effect of PFAS consists of an adverse effect on the immune system. For PFAS - as with dioxins - the critical effect does not emerge specifically during pregnancy, which is why the child’s

exposure before and after birth is relevant.[3]
- Fish is by far the most important dietary source of methylmercury. Dioxins are found in all animal products and, to a lesser extent, in vegetable oils. PFAS-compounds are also found in various foods. The levels of methylmercury, dioxins, and PFAS vary substantially between species of fish and shellfish.

Several assumptions had to be made to properly carry out the risk assessment:
- The TWIs of methylmercury, dioxins, and PFAS are expressed per kilogram of body weight per week.[2] For the purposes of this risk assessment, the committee has converted these TWIs into ceiling limits per person per week. In doing so, the committee adopted the reference weights used for the dietary reference values for protein for women of childbearing age. These reference weights are based on the average measured height of the demographic concerned and a BMI of 22 kg/m^2, which constitutes a healthy, average BMI: 64.6 kg for women aged 18-29 years and 63.0 kg for women aged 30-39 years.[4] The committee used the rounded average of these two reference weights for this risk assessment, i.e. a body weight of 64 kilograms. A significant proportion of women will be heavier, which means those women can have a slightly higher intake of harmful substances without exceeding the limit. However, setting the reference weight at 64 kilograms necessarily increases the risk run by lighter women and their offspring, and this demographic would only increase in size if the committee were to set a higher reference weight. As such, the committee has opted against the use of a higher reference weight.
- The committee based its risk assessment on serving sizes of 100 grams.

1.2 Experts consulted

For the purpose of assessing the fish species, committee chairman van Goudoever, committee member Rietjens and the committee secretaries consulted various experts who were not on the committee: L.A.P. Hoogenboom of the Wageningen Food Safety Research Institute; P.E. Boon and G. van Donkersgoed of the National Institute for Public Health and the Environment (RIVM); J.J.M. Castenmiller of the Netherlands Food and Consumer Product Safety Authority (NVWA), and S.E. van der Krieken and W.P. van der Vossen-Wijmenga of the Netherlands Nutrition Centre

1.3 Evaluation based on methylmercury levels

Ceiling limit for the weekly intake

EFSA has set the TWI for methylmercury at 1.3 micrograms per kilogram of body weight per week.[1] As reported in section 1.1, this TWI is based on an adverse effect on the development of the nervous system in offspring, thus, the critical effect emerges during pregnancy. EFSA does not outline why it opted to define the intake limit in terms of micrograms per *week* rather than micrograms per day, for instance, but does report that the

half-life of methylmercury is estimated to be around 50 days.[1] Based on this information, the committee infers that average exposure over an extended period of time is the key metric for this risk. Furthermore, fish is by far the most important dietary source of methylmercury, and people typically do not eat fish more than once or at most a few times a week. For this reason, too, a weekly intake limit seems more sensible than a daily intake limit.

At the reference weight of 64 kilograms, the ceiling limit of methylmercury is 83 micrograms per week. In line with the recommendation of eating two servings of fish every week, the committee will evaluate whether this limit is exceeded when consuming 200 grams of fish.

Fish species allowed to contain up to 100 micrograms of mercury per kilogram

Fish exceeding the maximum permitted level of mercury cannot be sold in Europe, and most of the mercury content of fish is made up by methylmercury. For most fish species, that maximum permitted level is 500 micrograms of mercury per kilogram. For certain species of predatory fish, a higher permitted level of 1,000 micrograms of mercury per kilogram of fish applies.[5] Since this higher maximum permitted level corresponds to 200 micrograms of mercury per 200 grams, consumption of 200 grams per week of these fish species can result in an exposure exceeding the limit of 83 micrograms per week. The committee therefore recommends that pregnant women avoid these species of predatory fish, unless a sufficiently large quantity of Dutch or European monitoring data, consisting of at least 30 samples, were to show that the measured average and peak levels are low enough to stay below the ceiling limit of 83 micrograms of methylmercury per week when eating 200 grams of the fish species in question per week. This is explained in greater detail in the next section, which presents a risk assessment of all fish species.

Risk assessment of fish species based on methylmercury levels

The committee's methylmercury risk assessment is based on:

- The maximum intake of methylmercury based on the TWI of 1.3 micrograms per kilogram of body weight per week, amounting to the ceiling limit of 83 micrograms per week for a woman weighing 64 kilograms.
- Exposure to methylmercury based on methylmercury levels found in fish in the Netherlands and Europe with the recommended weekly consumption of 200 grams of fish. The committee assessed average methylmercury levels as well as the highest levels found, hereinafter referred to as "potential peak exposure", where possible.[1,6,7] In the EFSA dataset, estimates of the 95th percentile of methylmercury levels were available and – if reported for the fish species – these were used to calculate the potential peak exposure. In the dataset with analysis data on Dutch fish species, the 95th percentile was not available, but the highest measured value - if reported for the fish species - was used.

The committee classified fish species and their methylmercury levels as follows:

Fish species which, when consumed in quantities of 200 grams a week, do not result in excessive exposure to methylmercury.

- Fish species are put into this category if consuming 200 grams of said species a week results in an *average exposure* and *potential peak exposure* to methylmercury of less than 83 micrograms a week.

Fish species which, when consumed in quantities of 200 grams a week, do not usually result in excessive exposure to methylmercury, but do in some cases. The committee recommends eating these fish species in moderation because of their methylmercury levels (less than once a week).

- Fish species subject to maximum permitted levels of 500 micrograms of mercury per kilogram of product are put into this category if (1) consuming 200 grams a week leads to an *average exposure* to methylmercury of less than 83 micrograms a week, and (2) consuming 200 grams a week leads to a *potential peak exposure* to methylmercury of 83 micrograms or more a week, or if no potential peak exposure has been reported.
- Fish species subject to maximum permitted levels of 1000 micrograms of mercury per kilogram of product (200 micrograms per 200 grams) are put into this category if (1) consuming 200 grams a week leads to an *average exposure* and *potential peak exposure* to methylmercury of less than 83 micrograms a week and if (2) *at least 30 samples* were analysed. This does not appear to be the case for any of these species.

Fish species recommended to be avoided based on their methylmercury levels.

- Fish species are put into this category if consuming 200 grams of said species a week result in an *average exposure* to methylmercury of 83 micrograms or more a week.
- Fish species subject to maximum permitted levels of 1000 micrograms of mercury per kilogram of product (200 micrograms per 200 grams) are always put into this category if *less than 30 samples* were analysed, regardless of the outcomes.

Fish species for which no methylmercury levels can be evaluated.

- This applies if there are no Dutch or European measurement data available on methylmercury levels.

1.4 Evaluation based on dioxin levels

The body stores dioxins in adipose tissue. The half-life of dioxins in the body spans many years, with estimates ranging from 3 to 10 years. The amount of dioxins stored in adipose tissue therefore increases with age until a balance is reached between intake and excretion. Breast-feeding women excrete part of the dioxins stored in their body through their breast milk. During pregnancy, some dioxins are transferred from mother to foetus.[2]

In 2018, EFSA set the TWI for exposure at 2 picograms of TEQ per kilogram of body weight per week (TEQ, or Toxic Equivalency, is a unit for expressing the total amount of combined dioxins and dioxin-like PCBs).[2] This marked a sharp decrease of the TWI, which had previously been 14 picograms TEQ per week. EFSA opted to set a weekly limit because research shows that, at the level in question, serum levels remain below the level at which the critical effect can occur in the event of chronic exposure.[2] The TWI is based on an adverse effect on the sperm quality of boys and men; thus, the critical effect of dioxins emerges after pregnancy.

Risk assessment of fish species based on dioxin levels

The committee's dioxin risk assessment is based on:

- The maximum intake of dioxins based on the TWI of 2 picograms of TEQ per kilogram of body weight per week, which equates to the ceiling limit of 128 picograms of TEQ per week for a woman weighing 64 kilograms.
- Exposure to dioxins based on dioxin levels found in fish in the Netherlands and Europe with the recommended weekly consumption of 200 grams of fish. In the event that consuming 200 grams of a particular fish species led to a dioxin intake of 128 picograms a week or more, the committee also evaluated dioxin intake when consuming 100 grams of fish a week. The rationale is that fatty fish in particular can contribute to total dioxin intake, and that the committee recommends eating only one serving (100 grams) of fatty fish weekly.
- With respect to dioxins, exposure over an extended period of time plays a role of particular prominence, as the body stores dioxins in adipose tissue and does not excrete them very well. Therefore, the risk assessment for dioxins is based on the average dioxin levels found in fish, rather than the peak levels found.

