Lead in game meat and implications for human health

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This report contains a *pro veritate* opinion requested by the Comitato Nazionale Caccia e Natura (IItaly) regarding the possible human health implications deriving from the use of lead ammunitions in hunting, paying particular attention to the 2012 ISPRA (Italy) report.

Introduction

Lead is an inevitable environmental contaminant and its widespread presence is also a consequence of past, and, to a lesser extent, present human activities. The sources of exposure are numerous and include food, water, soil and dust, and the air. **The main source of exposure is represented by food (water included).**

The European Food Safety Authority (EFSA, 2010) has recently reviewed the toxicological data on lead and concluded that, at low doses, the following toxicological effects may occur: neurotoxicological effects on children, nephrotoxic effects and effects on blood pressure on adults. The doses at which these effects are considered negligible have been identified as follows: for the effects on children 0.5 µg/kg body weight per day (corresponding to a blood lead level of 1.2 µg/dL), for the effects on pressure 1.5 µg/kg body weight per day (corresponding to a blood lead level of 3.6 µg/dL), for the nephrotoxic effects 0.63 µg/kg body weight per day (corresponding to a blood lead level of 1.5 µg/dL).

Report from the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)

ISPRA recently produced a document (ISPRA 2012) in which any adverse effect on the health of consumers of game due to the presence of lead shot in the meat of hunted animals has been taken into account. According to the authors two types of risk can be defined. The first is connected to the release of lead from the pellets that remained in the meat and the resulting lead intake by the consumer. The second is connected to the possibility of ingestion of pellets or fragments of lead shot, which can release lead along the digestive tract, especially in the presence of slow or poor elimination via the feces. For these reasons, in addition to the ecotoxicological effects not addressed in this report, the ISPRA document recommends the ban of lead shot in hunting.

Presence of lead in game meat and consequent exposure of consumers

The EFSA issued a Scientific Report in 2012 (EFSA 2012) on European population exposure to lead via the diet. Exposure estimates were carried out by the EFSA on the basis of almost 150,000 analytical data in food and on information on the diet in the various European countries. Table 1 shows the concentrations reported by the EFSA in game meat. Because of the presence of some anomalous very high values in wild

boar meat, the averages, distorted by these very high values, are not shown, but only the 95th percentile of the distribution. For comparison, the range of values of the same parameter referred to other types of meat or animal derivative is reported. As it can be seen, levels of lead in game meat are generally higher than those found in meat or other derivatives of reared animals.

However, to assess the impact on the intake of lead via food the quantity of different foods eaten by consumers must be taken into account. To do this, the EFSA used the concentration data of lead in various foods together with food consumption data. Based on these calculations, EFSA concluded that the average exposure to lead via food of the European population is estimated at 0.68 μg/kg body weight per day, with age-dependent variations between 0.47 to 0.50 (older adults) and 1.32 (infants) μg/kg body weight per day.

The EFSA also conducted a sensitivity analysis to identify which foods contribute most to lead intake. **In fact, not necessarily the food with the highest concentrations contributes significantly to the total, whereas the greatest impact comes from foods consumed in larger quantities**. Based on the available data, the EFSA concluded that the main contribution is provided by products based on cereals (16.1%), milk and dairy products (10.4%), non-alcoholic beverages (10.2%), vegetables and their derivatives (8.4%), water (7.0%), alcoholic beverages (6.7%). Therefore 6 groups of products, which do not include meat and other animal derivatives (<6%), account for almost 60% of the total intake. It should be noted that the frequency of game meat consumption is less than 1% of the total number of occasions in which meat or other animal derivative was consumed. **Therefore consumption of game meat with high lead concentration does not significantly change the total intake.**

This conclusion is also supported by a study by the Swiss Public Health Office (Haldimann et al., 2002). These authors compared the blood lead levels in hunters who referred game meat consumption with the levels found in control subjects, non hunters and non-consumers of game meat. The authors found no significant difference in blood lead levels between the two groups, nor any relationship, in the hunters, between blood lead levels and the number of game meat based meals eaten.

