Risk Assessment of Lead Exposure from Cervid Meat in Norwegian Consumers and in Hunting Dogs

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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.

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Grey Literature

ABSTRACT

The Norwegian Food Safety Authority requested the Norwegian Scientific Committee for Food Safety (VKM) to assess the risk of lead exposure to the Norwegian population by consumption of cervid meat, including any subpopulations with an increased risk. Further, VKM was asked to describe the distribution of lead from ammunition in the carcass and to estimate the tissue area associated with the wound channel that has to be removed in order to reduce the risk. VKM was also asked to present, if any, other appropriate measures in addition to removing tissue in order to limit the content of lead residues from ammunition in cervid meat. Finally, VKM was asked to assess the significance of lead exposure to the health of dogs if they were fed with trimmings from the wound channel.

Consumption of cervid meat in Norway:

Lead exposure from cervid meat can be seen as an addition to the exposure from other food sources. According to a recent exposure assessment by EFSA, grains and grain products, milk...
and dairy products, non-alcoholic beverages, vegetables and vegetable products are the major dietary lead sources in the general population.

According to the most recent (2012) representative national dietary survey in Norway, mean game (including cervid) meat consumption was low, approximately 5-7 meals per year. However, in other Norwegian population studies including hunters, a large proportion (70%) of the participants consumed cervid meat at least once a month or more often. No information on cervid meat consumption among Norwegian children has been found. However, it can be expected that children eat cervid meat equally often as the rest of the family.

**Negative health effects associated with lead exposure:**

Lead concentration in blood is considered to be a good indicator of lead exposure. Lead exposure in Europe has decreased dramatically over the last three decades. In Norwegian studies, the mean or median concentrations of lead in blood were from 11 to 27 µg/L, which is in the same range as studies in most European countries the last 10 years. Blood lead concentrations were lower in pregnant women than in other adult population groups in Norway. No information on blood lead levels in Norwegian children has been found. Neurodevelopmental effects and increased blood pressure in adults were critical effects of lead exposure identified by both EFSA and JECFA. Children are more sensitive than adults to the effects of lead because their brain is under development. Increased blood pressure is not an adverse outcome by itself, but it is associated with increased risk of cardiovascular mortality. In addition, EFSA pointed out chronic kidney disease as a sensitive endpoint in adults.

**Overview of reference values for blood lead concentrations associated with increased blood pressure and increased prevalence of chronic kidney disease in adults, and neurodevelopmental effects in children:**

<table>
<thead>
<tr>
<th>Blood concentration (µg/L)</th>
<th>lead</th>
<th>Health effects at the population level</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1% reduction in full scale IQ in children (1 IQ point given IQ=100)</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>1% increased systolic blood pressure in adults (1.2 mmHg given a blood pressure of 120 mmHg)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>10% increased prevalence of chronic kidney disease in adults</td>
<td></td>
</tr>
</tbody>
</table>

**Lead exposure in cervid meat consumers:**

Associations between game meat consumption and blood lead concentration have been studied in four population studies in Norway. In the three studies performed in the years 2003-2005, a significant association between game meat consumption and higher blood lead concentration was only seen in the subgroup of male participants in one of the studies (the Norwegian Fish and Game study).

In the fourth study, the Norwegian Game and Lead study conducted in 2012, the median blood lead concentration was in the lower range of medians measured in most European and Norwegian studies over the past 10 years. This study also showed association between cervid meat consumption and concentrations of lead in blood. Those with frequent (monthly or more often) cervid meat consumption had about 30% higher average levels of lead in blood than those with less frequent consumption. However, there was a wide range, and many participants with high or long-lasting game meat intake had low blood lead concentrations. The increase in blood lead concentrations seemed to be associated with consumption of minced cervid meat, particularly purchased minced meat. Blood lead concentration was significantly higher in participants who reported self-assembling of lead-containing bullets.
Risk characterization:

The blood lead concentrations measured in participants in the Norwegian population studies are in the range of, and partly exceeding, the reference values for increased risk of high blood pressure and increased prevalence of chronic kidney disease in adults, and for neurodevelopmental effects in children. The additional lead exposure from cervid meat in frequent (monthly or more often) consumers of such meat is therefore of concern.

At the individual level, the risk for adverse effect is likely to be small. At present lead levels, adults with for example normal blood pressure will most likely not experience any clinical symptoms by a small increase, although it may add to the burden of those individuals who are at risk of experiencing cardiovascular disease. A small reduction in the intelligence of children will not be notable at the individual level, but at the population level it can for instance increase the proportion not able to graduate from school. Lead exposure was declining in the population on which the reference value for increased prevalence of chronic kidney disease was based. EFSA noted that this reference value (15 µg/L) is likely to be numerically lower than necessary. The implications of having a concurrent blood lead concentration above the reference value cannot fully be interpreted, since it is not known when and at which level of lead exposure the kidney disease was initiated. However, an eventual increased risk of chronic kidney disease would be higher among those who consume cervid meat regularly or often than those who rarely consume such meat.

For these reasons, continued effort is needed in order to reduce lead exposure in the population.

Exposure reducing measurements:

Removal of meat around the wound channel reduces the lead exposure from cervid meat consumption. Lead fragmenting and distribution is dependent on several variables, and there are no available studies in moose. The available studies do not allow a firm conclusion on the amount of meat needed to be trimmed around the wound channel in order to remove lead originating from the ammunition. Other possible measures to reduce lead exposure from cervid meat would be to use lead based ammunition with low fragmentation or ammunition without lead.

Risk of negative health effects in dogs:

In dogs, metallic lead fragments most often pass through the gastrointestinal tract unretained. If larger lead fragments or particles are retained in the gastrointestinal tract for prolonged periods of time, this can result in a continual exposure and toxicity.

A daily dose around 1 mg lead acetate/kg bw is shown to increase the blood pressure in dogs after a few days of exposure, and is considered as a Lowest Observed Effect Level (LOEL). This corresponds to a lead acetate concentration of 10-20 mg/kg in fresh meat or offal when fed daily to dogs.

The uptake of lead from small metallic lead fragments in contaminated cervid products is probably lower than that of lead acetate. However, high metallic lead concentrations are expected to be present in meat trimmed from the wound channel. Even when a lower absorption of metallic lead than of lead acetate is taken into consideration, the risk for chronic health effects in dogs fed on trimmings of meat/offal from the wound channel from lead killed cervids can be considered as high. On the other hand, the risk for adverse effects after a single exposure of lead contaminated meat must be considered as low.

Keywords: Lead exposure; cervid/game meat consumption; lead-based ammunition; health risk.

Available: https://vkm.no/download/18.1b70ef9115d3ac37645e3fa4/1501682717201/cbfe3b0544.pdf
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.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.