The committee classified fish species and their dioxin levels as follows:

Fish species which, when consumed in quantities of 200 grams a week, do not result in excessive exposure to dioxins.

- Fish species are put into this category if consuming *200 grams* of said species a week result in an average exposure to dioxins of less than 128 picograms a week.

Fish species which, when consumed in quantities of 100 grams a week, do not result in excessive exposure to dioxins, whereas consumption of 200 grams a week does result in excessive exposure. The committee recommends eating these fish species not more than once a week because of their dioxin levels.

- Fish species are put into this category if consuming *100 grams* of said species a week result in an average exposure to dioxins of less than 128 picograms a week, whereas consuming *200 grams* of said species a week would lead to an average exposure to dioxins of 128 picograms or more a week.

Fish species recommended to be avoided based on their dioxin levels.

- Fish species are put into this category if consuming *100 grams* a week of said species would lead to an average exposure to dioxins of 128 picograms or more.

Fish species whose dioxin levels could not be assessed.

- Fish are put into this category if there are no Dutch or European measurement data available on dioxin levels.

1.5 Evaluation based on levels of PFAS-compounds

The report on the risks of PFAS in food published by EFSA in September 2020 marks a recent development.[3] With this report EFSA significantly decreased the TWI of PFAS. In 2018, TWI's were defined for two separate PFAS-compounds: a TWI of 13 nanograms per kilogram per week for PFOS and a TWI of 6 nanograms per kilogram per week for PFOA, respectively.[8] In 2020, the aggregate TWI for exposure to four types of

PFAS (PFOS, PFOA, PFNA, PFHxS) was set at 4.4 nanograms per kilogram per week.[3]

This new TWI is based on the effects of these substances on the immune system, which means that the “critical effect” is not pregnancy-specific. EFSA notes that there is evidence of a correlation between exposure to PFAS during pregnancy and birth weight, but also indicates it has its reservations with regard to whether or not there is a causal link.[3] In 2018, EFSA had denoted PFAS-compounds’ effect on serum cholesterol levels as the “critical effect” on which to base the TWI.[8] In 2020, however, EFSA reported being less convinced that there was a causal link between PFAS exposure and serum cholesterol levels.[3]

PFAS-compounds can be found in a variety of foods, but the EFSA data show that certain fish species in particular make a significant contribution to exposure. In its report, EFSA presented analysis data from countries other than the Netherlands,[3] but analysis results on PFAS levels in fish on the Dutch market have also been published.[9]

The committee’s PFAS risk assessment is based on:

- The maximum intake of PFAS based on the TWI of 4.4 nanograms per kilogram of body weight per week, which equates to the ceiling limit of 282 nanograms a week for a woman weighing 64 kilograms.
- Exposure to PFAS based on PFAS levels found in fish in the Netherlands and Europe with the recommended weekly consumption of 200 grams of fish.
- Because PFAS accumulates in the body and average chronic exposure plays a role of particular importance, the risk assessment of PFAS is based on the average PFAS levels found in fish, rather than the peak levels found.

The committee classified fish species and their aggregate levels of the four PFAS-compounds on which the TWI is based as follows:

Fish species which, when consumed in quantities of 200 grams a week, do not result in excessive exposure to PFAS.

- Fish species are put into this category if consuming 200 grams of said species a week result in an average exposure to PFAS of less than 282 nanograms a week.

Fish species recommended to be avoided based on their PFAS levels.

- Fish species are put into this category if consuming 200 grams a week of said species would lead to exposure to PFAS of 282 nanograms of more a week.

Fish species for which no PFAS levels can be evaluated.

- Fish are put into this category if there are no Dutch or European measurement data available on PFAS levels.

1.6 Approach to classifying fish species by methylmercury, dioxin, and PFAS levels

Based on the risk assessments of the fish species with regard to methylmercury (Sections 1.3 and 1.8), dioxins (Sections 1.4 and 1.9), and PFAS (Sections 1.5 and 1.10), the species were divided into five groups/classes (Section 1.7). These groups are specified and outlined below.

Group / class	Outcome of the assessment for harmful substances	Condition for inclusion in the advisory report
Class from which pregnant women can safely eat two servings a week 	Methylmercury, dioxins and PFAS: People can safely consume 200 grams of these species a week, because with consumption of 200 grams, the average exposure to methylmercury, dioxins, and PFAS is not excessive and the potential peak exposure to methylmercury is not excessive either.	These species are mentioned in the advisory report if the data on methylmercury, dioxins, and PFAS consist of at least 4 samples.
Class from which pregnant women can safely eat one serving a week 	Dioxins and PFAS: Pregnant women can safely eat one 100 gram serving of these species of fish a week, because with consumption of 100 grams, the average exposure to dioxins is not excessive. However, when consuming 200 grams of these fish species a week, the average exposure to dioxins exceeds the ceiling limit. (NOTE: Eating 200 grams a week of these species would not exceed the ceiling limits for methylmercury and PFAS; this applies to the average exposure to methylmercury and PFAS, and to the potential peak exposure to methylmercury.)	These species are mentioned in the advisory report if the data on methylmercury, dioxins, and PFAS consist of at least 4 samples.
Class from which pregnant women can occasionally eat a serving, but not weekly 	Methylmercury: Consuming 200 grams a week of these species does not - on average - lead to excess exposure, but the potential peak exposure to methylmercury does exceed the ceiling limit at this consumption level. Consumers have no way of knowing if the methylmercury levels of the fish on their plate is too high. (Note: For these species, average dioxin exposure is below the ceiling limit at consumption levels of 200 and/or 100 grams a week, and the average PFAS exposure is below the ceiling limit at a consumption level of 200 grams a week).	These species are mentioned in the advisory report if the data on methylmercury, dioxins, and PFAS consist of at least 4 samples.

Group / class	Outcome of the assessment for harmful substances	Condition for inclusion in the advisory report
Fish species to avoid eating 	Fish species can be put into this class for various reasons: • At a consumption level of 200 grams a week, the average exposure to methylmercury and/or PFAS is too high, or at a consumption level of 100 grams a week, the average exposure to dioxins is too high. • This is a fish species for which the maximum permitted level for mercury is higher than for the other species (1,000 micrograms per kilogram of fish) and at least one of the following three situations applies: 1. Although the potential peak exposure to methylmercury (and therefore also the average exposure) is below the limit at consumption levels of 200 grams, this is demonstrated in fewer than 30 samples. Because of the high maximum permitted level, the committee requires that the potential peak exposure linked to these fish species be determined from at least 30 samples. 2. At a consumption level of 200 grams a week, the average exposure and/or the potential peak exposure to methylmercury is too high. 3. Here are no data on potential peak exposure to methylmercury. Note: With the data currently available, the committee recommends pregnant women to avoid eating all fish species with this high maximum permitted level for mercury.	These species are listed in the advisory report if the data on methylmercury and/or dioxin and/or PFAS used to recommend avoiding the species in question consist of at least 4 samples.
Assessment not possible 	This species of fish could not be assessed because there were no data on at least one of the harmful substances. Sometimes, there are data on part of the substances that do not give any reason to discourage consumption. (Indeed, the committee only recommends avoiding a fish species if exposure to one of the harmful substances covered here is too high, even if there are no data available on other harmful substances; see above.)	These species are not mentioned in the advisory report.

For all fish species not mentioned in this background document, the committee had no information to warrant a conclusion, which means that exposure to harmful substances as a result from consuming all non-mentioned species of fish is still uncertain.
The committee believes it is desirable that the fish species assessment be updated periodically as new analytical data on methylmercury and/or dioxins and/or PFAS become available.