The Istituto Nazionale per la Ricerca sull'Alimentazione e Nutrizione (INRAN, now CRA) released a report on the Italian population diet (INRAN-SCAN, 2010-2011); the data allow some calculations on the intake of lead from game meat by Italian consumers. From the data in Table 1.1 of part B5 of the report, it is possible to derive that the average consumption of "other meat", calculated only among consumers of that meat, is equal to 0.55 g/kg body weight per day, assuming an average body weight of 60 kg. Under "other meats" not only game meat (in detail: duck meat, deer, boar, pheasant, goose, pigeon, quail, venison ham) is included. It is therefore clear that game meat contributes only partially to this entry, even if hare and pheasant are missing out. Applying to this consumption figure the highest 95th percentile of lead concentration in game meat according to the EFSA data (982 μg/kg in pheasant meat), a dietary intake of 0.54 μg/kg body weight is estimated. This estimation is largely in excess, because it is quite unlikely that on each occasion the lead concentration corresponds to such a high percentile, which in addition refers to the type of meat presenting by far the highest concentration. Despite this, the dietary intake estimated in this way is equal to the average intake estimated for the European consumer taking into account all foods. The EFSA (2010) also estimated the dietary exposure for game meat consumers using consumption data that are comparable to those reported by the INRAN (0.47 instead of 0.55 g / kg of body weight per day). However, the EFSA used much higher lead concentration values (3150 instead of 982 μg/kg). In this way, an estimate of lead intake approximately 3 times higher than that calculated in this report was obtained. Moreover, it should be noted that the EFSA data indicate a median lead concentration in game meat of

0.02 µg/kg, approximately 150 000 times lower than the average value of 3 150 µg/kg used for the dietry exposure estimate. In fact, the average is skewed by a few exceptionally high values (up to 867 000 µg/kg, data which should certainly be double-checked); indeed the 95th percentile is below the average. The estimate of the EFSA is even more in excess, because it is basically impossible that in all meals game meat contains such high level of lead. Moreover, since the effects of lead are chronic, related to its accumulation, a single episode of intake above levels considered safe, which may occur during a meal with game meat with the highest levels of lead, has no significant impact on the total load of lead in the body. It is interesting to note that the **EFSA made a calculation of game intake similar to the Italian one**, and this might imply that **the intake of lead from game meat should be no different in the rest of Europe**.

The ISPRA document cites numerous studies carried out in populations living in areas near the Arctic Circle (Canada, Alaska, Greenland, Northern Russia), which suggest that a high consumption of wild game hunted using ammunition containing lead is associated with an increase in blood lead levels. This is a particular situation where the consumption of wild game meat is very high, not comparable to what happens in Italy. For example, Bjerregaard et al. (2004) reported that the blood lead levels tend to increase in presence of at least one meal a week of game meat, and that daily consumption of this type of meal is associated with a doubling of blood lead levels compared to non-users or consumers of up to 3 meals per month. Johansen et al. (2006) report that, in Greenland, those who do not consume hunted birds have blood lead levels lower than occasional consumers. But it must be noted that the main difference is observed on regular users (over 1 time per week), while in those who consume less meals of hunted birds the increase is more modest and above all there is no difference between consumers of <1 meal per month, 1-2 meals per month, 2-3 meals per month. Of note, however, that non-consumers were 4 subjects. This makes the observation not very reliable, and therefore not in contrast with that of Bjerregaard et al. (2004): namely, that only strong consumers show a significant increase in blood lead levels. Fontaine et al. (2008) suggest that the ban on use of lead bullets in Canada since 1999 has contributed to the reduction in blood lead levels in the Inuit of Northern Canada between 1992 and 2004. But we must also take into account the elimination of lead from gasoline, which has reduced lead pollution in the cold regions of the Arctic, so that it is not easy to assess the contribution of the two phenomena. Certainly, the authors observe a strong correlation between blood lead levels and cigarette smoking.

Risks associated with the ingestion of game containing lead shot

In the literature there are few case reports of pellets ingestion or, more often, fragments of bullets overlooked, and hence not removed, during the preparation of game meat (Gustafsson and Gerhardsson, 2005) which caused high levels of lead in blood and, in some cases, signs of lead poisoning when stuck in the digestive tract (usually the appendix). Gerhardsson and Gustafsson (2005) also cite other cases reported in literature. Other similar cases are reported by Cox and Pesola (2005) and Madsen et al. (1988), but they are certainly very rare cases.

Conclusions

Based on the data presented and discussed, it is believed, in accordance with the EFSA and on the basis of the calculations made taking into account the Italian diet, that there is no risk of significant increase in the body burden of lead for Italian consumers of wild game hunted using lead ammunitions. Based on the EFSA data it is possible to argue that the contribution of lead content in the meat of game is negligible, and even the worst case calculated with the Italian diet data provides a contribution of lead not higher than the current intake through food. As for the permanence in the intestine of lead pellets or fragments thereof,

this appears to be a rare event, and the few observed cases generally involved frequent game consumers, like the inhabitants of the Arctic.

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Table 1: lead content in various types of meat or animal derivatives

Meat kind	Lead concentration (µg/kg) 95th percentile
Boar	670
Deer	124
Elk	46
Reindeer	150
Hare	475

Pheasant	982
Quail	34
Mammals for rearing	10-88 (range)
Poultry	13-92 (range)
Offal and entrails	38-180 (range)

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