European Journal of Nutrition & Food Safety

8(4): 157-161, 2018; Article no.EJNFS.2018.026
ISSN: 2347-5641

Risk Assessment of Dietary Cadmium Exposure in the Norwegian Population

Helle Katrin Knutsen[1*], Heidi Amlund[2], Anne Lise Brantsæter[1], Dagrun Engeset[3], Christiane Kruse Fæste[4], Edel Holene[3], Anders Ruus[5], Inger Therese L. Lillegaard[3], Gunnar Sundstøl Eriksen[4], Helen Engelstad Kvalem[6], Christopher Owen Miles[7], Hedvig Marie Egeland Nordeng[8], Irma Caroline Oskam[9], Cathrine Thomsen[1] and Janneche Utne Skåre[4]

[1]Norwegian Scientific Committee for Food Safety (VKM), Norwegian Institute of Public Health (FHI), Norway.
[2]Norwegian Scientific Committee for Food Safety (VKM), Institute for Marine Research, Norway.
[3]Norwegian Scientific Committee for Food Safety (VKM), Norway.
[4]Norwegian Scientific Committee for Food Safety (VKM), Norwegian Veterinary Institute, Norway.
[5]Norwegian Scientific Committee for Food Safety (VKM), Norwegian Institute for Water Research, Norway.
[6]Norwegian Scientific Committee for Food Safety (VKM), University of Bergen, Norway.
[7]Norwegian Scientific Committee for Food Safety (VKM), Norwegian Veterinary University, University of Oslo, Norway.
[8]Norwegian Scientific Committee for Food Safety (VKM), University of Oslo, Norway.
[9]Norwegian Scientific Committee for Food Safety (VKM), Norwegian University of Life Sciences, Norway.

Authors' contributions

This work was carried out in collaboration between all authors. The opinion has been assessed and approved by the Panel on Contaminants of VKM. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2018/42537

Grey Literature

Received 2nd June 2018
Accepted 28th June 2018
Published 3rd July 2018

ABSTRACT

Request from the Norwegian Food Safety Authority (NFSA):

The Norwegian Food Safety Authority requested the Norwegian Scientific Committee for Food Safety (VKM) to evaluate whether Norwegians in general or subgroups in the population could be expected to have different dietary exposure to cadmium than reported for other European

**Corresponding author: Email: tron.gifstad@vkm.no;*

population groups. Furthermore, VKM was asked to assess the potential health risk of cadmium exposure from brown meat of crabs and to identify how much crab can be eaten by children and adults without exceedance of the tolerable intake for cadmium. Finally, VKM was asked to identify other particular food items which would lead to an added cadmium exposure in Norway. The Norwegian Food Safety Authority intends to use the risk assessment as a basis for the Norwegian contribution to the ongoing legislative work in the EU and to consider the necessity to adjust the existing national dietary advices or to issue new ones.

How VKM has Addressed the Request:

VKM appointed a working group consisting of members of the Panel on Contaminants to answer the request. The Panel on Contaminants has reviewed and revised the draft prepared by the working group and finally approved the risk assessment on dietary cadmium intake in the Norwegian population.

What Cadmium is and Its Toxicity to Humans:

Cadmium (Cd) is a heavy metal found as an environmental contaminant, both through natural occurrence and from industrial and agricultural sources.

Humans are exposed to cadmium by food, water and air, with food as the most important source in non-smokers. Cadmium accumulates especially in the kidneys and in liver. The amount of cadmium in the body increases continuously during life until the age of about 6070 years, from which it levels off. The most well characterised chronic toxic effects resulting from cadmium exposure are on kidneys and bones.

The tolerable weekly intake (TWI) of cadmium was in 2009 reduced by EFSA from 7 to 2.5 µg /kg body weight (bw). The new TWI established was based on human studies on the dose-response relationship between concentration of cadmium in urine and kidney function. Severe cadmium-induced damage in cells in the proximal kidney tubules is considered to be irreversible and results in the progressive deterioration of renal function, even after cessation of exposure. Long-term exceedance of the TWI is of concern as it can increase the risk of developing kidney disease in the population. Keeping the exposure below the TWI will ensure that the cadmium concentrations in the kidneys will not reach a critical level for reduced kidney function.

Dietary Intakes in Europe and Norway, and Major Dietary Cadmium Sources:

In 2012, EFSA estimated that the mean cadmium exposure from food in Europe was close to the TWI and exceeded the TWI in some population groups, like toddlers and other children.