1.7 Classification of fish species based on methylmercury, dioxin, and PFAS levels

1.7.1 Fish species in the class that allows for 2 weekly servings

Fish species in the class that allows for 2 weekly servings 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report (Yes/No) ('No' if sample count for at least 1 substance is ≤3)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Catfish, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Dab	Yes	Yes	500	Yes	Yes	Yes	Yes			
Haddock	Yes	Yes	500	Yes	Yes	Yes	Yes			
Hake	Yes	Yes	500	Yes	Yes	Yes	Yes			
Pangasius, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Plaice	Yes	Yes	500	Yes	Yes	Yes	Yes			
Salmon, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Sole	Yes	Yes	500	Yes	Yes	Yes	Yes			
Tilapia, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Trout, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Turbot, from aquaculture	Yes	Yes	500	Yes	Yes	Yes	Yes			
Whiting	Yes	Yes	500	Yes	Yes	Yes	Yes			
Anchovy	Yes	Yes	500	Yes	Yes	Yes	No		1 sample	
Cockles	Yes	Yes	500	Yes	Yes	Yes	No	2 samples		1 sample

1.7.2 Fish species in the class that allows for 1 weekly serving

Fish species in the class that allows for 1 weekly serving 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report (Yes/No) ('No' if sample count for at least 1 substance is ≤3)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Herring	Yes	Yes	500	No	Yes	Yes	Yes			
Mussel	Yes	Yes	500	No	Yes	Yes	Yes			
Wild salmon[a]	Yes	Yes	500	No	Yes	Yes	Yes			
Wild trout[a]	Yes	Yes	500	No	Yes	Yes	Yes			

[a] Wild trout and wild salmon were assessed based on combined EFSA analyses for salmon and trout.

1.7.3 Fish species that can best be consumed occasionally, but not weekly

Fish species that can best be consumed occasionally, but not weekly 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report (Yes/No) ('No' if sample count for at least 1 substance is ≤3)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Cod	Yes	No	500	Yes	Yes	Yes	Yes			
Char	Yes	Not available	500	Yes	Yes	Yes	No			
Norway lobster	Yes	Not available	500	Yes	Yes	Yes	No	1 sample		
Scallops	Yes	No data	500	Yes	Yes	Yes	No	1 sample		
Squid	Yes	Not available	500	Yes	Yes	Yes	No	2 samples		

1.7.4 Fish species to avoid consuming

Fish species to avoid consuming 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report ('Yes' if the exposure to at least one of the substances warrants a recommendation to avoid eating the species)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Carp	Yes	Yes	500	Yes	Yes	No	Yes			
Crab, brown meat from the body (NB: white meat from the body and legs could not be assessed, see section 1.7.5)	Yes	Yes	500	No	No	No	Yes (crab)			
Crab, species: Chinese mitten crab	Yes	Yes	500	No	No	No data	Yes (crab)			None
Eel, from aquaculture	Yes	Not available	1000	No	Yes	No	Yes (eel)	3 samples		
Wild eel	Yes	No	1000	No	No	No data	Yes (eel)			None
Flounder	Yes	Yes	500	No	No	Yes	Yes			
Halibut	Yes	No	1000	No	Yes	Yes	Yes			
Liver of hake	No data	No data	500	No	No	No data	Yes (liver of hake, cod, etc.)	None		None
Liver of cod	No data	No data	500	No	No	No data	Yes (liver of hake, cod, etc.)	None		None
Fish offal	No data	No data	500	No	No	No data	Yes (liver of hake, cod, etc.)	None		None
Lophiiformes	Yes	No	1000	Yes	Yes	Yes	Yes			
Mackerel	Yes	Yes	500	No	No	Yes	Yes			
Perch (Perca)	Yes	Yes	500	Yes	Yes	No	Yes			
Sardine	Yes	Yes	500	No	No	No	Yes			
Sea bass	No	No	500	No	No	No	Yes			
Shrimp general & species: common shrimp	Yes	Yes	500	No	Yes	No	Yes (shrimp)			
Sprat	Yes	Yes	500	No	No	Yes	Yes			
Tuna	Yes	No	1000	Yes	Yes	Yes	Yes (tuna)			
Whitefish	Yes	Yes	500	No	No	No	Yes			

Fish species to avoid consuming 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report ('Yes' if the exposure to at least one of the substances warrants a recommendation to avoid eating the species)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Wolffish	Yes	No	1000	Yes	Yes	No	Yes			
Atlantic Dory	No data	No data	1000	No data	No data	No data	No	None	None	None
Barbel	Yes	Not available	500	No	No	No	No			
Bonito (Sarda Sarda)	No	No	1000	No	Yes	Yes	No			1 sample
Bream	Yes	No	500	No	No	No	No			
Common dentex	No	Not available	500	No data	No data	No data	No	3 samples	None	None
Escolar or snake mackerel	No	No	1000	No data	No data	No data	No		None	None
Greater weever	No	Not available	500	No data	No data	No data	No		None	None
Kingklip	No data	No data	1000	No data	No data	No data	No	None	None	None
Marlin	No	No	1000	No data	No data	No data	No		None	None
Megrim	No data	No data	1000	No data	No data	No data	No	None	None	None
Mullet	No data	No data	1000	No data	No data	No data	No	None	None	None
Mullet, species: grey mullet	Yes	No	1000	No	Yes	No data	No			None
Orange roughy	No data	No data	1000	No data	No data	No data	No	None	None	None
Pike Mackerel	No data	No data	1000	No data	No data	No data	No	None	None	None
Pink cusk-eel	No data	No data	1000	No data	No data	No data	No	None	None	None
Plain bonito	No data	No data	1000	No data	No data	No data	No	None	None	None
Poor cod	No data	No data	1000	No data	No data	No data	No	None	None	None
Portugese dogfish	No	Not available	1000	No data	No data	No data	No		None	None
Rays	Yes	No	1000	Yes	Yes	Yes	No			2 samples
Red perch	Yes	No	1000	No data	No data	No data	No		None	None
Roach	Yes	Not available	500	No	Yes	No	No			
Rock grenadier	Yes	Not available	1000	No data	No data	No data	No	3 samples	None	None
Sailfish	No data	No data	1000	No data	No data	No data	No	None	None	None
Scabbardfish	No data	No data	1000	No data	No data	No data	No	None	None	None
Sea Bream	Yes	No data	1000	No data	No data	No data	No	1 sample	None	None
Shark, selachoidei	No	No	1000	Yes	Yes	No data	No			None
Silver roughy	No data	No data	1000	No data	No data	No data	No	None	None	None
Skipjack tuna & Little tunny	No data	No data	1000	No data	No data	No data	No	None	None	None
Smelt	Yes	Not available	500	No	No	No data	No	3 samples		None

Fish species to avoid consuming 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	Mentioned or not mentioned in advisory report ('Yes' if the exposure to at least one of the substances warrants a recommendation to avoid eating the species)	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Sturgeon	Yes	Not available	1000	Yes	Yes	No data	No			None
Swordfish	No	No	1000	No	Yes	No data	No			None
Wrasse	No	Not available	500	No data	No data	No data	No		None	None
Yellowtail, from aquaculture	Yes	Not available	500	No	No	No data	No	1 sample		None
Fish roe	No data	No data	500	No	No	No data	No	None		None
Fish pate	No data	No data	500	No	No	No data	No	None		None

1.7.5 Fish species that could not be assessed because of insufficient data

Fish species that could not be assessed because of insufficient data 	Methylmercury: average exposure <83 µg per 200 g of fish (see 1.8)	Methylmercury: potential peak exposure <83 µg per 200 g of fish (see 1.8)	Maximum permitted level of mercury in micrograms per kg of fresh fish (see 1.8)	Dioxins: average exposure <128 µg per 200 g of fish (see 1.9)	Dioxins: average exposure <128 µg per 100 g of fish (see 1.9)	PFAS: average exposure <282 ng per 200 g of fish (see 1.10)	None of these species are mentioned in the advisory report	None or 1-3 samples analysed for methylmercury (see 1.8)	None or 1-3 samples analysed for dioxins (see 1.9)	None or 1-3 samples analysed for PFAS (see 1.10)
Barracuda	Yes	Yes	500	No data	No data	No data	No	3 samples	None	None
Crab, leg	Yes	No data	500	No data	No data	No	No	3 samples	None	
Crab, white meat from the body	Yes	Yes	500	Yes	Yes	No data	No			None
Capelin	Yes	No data	500	No data	No data	No data	No		None	None
Clam	No data	No data	500	Yes	Yes	No data	No	None		None
Crayfish	No data	No data	500	No data	No data	Yes	No	None	None	2 samples
Gar	No	No data	500	No data	No data	No data	No	3 samples	None	None
Grouper	Yes	No data	500	No data	No data	No data	No	2 samples	None	None
Gurnard	Yes	No data	500	Yes	Yes	No data	No		3 samples	None
Gurnard, species: red gurnard	Yes	No data	500	No data	No data	No data	No	1 sample	None	None
Jack mackerel	Yes	No data	500	No data	No data	No data	No	3 samples	None	None
John Dory	Yes	No data	500	No data	No data	No data	No		None	None
Lizardfish	No	No data	500	No data	No data	No data	No	2 samples	None	None
Lobster	Yes	No data	500	Yes	Yes	No data	No	1 sample		None
Louvar	No	No data	500	No data	No data	No data	No	1 sample	None	None
Octopus	No data	No data	500	Yes	Yes	No data	No	None		None
Oyster	No data	No data	500	No	Yes	Yes	No	None		
Pike	Yes	No	1000	No data	No data	No data	No		None	None
Pike perch	Yes	Yes	500	Yes	Yes	No data	No	3 samples	1 sample	None
Pollack	Yes	No data	500	No data	No data	No data	No		None	None
Ribbonfish	Yes	No data	500	No data	No data	No data	No	1 sample	None	None
Scorpionfish	No	No data	500	No data	No data	No data	No	1 sample	None	None
Shrimps, species: prawn	No data	No data	500	Yes	Yes	Yes	No	None		
Umberfish	Yes	No data	500	No data	No data	No data	No	3 samples	None	None
Whelk (sea snail)	No data	No data	500	Yes	Yes	No data	No	None		None
Fish fingers	No data	No data	500	Yes	Yes	No data	No	None	None	None

1.8 Available data on methylmercury in fish species: average exposure and potential peak exposure per 200 grams

Species	Maximum permitted level[5] 1000 micrograms of mercury per kg	EFSA 2012[1] N	EFSA 2012[1] average (µg/200g)	EFSA 2012[1] peak = P95 value (µg/200g)	NL data 2016[6] N	NL data 2016[6] average (µg/200g)	NL data 2021[7] N	NL data 2021[7] average (µg/200g)	NL data 2021[7] peak = highest value (µg/200g)	NL data 2016 and 2021 N	N total	Limited data	Assessed average exposure (µg/200g)	Assessed potential peak exposure (µg/200g)	Average exposure <83 µg /200g	Potential peak exposure <83 µg/ 200g
Anchovy		110	17	40	5	12	1	7		6	116		17	40	Yes	Yes
Atlantic Dory	1000											No data				
Barbel		10	42							0	10	N<11	42		Yes	
Barracuda		1	68				2	15	20	2	3	N<4	68	20	Yes	Yes
Bonito	1000	25	117	384						0	25		117	384	No	No
Bream		253	45	177						0	253		45	177	Yes	No
Capelin		11	1							0	11		1		Yes	
Carp		338	11	39						0	338		11	39	Yes	Yes
Catfish, assumed: farmed							2	3	5	2	2					
Catfish, farmed							2	4	5	2	2					
Catfish, farmed merged										4	4	N<11	4	5	Yes	Yes
Char		8	6							0	8	N<11	6		Yes	
Crab, species: Chinese mitten crab							4	5	7	4	4	N<11	5	7	Yes	Yes
Crab, brown meat from the body							5	15	22	5	5	N<11	15	22	Yes	Yes
Crab, white meat from the body							5	35	50	5	5	N<11	35	50	Yes	Yes
Crab, leg					3	26				3	3	N<4	26		Yes	
Cockles							2	4	4	2	2	N<4	4	4	Yes	Yes
Cod & whiting[a]		1308	19	68												
Cod[a]					5	20	22	32	176[a]	27						
Cod merged[a]											1335		32	176[a]	Yes	No[a]
Dab					3	36	10	33	42	13	13		36	42	Yes	Yes
Dentex, species: common dentex		3	404							0	3	N<4	404		No	
Eel/Eel, farmed	1000				2	10	1	20		3	3	N<4	20		Yes	

Species	Maximum permitted level[5] 1000 micrograms of mercury per kg	EFSA 2012[1] N	EFSA 2012[1] average (µg/200g)	EFSA 2012[1] peak = P95 value (µg/200g)	NL data 2016[6] N	NL data 2016[6] average (µg/200g)	NL data 2021[7] N	NL data 2021[7] average (µg/200g)	NL data 2021[7] peak = highest value (µg/200g)	NL data 2016 and 2021 N	N total	Limited data	Assessed average exposure (µg/200g)	Assessed potential peak exposure (µg/200g)	Average exposure <83 µg /200g	Potential peak exposure <83 µg/ 200g
Eel, assumed wild	1000	487	36	92						0	487					
Eel, wild	1000				17	26	29	35	78	46	46					
Eel, wild merged										46	533		36	92	Yes	No
Escolar or oilfish or snake mackerel	1000						2	172	296	2	2	N<4	172	296	No	No
Flounder		23	18	37	1	22	2	40	44	3	26		40	44	Yes	Yes
Gar		3	236							0	3	N<4	236		No	
Greater weever		11	153				1	22		1	12		153		No	
Grouper		2	39							0	2	N<4	39		Yes	
Gurnard		4	22		4	22				4	8	N<11	22		Yes	
Gurnard, species: red gurnard							1	26		1	1	N<4	26		Yes	
Haddock							5	16	26	5	5	N<11	16	26	Yes	Yes
Hake[b]		131	27	84[b]						0	131		27	84[b]	Yes	Yes[b]
Halibut	1000	1713	42	122						0	1713		42	122	Yes	No
Herring		1272	7	16	3	6	7	8	14	10	1282		8	16	Yes	Yes
Jack Mackerel		3	25							0	3	N<4	25		Yes	
John Dory		6	60							0	6	N<11	60		Yes	
Kingklip	1000											No data				
Lizardfish		2	122							0	2	N<4	122		No	
Lobster							1	11		1	1	N<4	11		Yes	
Lophiiformes	1000	61	39	110						0	61		39	110	Yes	No
Louvar		1	118							0	1	N<4	118		No	
Mackerel[c]		1348	22	104	1	12	24[c]	14	38[c]	25	1373		22	EFSA: 104; NL: 38	Yes	Yes[c]
Marlin	1000						18	213	426	18	18	N<21	213	426	No	No
Megrim	1000											No data				
Mullet	1000											No data				
Mullet, species: grey mullet	1000	52	32	113						0	52		32	113	Yes	No

Species	Maximum permitted level[5] 1000 micrograms of mercury per kg	EFSA 2012[1] N	EFSA 2012[1] average (µg/200g)	EFSA 2012[1] peak = P95 value (µg/200g)	NL data 2016[6] N	NL data 2016[6] average (µg/200g)	NL data 2021[7] N	NL data 2021[7] average (µg/200g)	NL data 2021[7] peak = highest value (µg/200g)	NL data 2016 and 2021 N	N total	Limited data	Assessed average exposure (µg/200g)	Assessed potential peak exposure (µg/200g)	Average exposure <83 µg /200g	Potential peak exposure <83 µg/ 200g
Mussel							5	2	4	5	5	N<11	2	4	Yes	Yes
Norway Lobster							1	28		1	1	N<4	28		Yes	
Orange Roughy	1000											No data				
Pangasius, farmed					2	1	2	1	1	4	4	N<11	1	1	Yes	Yes
Perch (Perca)		423	33	74			3	42	60	3	426		42	74	Yes	Yes
Plain Bonito	1000											No data				
Pike	1000	267	79	196						0	267		79	196	Yes	No
Pike perch							3	14	27	3	3	N<4	14	27	Yes	Yes
Pink cusk-eel	1000											No data				
Plaice		194	13	32	9	12	12	17	24	21	215		17	32	Yes	Yes
Pollack					10	19				10	10	N<11	19		Yes	
Poor cod	1000											No data				
Portugese dogfish	1000						1	156		1	1	N<4	156		No	
Rays	1000	32	46	234						0	32		46	234	Yes	No
Ribbonfish							1	9		1	1	N<4	9		Yes	
Roach		17	24							0	17	N<21	24		Yes	
Rock grenadier	1000	3	21							0	3	N<4	21		Yes	
Rose fish or deepwater redfish[d]	1000[d]	221	38	135[d]			2	28	30[d]	2	223		38	135[d]	Yes	No[d]
Sailfish	1000											No data				
Salmon and trout, salmon assumed wild		1741	7	11						0	1741		7	11	Yes	Yes
Salmon, assumed farmed					4	5	11	8	22	15	15					
Salmon, farmed							6	5	7	6	6					
Salmon, farmed merged										21	21		8	22	Yes	Yes
Sardine		399	8	23	16	12	2	18	19	18	417		18	23	Yes	Yes
Scabbardfish	1000											No data				