Previous exposure assessments in Europe and Scandinavia, including Norway, clearly show that cereal based food and root vegetables, particular potatoes, are the major dietary cadmium sources in the general population. These are, however, not the food groups with the highest cadmium concentrations. The highest concentrations have been found in offal, bivalve molluscs and crustaceans (e.g. crabs), and previous exposure assessments have shown that high consumption of such food can be associated with high cadmium exposure at the individual level. There is large variation at the individual level regarding consumption of particular food items (e.g. crab brown meat) that can be important contributors to cadmium exposure in addition to the exposure from the regular diet.

VKM has compiled the available Norwegian data on cadmium concentrations in food, mainly from 2006 and onwards. Comparison of Norwegian and European occurrence data shows that the cadmium concentrations for the food categories and items in the two datasets are within a similar range. The exceptions are fish filet and fish products (dishes based on minced fish meat), in which the mean cadmium concentrations were higher in products on the European market than in fish from Norway.

VKM has evaluated if there are national factors (geological factors, self-sufficiency rate, national occurrence data and food consumption habits) that would indicate that exposure in Norway is different from the rest of Europe. VKM has also evaluated available national and European data on concentrations of cadmium in blood and urine in relation to estimated dietary intakes.

VKM concludes that it can be expected that cadmium exposure among adults in Norway is within the range previously identified by EFSA, and close to the exposure estimated for Sweden. VKM is of the opinion that long-term cadmium exposure above the TWI as result from the regular diet in adults is unlikely in Norway, but that exceedance might occur from the additional consumption of food items with high cadmium concentrations, in particular brown meat of crabs. In dietary exposure estimates from EFSA, toddlers and other children have mean cadmium exposure exceeding the TWI, due to their higher food consumption relative to the body weight. Based on this, VKM expects that the mean dietary cadmium exposure in toddlers and children may exceed the TWI also in Norway.

Risk from Cadmium Intake from Particular Foods in Norway:

Based on the mean concentrations of cadmium, VKM identified fish liver, bivalve molluscs and offal in addition to brown crab meat as particular food items that potentially can lead to added cadmium exposure in Norway.

Since these particular food items are mainly eaten on a seasonal or non-regular basis, it was stipulated that the associated cadmium exposure would come in addition to the mean exposure from regularly eaten food. In scenario exposure assessments, VKM calculated how much crabs/fish liver that could be consumed by adults and adolescents in addition to the regular diet without exceeding the TWI. The mean dietary exposures in adults and adolescents calculated by EFSA in 2012 were used as the mean exposures from regularly eaten food.

Since cadmium accumulates in the kidneys over time (decades), VKM is of the opinion that a short-term exceedance of the TWI (for some weeks or a few months) will not lead to adverse effects in the kidneys as long as the long-term exposure (for several months and years) is below the TWI. VKM therefore considers that the cadmium exposure from particular food items can be averaged over longer time-periods (for months and up to one year) than a week.

Crabs and fish liver: The edible crab Cancer pagurus is found all along the Norwegian coast up to Vesterålen, whereas further north the occurrence is infrequent. Brown meat from crabs contains much higher concentrations of cadmium than any other food item commonly consumed in Norway, and has approximately 14 to 20-fold higher concentration of cadmium than white crab meat. The cadmium concentration in fish liver is about two-fold higher than in white meat from crabs caught south of Saltenfjorden. A large part of the Norwegian adult population report consumption of crabs or fish liver at least a few times a year, while a small fraction consume these particular food items more frequently. Consumption of brown meat from crabs and fish liver is, however, not common in most European regions and therefore not covered by the exposure estimates performed by EFSA. The dietary assessment method used in the recent Norwegian national food consumption survey in adults (two times 24h dietary recall) does not supply reliable information about consumption of foods that are not eaten on a daily basis. In order to estimate cadmium exposure from rarely eaten foods, VKM has calculated scenarios for the exposure to cadmium from consumption of crabs and fish liver.

Scallops, oysters and offal: The cadmium concentrations in scallops and oysters are 2-3 fold higher than in white meat from crabs caught south of Saltenfjorden. Offal, in particular offal from game and sheep, contains much higher cadmium concentrations than the meat from the same species. However, consumption of offal, including offal from game, and bivalve molluscs is generally low in Norway, although high consumption in some population groups cannot be excluded. In contrast to Norway, consumption of offal and bivalve molluscs is more common in some European regions, and is therefore covered by the exposure estimates performed by EFSA.

Scenarios for Cadmium Exposure from Crab or Fish Liver Consumption:

Crabs and filled crab shells: Because of high cadmium levels in edible crabs (Cancer pagurus) north of Saltenfjorden up to Vesterålen, Norwegian Food Safety Authority has issued advice to avoid consumption of all parts of crabs caught in this area. The scenarios presented below are valid only for meat of crabs caught south of Saltenfjorden.