Species	Maximum permitted level[5] 1000 micrograms of mercury per kg	EFSA 2012[1] N	EFSA 2012[1] average (µg/200g)	EFSA 2012[1] peak = P95 value (µg/200g)	NL data 2016[6] N	NL data 2016[6] average (µg/200g)	NL data 2021[7] N	NL data 2021[7] average (µg/200g)	NL data 2021[7] peak = highest value (µg/200g)	NL data 2016 and 2021 N	N total	Limited data	Assessed average exposure (µg/200g)	Assessed potential peak exposure (µg/200g)	Average exposure <83 µg /200g	Potential peak exposure <83 µg/ 200g
Scallop, species: king scallop							1	2		1	1	N<4	2		Yes	
Scorpionfish		1	84							0	1	N<4	84		No	
Sea Bass		78	41	140						0	78		41	140	Yes	No
Sea Bass		10	60		3	97	5	98	164	8	18		98	164	No	No
Sea bass merged													98	164	No	No
Sea bream	1000						1	28		1	1	N<4	28		Yes	
Shark or selachoidei	1000	272	138	380			3	96	130	3	275		138	380	No	No
Shrimps					5	13	22	9	16	27	27		13	16	Yes	Yes
Silver Roughy	1000											No data				
Skipjack tuna & Little tuna	1000											No data				
Smelt		2	65				1	9		1	3	N<4	65		Yes	
Sole		49	15	36	4	10	7	17	22	11	60		17	36	Yes	Yes
Sprat		107	4	10						0	107		4	10	Yes	Yes
Squid					1	8	1	1		2	2	N<4	8		Yes	
Sturgeon	1000	4	10							0	4	N<11	10		Yes	
Swordfish	1000	264	242	660			110	214	740	110	374		242	740	No	No
Tilapia, farmed							2	1	1	4	4					
Tilapia, assumed farmed					2	1	3	9	26	5	5					
Tilapia, farmed merged										9	9	N<11	9	26	Yes	Yes
Trout, assumed farmed					2		3	6	9	3	3					
Trout, farmed							2	6	6	2	2					
Trout, farmed merged										5	5	N<11	6	9	Yes	Yes
Trout & salmon, assumed wild		1741	7	11						0	1741		7	11	Yes	Yes
Tuna	1000	849	58	170	125	44	77	81	312	202	1051		81	312	Yes	No
Turbot		4	12				4	16	28	4	8	N<11	16	28	Yes	Yes
Umberfish		2	34				1	4		1	3	N<4	34		Yes	

Species	Maximum permitted level[5] 1000 micrograms of mercury per kg	EFSA 2012[1] N	EFSA 2012[1] average (µg/200g)	EFSA 2012[1] peak = P95 value (µg/200g)	NL data 2016[6] N	NL data 2016[6] average (µg/200g)	NL data 2021[7] N	NL data 2021[7] average (µg/200g)	NL data 2021[7] peak = highest value (µg/200g)	NL data 2016 and 2021 N	N total	Limited data	Assessed average exposure (µg/200g)	Assessed potential peak exposure (µg/200g)	Average exposure <83 µg /200g	Potential peak exposure <83 µg/ 200g
Water molluscs							1	7		1	1	N<4	7		Yes	
Whitefish		37	17	50						0	37		17	50	Yes	Yes
Whiting and cod		1308	19	68							1308		32	68	Yes	Yes
Whiting							5	16	22	27	5		22	27	Yes	Yes
Wolffish	1000	67	22	154	1	24				1	68		24	154	Yes	No
Wrasse		12	102							0	12		102		No	
Yellowtail							1	26		1	1	N<4	26		Yes	

[a] Cod: The potential peak exposure to methylmercury at 200 g is below the limit, based on EFSA data (NB: EFSA merged cod and whiting; 1335 samples: P95 = 68 µg/200g), but the Dutch data show that the potential peak exposure is too high (27 samples: highest value = 176 µg/200g). The committee has opted to follow the Dutch data, as the number of Dutch samples analysed is sufficient and because these samples are more representative of the levels found on the Dutch market.

[b] Hake. The EFSA-2012 data (131 samples) show that the potential peak exposure to methylmercury at 200 grams is only 1 microgram per 200 grams above the limit for methylmercury, which is therefore considered acceptable. The average levels are well below that.

[c] Mackerel: Based on EFSA data (1348 samples), the potential peak exposure to methylmercury at 200 g is too high (P95 = 104 µg/200g), whilst Dutch data show it is below the ceiling limit (24 samples: highest level = 38 µg/200g). The committee has opted to follow the Dutch data, as the number of Dutch samples analysed is sufficient and because these samples are more representative of the levels found on the Dutch market.

[d] Red Perch: Based on EFSA data (221 samples), the potential peak exposure to methylmercury at 200 g is too high (P95 = 135 µg/200g), whilst Dutch data show it is below the ceiling limit (2 samples: highest level = 30 µg/200g). In this case, the committee opted to follow the EFSA data, because of the limited sample size of the Dutch data and because the maximum permitted level is 1000 micrograms of mercury per kilogram.

1.9 Available data on dioxins in fish species: average exposure per 200 grams and per 100 grams

Species	EFSA 2018[2] N	EFSA 2018[2] (picograms per 100g)	NL data 2014[10] N	NL data 2014[10] (picograms per 100g)	NL data 2021[7] N	NL data 2021[7] (picograms per 100g)	N NL-data total	N total (EFSA + NL data)	Limited data	Assessed average exposure per 200 grams (picograms)	Assessed average exposure per 100 grams (picograms)	Average exposure per 200 grams of fish <128 picograms	Average exposure per 100 grams of fish <128 picograms
Anchovy	1	10					0	1	N<4	20	10	Yes	Yes
Barbel	39	602					0	39		1203	602	No	No
Bonito	1	69					0	1	N<4	138	69	No	Yes
Bream	100	293			1	135	1	101		587	293	No	No
Carp	87	37					0	87		73	37	Yes	Yes
Catfish, assumed: farmed					2	13	2	2					
Catfish, farmed					2	15	2	2					
Catfish, farmed merged							4	4	N<11	30	15	Yes	Yes
Char	15	46					0	15	N<21	93	46	Yes	Yes
Clam (Water mollusc)	18	8					0	18	N<21	15	8	Yes	Yes
Cockle (Water mollusc)	12	13					0	12	N<21	27	13	Yes	Yes
Cod			7	28	8	28	15	15		56	28	Yes	Yes
Cod and whiting	375	23					0	375		46	23	Yes	Yes
Crab	274	127	3	1110			3	277		2220	1110	No	No
Crab (body, brown meat)					5	781	5	5	N<11	1562	781	No	No
Crab, species: Chines mitten crab					4	2870	4	4	N<11	5740	2870	No	No
Crab (body, white meat)					5	29	5	5	N<11	59	29	Yes	Yes
Crustaceans	29	184					0	29		367	184	No	No
Dab			2	41	9	50	11	11	N<21	101	50	Yes	Yes
Eel, assumed wild	258	919	9	157	57	841	66	324		1837	919	No	No
Eel, farmed[a]			15[a]	126[a]			15[a]	15	N<21	261[a]	126[a]	No[a]	Yes[a]
Flounder	32	175	2	106	2	133	4	36		349	175	No	No
Gurnard			1	44	2	3	3	3	N<4	88	44	Yes	Yes
Haddock					4	18	4	4	N<11	36	18	Yes	Yes
Hake	52	26					0	52		52	26	Yes	Yes
Halibut	466	114					0	466		228	114	No	Yes
Herring[b]	399	237	5[b]	82[b]	5[b]	64[b]	10[b]	409		164[b]	82[b]	No[b]	Yes[b]

Species	EFSA 2018[2] N	EFSA 2018[2] (picograms per 100g)	NL data 2014[10] N	NL data 2014[10] (picograms per 100g)	NL data 2021[7] N	NL data 2021[7] (picograms per 100g)	N NL-data total	N total (EFSA + NL data)	Limited data	Assessed average exposure per 200 grams (picograms)	Assessed average exposure per 100 grams (picograms)	Average exposure per 200 grams of fish <128 picograms	Average exposure per 100 grams of fish <128 picograms
Liver of cod					9	4892	9	9	N<11	9784	4892	No	No
Liver of hake					5	826	5	5	N<11	1652	826	No	No
Fish offal	120	1594					0	120		3189	1594	No	No
Fish offal	911	2197					0	911		4393	2197	No	No
Liver of cod, hake, etc. merged												No	No
Lobster	46	21					0	46		41	21	Yes	Yes
Lobster, species: Astacus	25	40					0	25		79	40	Yes	Yes
Lobster, species: Panulirus	5	1					0	5	N<11	3	1	Yes	Yes
Lophiiformes	11	14					0	11	N<21	28	14	Yes	Yes
Norway lobster	23	27			1	26	1	24		54	27	Yes	Yes
Mackerel	317	140	2	84	2	435	4	321		870	435	No	No
Mussel[c]	320	56	4[c]	101[c]	4	52	8	328		202[c]	101[c]	No[c]	Yes[c]
Mullet, species: grey mullet	33	84					0	33		167	84	No	Yes
Octopus	7	11					0	7	N<11	23	11	Yes	Yes
Oyster	235	89					0	235		178	89	No	Yes
Pangasius, assumed farmed			3	9			3	3	N<4				
Pangasius, farmed					2	3	2	2	N<4				
Pangasius, farmed merged							5		N<11	18	9	Yes	Yes
Perch (Perca)	46	46			1	18	1	47		92	46	Yes	Yes
Pike perch					1	12	1	1	N<4	24	12	Yes	Yes
Plaice	61	48	3	27	12	40	15	76		96	48	Yes	Yes
Rays	13	15					0	13	N<21	30	15	Yes	Yes
Roach[d]	18[d]	91[d]			1	47	1	19	N<21	183[d]	91[d]	No[d]	Yes[d]
Salmon and trout, assumption: wild salmon[e]	857[e]	91[e]						857[e]		181[e]	91[e]	No[e]	Yes[e]
Salmon, assumed farmed[e]			6	62	4	60 [e]	10	10					
Salmon, farmed [e]					6	59 [e]	6	6					
Salmon, farmed merged [e]							16[e]		N<21	124[e]	62[e]	Yes[e]	Yes[e]
Sardine	177	165					0	177		330	165	No	No
Scallop	98	8					0	98		16	8	Yes	Yes
Scallop, species: queen scallop	69	8					0	69		17	8	Yes	Yes

Species	EFSA 2018[2] N	EFSA 2018[2] (picograms per 100g)	NL data 2014[10] N	NL data 2014[10] (picograms per 100g)	NL data 2021[7] N	NL data 2021[7] (picograms per 100g)	N NL-data total	N total (EFSA + NL data)	Limited data	Assessed average exposure per 200 grams (picograms)	Assessed average exposure per 100 grams (picograms)	Average exposure per 200 grams of fish <128 picograms	Average exposure per 100 grams of fish <128 picograms
Sea Bass	59	128	2	211	4	535	6	65		1069	535	No	No
Shark, selachoidei	22	26					0	22		53	26	Yes	Yes
Shrimps, species: common shrimp[f]	47	24	8[f]	106[f]	13[f]	104[f]	21	68		212[f]	106[f]	No[f]	Yes[f]
Shrimps, species: prawn	33	63					0	33		125	63	Yes	Yes
Smelt	3	527					0	3	N<4	1053	527	No	No
Sole	37	26	3	32	7	27	10	47		64	32	Yes	Yes
Sprat	91	345					0	91		690	345	No	No
Squid, species: common squid	15	19					0	15		39	19	Yes	Yes
Squid, species: common cuttlefish	6	6					0	6	N<11	12	6	Yes	Yes
Sturgeon	6	28					0	6	N<11	56	28	Yes	Yes
Swordfish	4	103					0	4	N<11	205	103	No	Yes
Tilapia, assumed farmed			3	9	2	3	5	5					
Tilapia, farmed					2	4	2	2					
Tilapia, farmed merged							7		N<11	18	9	Yes	Yes
Trout and salmon, trout assumed wild[g]	857[g]	91[g]					0	857[g]		181[g]	91[g]	No[g]	Yes[g]
Trout, assumed farmed[g]			3	20[g]	2	18[g]	5	5					
Trout, farmed[g]					2	11[g]	2	2					
Trout, farmed merged[g]							7[g]		N<11	40[g]	20[g]	Yes[g]	Yes[g]
Tuna	101	15					0	101		30	15	Yes	Yes
Turbot					4	34	4	4	N<11	68	34	Yes	Yes
Water molluscs	49	16					0	49		31	16	Yes	Yes
Whelk (sea snail)	26	35					0	26		71	35	Yes	Yes
Whitefish	53	446					0	53		893	446	No	No
Whiting					4	17	4	4	N<11	34	17	Yes	Yes
Whiting & cod	375	23					0	375		46	23	Yes	Yes
Wolffish	69	14					0	69		28	14	Yes	Yes
Yellowtail					1	161	1	1	N<4	323	161	No	No
Fish	65	32					0	65		64	32	Yes	Yes

Species	EFSA 2018[2] N	EFSA 2018[2] (picograms per 100g)	NL data 2014[10] N	NL data 2014[10] (picograms per 100g)	NL data 2021[7] N	NL data 2021[7] (picograms per 100g)	N NL-data total	N total (EFSA + NL data)	Limited data	Assessed average exposure per 200 grams (picograms)	Assessed average exposure per 100 grams (picograms)	Average exposure per 200 grams of fish <128 picograms	Average exposure per 100 grams of fish <128 picograms
Fish roe	5	824					0	5	N<11	1648	824	No	No
Fish pate	4	494					0	4	N<11	988	494	No	No
Fish products	42	91					0	42		183	91	No	Yes
Fish fingers	6	8					0	6	N<11	16	8	Yes	Yes
Fish meat	565	81					0	565		162	81	No	Yes

[a] Eel: Eels caught in the wild contain high levels of dioxin. In 2006-2007, the dioxin levels of 15 Dutch samples of farmed eel were analysed, and no further analysis has been conducted since. Because these are the only available data for farmed eel and the number of analysed Dutch samples suffices, they have been included the report (NB: even though the column title mentions NL data 2014, the data for farmed eel date back to 2006-2007). The exposure to dioxins per 100 grams of farmed eel is near the ceiling limit and is either, depending on the calculation model used, just below the limit (*"lower-bound scenario":* 126 pg/100g) or just above the limit (*"medium-bound scenario"* and *"upper-bound scenario":* 131 and 136 pg/100g).

[b] Herring: Based on Dutch data, dioxin exposure per 100 grams of fish is below the ceiling limit (10 samples: 82 pg /100 g), while EFSA data show that the exposure is too high (399 samples: 237 pg/100g). The committee has opted to follow the Dutch data, as the number of Dutch samples analysed is sufficient and because they are more representative of the levels found on the Dutch market.

[c] Mussel: Based on Dutch data from 2014, average dioxin levels per 200 grams are too high (4 samples: 202 pg), but based on Dutch data from 2020 (4 samples: 104 pg) and EFSA data (320 samples: 112 pg), dioxin levels fall below the ceiling limit. The committee has opted to follow the highest average shown by Dutch data, as the number of Dutch samples analysed is sufficient and because they are more representative of the levels found on the Dutch market.

[d] Roach; Based on EFSA data, dioxin levels per 200 grams are too high (18 samples: 183 pg), but based on Dutch data, dioxin levels fall below the ceiling limit (1 sample: 47 pg). The committee has opted to follow the EFSA data, as only 1 Dutch sample has been analysed. (Note: At 100 grams, both EFSA and NL data show that exposure falls below the ceiling limit.)

[e] Salmon: Based on EFSA data (trout and salmon merged), dioxin exposure per 200g is too high (857 samples; 181 pg). At 100 grams, the average dioxin exposure is below the ceiling value according to EFSA data. EFSA values are used for wild salmon. The Dutch data contains data specific to salmon. As the differences between the Dutch data for salmon and farmed salmon are negligible, the two have been merged. These Dutch data were used for farmed salmon. Based on the Dutch data, exposure per 200 grams of farmed salmon is just below the ceiling limit (16 samples: 124 pg). EFSA data for farmed salmon (not shown in the table) are also below the limit (168 samples: 96 pg per 200g).

[f] Shrimp, species: common shrimp. Based on Dutch data for common shrimp (21 samples), the dioxin exposure per 200 grams is too high (212 pg), while EFSA data show it is below the ceiling limit (47 samples: 48 pg/200g). The committee has opted to follow Dutch data, as the number of Dutch samples analysed is sufficient and because they are more representative of the levels found on the Dutch market. (Note: At 100 grams, both EFSA and NL data show that exposure falls below the ceiling limit.)

[g] Trout: Based on EFSA data (trout and salmon merged, 857 samples), dioxin exposure per 200g is too high: 181 pg/200g. EFSA values are used for wild trout. At 100 grams, the average dioxin exposure is below the ceiling value according to EFSA data. The Dutch data contains specific data on trout. Based on Dutch data, dioxin exposure per 200 grams of trout is below the ceiling limit (5 + 2 samples, 40 and 36 pg/ 200g). For farmed trout, the committee has opted to follow Dutch data, as the number of Dutch samples analysed is sufficient and because they are more representative of the levels found on the Dutch market.