Whole crabs contain a higher percentage of brown meat than commercially available filled crab shells, and this was taken into account in the scenarios.

Scenarios of cadmium exposure from crab consumption indicate that adults can eat approximately one whole crab or two filled crab shells per month in addition to regular food without exceeding the TWI. Averaged over a year, this corresponds to 13.5 whole crabs or approximately 25 filled crab shells. If adults only eat white crab meat, they can consume white meat from approximately nine crabs per week, which corresponds to white meat from approximately 468 crabs per year.

Adolescents can eat as little as approximately 0.3 whole crabs or 0.6 filled crab shells per month in addition to regular food without exceeding the TWI. Averaged over a year, this corresponds to 3-4 whole crabs per year or approximately 7 filled crab shells. If adolescents only eat white crab meat, they can consume white meat from about 2.5 crabs per week, which corresponds to white meat from approximately 129 crabs per year.

Since a higher crab consumption than the acceptable range calculated in the scenarios has been reported in Norwegian dietary surveys, VKM concludes that high consumers of crab brown meat are at high risk of exceeding the TWI. VKM concludes that cadmium exposure from white crab meat is not of concern in Norway.

Fish liver: The scenarios for fish liver consumption performed by VKM indicated that adults can in average consume 224 g saithe liver or 273 g cod liver from the North-Eastern Arctic Sea (Barents Sea) or 737 g cod liver from the North Sea per week in addition to regular food without exceeding the TWI. Because of their lower body weight, adolescents can consume less fish liver than adults in addition to regular food without exceeding the TWI. The scenarios indicated that adolescents can in average consume 60 g saithe liver or 73 g cod liver from the North-East Arctic Sea (Barents Sea) or 196 g cod liver from the North Sea per week in addition to regular food without exceeding the TWI.

The available Norwegian data on the consumption of fish liver indicate that such high fish liver consumption over a longer period (months and years) is unlikely, and consequently VKM concludes that cadmium exposure from fish liver consumption is not of concern in adults and adolescents.

Cadmium Exposure from Particular Food Items was not Addressed for Toddlers and Children:

Exposure scenarios were not calculated for children because there are no Norwegian data on the consumption of crabs or fish liver for toddlers and children. It was, however, anticipated by VKM based on common knowledge regarding children's food habits that crab brown meat and fish liver are rarely consumed by children. However, if consumed by children, crabs and fish liver would contribute more to the exposure in children than in adolescents and adults because of the low body weight in children and their high energy requirement relative to the body weight. Furthermore, they already have a mean cadmium exposure above the TWI from the regular diet as estimated by EFSA.

Uncertainties:

VKM considers the uncertainties in the outcome of the present risk assessment as moderate. The highest uncertainty is associated with the amount of cadmium that can be allocated to particular

food items, such as brown meat of crabs, before TWI is exceeded, since there is a high individual variation in cadmium exposure from regularly eaten food. The scenarios for exposure to cadmium from consumption of crabs and fish liver are VKM's best estimate for the maximum possible amounts of these particular food items that can be eaten without exceeding the TWI for cadmium.

Data Gaps and Recommendations:

During the work with this risk assessment, VKM identified a need for updated consumption information for rarely consumed food in adults and children, as well as for more occurrence data on cadmium in food. There is a lack of information about cadmium levels in organically produced vegetables including those grown in alum shale areas. Furthermore, there is a need for systematic human biomonitoring studies (e.g. blood and urine) and Norwegian participation in European collaborative biomarker studies. A Total Diet Study would be helpful to reduce the uncertainty in the estimates of the mean dietary cadmium exposure in Norway.

Keywords: VKM; risk assessment; cadmium; Cd; dietary; exposure scenario; crab consumption; fish liver consumption; Norwegian Scientific Committee for Food Safety.

Available:https://vkm.no/download/18.2994e95b15cc54507161525b/1498142416154/07cfa5d365.pdf

ISBN: 978-82-8259-167-6

NOTE:

This work was carried out in collaboration between all authors. The opinion has been assessed and approved by the Panel on Contaminants of VKM. All authors read and approved the final manuscript.

Competence of VKM experts: Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third party interests. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

Suggested citation: VKM (2015). Risk assessment of dietary cadmium exposure in the Norwegian population. Opinion of the Panel on Contaminants of the Norwegian Scientific Committee for Food Safety. VKM Report 2015:12, ISBN: 978-82-8259-167-6, Oslo, Norway.

COMPETING INTERESTS

Authors have declared that no competing interests exist.