1.10 Available data on PFAS-compounds in fish species: average exposure per 200 grams

Species	EFSA 2020[3]: PFOS N	EFSA 2020[3]: PFOA N	EFSA 2020[3]: PFNA N	EFSA 2020[3]: PFHxS N	EFSA 2020[3]: Aggregate of 4 PFAS-compounds (LB scenario) nanograms per gram	NL data 2019[9]: N	NL data 2019[9]: Aggregate of 4 PFAS-compounds in nanograms per grams	N total	Assessed aggregate level of the 4 PFAS-compounds in nanograms per gram	Aggregate of four PFAS-compounds in nanograms per 200 grams	Average exposure <282 nanograms per 200 grams
Anchovy[a]	5	13	0[a]	0[a]	0.62[a]			0-13[a]	0.64 (0.62-1.01)[a]	128 (125-201)[a]	Yes
Barbel	13	14	5	5	5.17			5-14	5.17	1034	No
Bonito	1	1	0	0	0.7			0-1	0.7	140	Yes
Bream	41	45	16	16	6.03			16-45	6.03	1206	No
Carp	145	149	125	126	19.13			125-149	19.13	3826	No
Catfish, farmed						7	0.09	7	0.09	18	Yes
Char	3	1	3	2	0.71			1-3	0.71	142	Yes
Cod	174	145	130	27	0.5	8	0.77	35-182	0.77	154	Yes
Cockle	1	1	1	0	0.07			0-1	0.07	14	Yes
Crab brown meat from body						6	1.93	6	1.93	386	No
Crab leg	16	13	16	20	1.72			13-20	1.72	344	No
Crab brown meat from leg/claw						7	0.16	7	0.16	32	Yes
Crab, merged								19-26	1.93	386	No
Crayfish	2	2	1	1	0.79			1-2	0.79	158	Yes
Dab						11	0.91	11	0.91	182	Yes
Eel, assumed wild	164	177	54	58	10.3			54-177	10.3	2060	No
Eel, farmed						4	1.54	4	1.54	308	No
Flounder	16	17	7	1	0.72			1-17	0.72	144	Yes
Haddock						7	0.32	7	0.32	64	Yes
Hake	32	35	19	15	0.33	4	0.15	19-36	0.33	66	Yes
Halibut	487	106	487	487	0.26			106-487	0.26	52	Yes
Herring	288	290	243	237	0.36	7	0.2	244-297	0.36	72	Yes
Lophiiformes	4	7	7	3	0.58			3-7	0.58	116	Yes
Mackerel	125	136	129	122	0.67	3	0.68	122-136	0.68	136	Yes
Mullet, species: grey mullet	13	18	8	8	1.27			8-18	1.27	254	Yes
Mussel	55	58	53	33	0.08	4	0.49	33-58	0.49	98	Yes
Norway lobster	2	2	2	2	0.79			2	0.79	158	Yes
Oyster	36	37	37	33	0			33-37	0	0	Yes
Pangasius, farmed						7	0.191	7	0.191	38.2	Yes
Perch (Perca)	47	49	17	15	6.12			15-49	6.12	1224	No
Plaice[b]	39	39	28	5	3.03	15[b]	0,71[b]	15[b]	0,71[b]	142[b]	Yes [b]
Rays	2	2	2	1	0.71			1-2	0.71	142	Yes

Species	EFSA 2020[3]: PFOS N	EFSA 2020[3]: PFOA N	EFSA 2020[3]: PFNA N	EFSA 2020[3]: PFHxS N	EFSA 2020[3]: Aggregate of 4 PFAS-compounds (LB scenario) nanograms per gram	NL data 2019[9]: N	NL data 2019[9]: Aggregate of 4 PFAS-compounds in nanograms per grams	N total	Assessed aggregate level of the 4 PFAS-compounds in nanograms per gram	Aggregate of four PFAS-compounds in nanograms per 200 grams	Average exposure <282 nanograms per 200 grams
Roach	8	10	10	10	8.05			8-10	8.05	1610	No
Salmon and trout, assumption: wild salmon	574	521	522	365	0.44			365-574	0.44	88	Yes
Salmon, farmed from Norway						7	0.11				
Salmon, farmed from Scotland						7	0.03				
Salmon, farmed merged								14	0.11	22	Yes
Sardine	14	28	14	14	4.92			14-28	4.92	984	No
Scallop	19	19	19	19	0.02			19	0.02	4	Yes
Scallop, species: queen scallop	9	9	9	9	0			9	0	0	Yes
Sea Bass	6	6	3	3	1.41	6	4.22	9-12	4.22	844	No
Shrimps[c]	39	38	34	19	0.78	13[c]	4.99[c]	13[c]	4.99[c]	998[c]	No[c]
Shrimps, species: common prawn	8	9	2	2	0.56						
Shrimps, merged											No
Sole	15	16	11	3	0.85	10	1.23	13-26	1.23	246	Yes
Sprat	51	56	58	58	0.96			51-58	0.96	192	Yes
Squid, species: squid	4	4	0	0	0.07						
Squid	2	2	1	1	0.07			1-6	0.07	14	Yes
Tilapia, farmed						7	0.093	7	0.093	18.6	Yes
Trout and salmon, assumption: wild trout	574	521	522	365	0.44			365-574	0.44	88	Yes
Trout, farmed						7	0.201	7	0.201	40.2	Yes
Tuna	21	34	17	17	0.16			17-34	0.16	32	Yes
Turbot, farmed						6	0.13	6	0.13	26	Yes
Water molluscs (general)	10	10	9	9	0.07			9-10	0.07	14	Yes
Whitefish	18	18	1	0	1.53			0-18	1.53	306	No
Whiting						6	0.06	6	0.06	12	Yes
Wolffish	20	16	13	13	3.15			13-20	3.15	630	No

[a] Anchovy. For anchovy, average levels of two of the four PFAS-compounds were determined: PFOS and PFOA. Therefore, based on EFSA data for other fish species, the average contribution of these two PFAS-compounds (PFOS + PFOA) to the aggregate of the four PFAS-compounds (PFOS + PFOA + PFNA + PFHxS) was estimated, averaging 97% and ranging from 62% (crab) to 100%. Based on these three percentages, the PFOS + PFOA levels in anchovies were used to estimate the aggregate level of the four PFAS-compounds in anchovy. Assuming 97%, 62% and 100% respectively, these estimates are 128, 202 and 124 nanograms per 200 grams of anchovy. The committee notes that the sum of 4 PFAS-compounds is less than 282 nanograms per 200 grams of anchovies.

[b] Plaice. Based on EFSA data, the average PFAS exposure per 200 grams is above the ceiling limit (606 ng/200g), while RIVM data show that the average PFAS exposure is under the ceiling limit (142 ng/200g). The committee has opted to follow the Dutch data, as the sample size is sufficient (N=15).

[c] Shrimps. Based on EFSA data, the average PFAS exposure per 200 grams is below the ceiling limit (156 ng/200g), while Dutch data show that the average PFAS exposure is too high (998 ng/200g). The committee has opted to follow the Dutch data, as the sample size is sufficient (N=13).

1.11 Names of species in Dutch, English, and Latin

English	Dutch	Latin
Anchovy	Ansjovis	Engraulis
Barbel	Barbeel	Barbus
Bonito	Bonito	Sarda Sarda
Bream	Brasem	Charax
Capelin	Lodde	Mallotus villosus
Carp	Karper	Cyprinus
Catfish	Meerval	
Char	Trekzalm	Salvelinus
Clam	Strandgaper (schelpdier)	Mya arenaria
Cockle	Kokkel (schelpdier)	Cardium edule
Cod	Kabeljauw	Gadus spp.
Crab	Krab	Cancer spp.
Crab, species: chinese mitten crab	Wolhandkrab (Chinese wolhandkrab)	Eriocheir sinensis
Crayfish	Kreeft, rivierkreeftsoort Astacus	Astacus spp.
Crawfish	Kreeft, zeekreeftsoort Panulirus	Panulirus spp.
Crustaceans	Kreeftachtigen	Crustaceans
Cuttlefish	Inktvis, soort: gewone zeekat	Sepia officinalis
Dab	Schar	Limanda limanda
Eel	Paling of aal	Apodes
Escolar, oilfish, snake mackerel	Botermakreel / escolar, olievis, slangmakreel	Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens
Flounder	Bot	Platichthys flesus
Gar	Geep	Lepisosteiformes
Greater weever	Pieterman, grote of gewone pieterman	Trachinus draco
Gurnard (king)	Poon	Triglidae familie
Gurnard, species: red gurnard	Poon, soort: rode poon	Chelidonichthys lucernus
Haddock	Schelvis	Melanogrammus aeglefinus
Hake	Heek	Merluccius
Halibut	Heilbot	Hippoglossus hypoglossus
Herring	Haring	Clupea
Jack mackerel	Horsmakreel (Carangidae), soort: Trachurus	Trachurus (family of Carangidae)
John Dory	Zonnevis	Zeus faber
Kingklip	Kaapse koningsklip	Genypterug capensis
Little tunny	Dwergtonijn	Euthynnus spp.
Lizardfish	Hagedisvis	Synodontidae
Lobster, species: European lobster or common lobster	Kreeft, zeekreeftsoort: Europese zeekreeft of Noordzeekreeft	Homarus vulgaris of Homarus gammarus
Lophiiformes	Zeeduivel	Lophius spp.
Louvar	Haanvis	Luvarus imperialis
Mackeral	Makreel	Scomber
Marlin	Marlijn	Maraira spp.
Megrim	Scharrentong, schartong	Lepidorhombus spp.
Mullet, species: Grey mullet	Mul, soort: grijze mul	Mullus spp., species: Mugil cephalus
Mussel	Mossel	Mytilus edulis
Northern pike	Snoek	Esox lucius
Norway lobster	Langoestine of Noorse kreeft	Nephrops norvegicus
Octopus	Octopus	Octopus vulgaris
Orange roughy, silver roughy	Keizerbaars, Middellandsezee-slijmkop, Atlantische dorie	Hoplostethus spp.
Oyster	Oester	Ostrea edulis
Pagellus spp.	Zeebrasem	Pagellus spp.
Pangasius	Pangasius	
Perch	Baars (zoetwatervis)	Perca
Pike perch	Snoekbaars	Sander lucioperca
Pink cusk-eel	Roze koningsklip	Genypterug blacodes
Plaice	Schol	Pleuronectes
Plain bonito	Ongestreepte bonito	Orcynopsis unicolor
Poor cod	Dwergbolk	Trisopterus minutus
Portugese dogfish	Portugese ijshaai (EC: Bandvis)	Centroscymnus coelolepis

English	Dutch	Latin
Prawns	Garnaal, soort: steurgarnaal	Palaemon serratus
Rays	Rog	Raja spp.
Ribbonfish	Spaanvis	Trachipterus trachypterus
Roach (blankroach)	Blankvoorn	Rutilus
Rock grenadier or roundnose grenadier	Grenadiervis, soort rondneusgrenadiervis	Coryphaenoides rupestris
Rose fish, deepwater redfish and Sebastes viviparus	Roodbaars, diepzeeroodbaars en kleine roodbaars	Sebastes marinus, Sebastes mentella, Sebastes viviparus
Sailfish	Zeilvis	Istiophorus platypterus
Salmon	Zalm	Salmo spp.
Sardine and pilchard	Sardine	Sardina
Scabbardfish	Haarstaartvis	Aphanopus carbo, Lepidopus cadatus
Scallop	Kamschelp	Pecten spp.
Scallop, species: great scallop, king scallop, St James shell, escallop, Mediterranean scallop	Kamschelp, soorten jacobsmantel en grote mantel, die beide ook sint-jacobsschelp worden genoemd	Pecten jacobaeus (Middellandse zee) en Pecten maximus (Noordzee en Europees deel van de Atlantische oceaan)
Scallop, species: queen scallop	Kamschelp, soort wijde mantel	Aequipecten opercularis
Scorpionfish	Schorpioenvis	Scorpaenidae
Sea bass or bass	Zeebaars	Morone
Shark or selachoidei	Haaien	Pleurotremata
Shrimps	Garnaal, soort: gewone garnaal	Crangon crangon
Skypjack tuna	Bonito, soort: echte bonito	Katsuwonus pelamis
Smelt	Spiering	Osmerus
Sole	Tong	Limanda; Solea
Sprat	Sprot	Sprattus sprattus
Squid	Inktvis, soort: gewone pijlinktvis	Loligo vulgaris
Sturgeon	Steur	Acipenser spp.
Swordfish	Zwaardvis	Xiphidae gladius
Tilapia	Tilapia	
Trout	Forel	Salmo spp.
Tuna	Tonijn	Thunnus spp
Turbot	Tarbot	Psetta maxima of Scophthalmus maximus
Umberfish	Ombervis	Argyrosomus regius
Water molluscs (general)	Schelpdieren (algemeen)	
Whelk	Wulk (zeeslak)	Buccinum undatum, Fusus antiquus
Whitefish	Houting (verwant aan zalm)	Coregonus
Whyting	Wijting	Gadus spp.
Wrasse	Lipvis	Labridae
Wolffish	Zeewolf	Anarhichas lupus
Yellowtail	Yellowtail	Seriola Lalandi
Fish roe	Viskuit/hom	Fish roe
Fish offal	Visorganen	Fish offal

02
dosage calculations for fish-fatty-acid supplements for pregnant women

Fish contains the so called ‘fish fatty acids’ eicosapentaenic acid (EPA) and docosahexaenic acid (DHA). Most RCTs on the effects of fish-fatty-acid supplements in pregnancy, use supplements with both EPA and DHA.[11] The Committee therefore considers it sensible, when using a fish-fatty-acid supplement, to opt for a supplement that – like fish – contains both EPA and DHA. However, when it comes to the recommendation on the dosage of fish-fatty-acid supplements for pregnant women, the committee considers it sufficient to only specify the recommended DHA level.[12] Although the supplement preferably also contains EPA, the dosage of EPA is less important, and is therefore not specified by the committee. This is based on the evidence presented by EFSA that conversions from ALA to EPA to DHA are not always efficient.

EFSA notes that women specifically require additional DHA during pregnancy to promote healthy brain and retina development in the foetus. For pregnant women, the recommended intake of DHA is 100 to 200 milligrams on top of that adult reference value (sufficient intake) of 250 milligrams of fish fatty acids (EPA and DHA combined) per day.[13] Based on both this EFSA recommendation and the average DHA content of 100 grams of fatty fish and 100 grams of lean fish[14], after rounding down to the nearest hundred, the committee recommends that pregnant women who do not eat fish take a supplement with a dosage of 250 to 450 milligrams of DHA per day.

2.1 Calculation of the lower limit of the dosage range for DHA in supplements

The committee bases the lower end of the range on the average DHA intake associated with consuming the recommended one serving of fatty fish and one serving of lean fish per week. The committee based the calculation on serving sizes of 100 grams, and on the DHA levels of “average fatty fish” (NEVO code 116: 1,560 milligrams of DHA per 100 grams) and “average lean fish” (NEVO code 114: 240 milligrams of DHA per 100 grams).[14] Pregnant women consuming fish according to the recommendations have an average intake of 1,800 milligrams of DHA a week. Because supplements are taken daily, this can be converted to 257 milligrams of DHA per day, which the committee rounded down to 250 milligrams. Because this calculation is based on “average” lean fish and “average” fatty fish, this is a conservative figure, and the committee notes that lower levels may also suffice.

2.2 Calculation of the upper limit of the dosage range for DHA in supplements

The committee bases the upper end of the range on the EFSA reference value for fish fatty acids for pregnant women. This consists of two components: the reference value for omega fatty acids for adults (250 milligrams of EPA + DHA per day), and a supplement for pregnant women (100-200 milligrams DHA per day).[13] In total, the reference value for pregnant women comes out at 350 to 450 milligrams of EPA + DHA a day.

For the upper end of the dosage range of DHA in supplements, the committee assumes that the reference intake would be obtained in full from DHA, resulting in a daily dose of 450 milligrams of DHA.

2.3 Pregnant women who eat the recommended amounts of fish do not need to take supplements

In the advisory report, the committee notes that, based on the available research (cohort studies and RCTs), the intended effect on preterm birth is achieved if a pregnant woman eats fish twice a week, including one serving of fatty fish.[12] The risk estimate for the association in the cohort studies[15] equals the effect size found in RCTs[11]. The recommendation to take fish-fatty-acid supplements only applies to pregnant women who structurally fail to eat two servings of fish a week. Pregnant women who eat two servings of fish a week, including one serving of fatty fish meet the recommended weekly intake of fish, even if their DHA intake were to be lower than 250 milligrams per day.

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