# Lead poisoning in shooting ranges: a risk that persists, despite being known

**Visiting a shooting range, whether for leisure or work, can lead to exposure to lead dust through inhalation or ingestion. This is a health risk, especially for children and pregnant or breastfeeding women. Although this risk is known and is governed by regulations and good practice guidelines, lead levels above the vigilance thresholds are regularly reported by poison control centres and occupational disease consultation centres in France.**

The Nancy and Lyon poison control centres (PCCs) recently notified ANSES of several clustered cases of lead poisoning among people practising sport shooting in clubs. Although the phenomenon is far from new, these alerts are an opportunity to highlight the risk presented by this exposure for the shooters themselves, particularly children and pregnant women, but also for their families and professionals.

**Lead poisoning: "non-threshold" toxicity**

Lead poisoning results from the excessive penetration of lead into the body. While there is no threshold for non-toxicity, exposure is most hazardous in children, even at low concentrations, and can lead to a decrease in cognitive (attention, learning, reasoning, etc.) and sensorimotor performance, in particular affecting hearing acuity, inhibiting height and weight growth, and causing sexual maturation disorders [1]. Lead exposure during pregnancy harms foetal development. In adults, even at low doses, it can lead to high blood pressure, increase the risk of chronic kidney disease and promote male fertility problems. Population exposure has decreased sharply in recent years due to the ban on lead paints (prohibited as early as 1909 but still found in housing built before 1949 and in some paints until the 1970s), the replacement of lead pipes supplying water, the ban on leaded petrol (from 2000), the control of industrial emissions, and the lowering of the threshold for lead in drinking water (European Directive 98/83/EC of 1998).

Childhood lead poisoning is a disease often associated with poverty because lead is still found in old or unsanitary homes, due to old lead-based paints and the dust they generate indoors, which young children can put in their mouth or inhale. Because of its seriousness, childhood lead poisoning is a notifiable disease, monitored by *Santé Publique France*[1]. It must be notified when the blood lead level is 50 µg/L or more in a minor child. This is a threshold for intervention and not a toxicity threshold since, as already mentioned, there is no "zero toxicity" threshold. Blood lead levels between 25 and 50 µg/L should therefore also be monitored (this is known as the vigilance zone) [2]. For adults, the French Labour Code defines different blood lead levels for workers exposed to lead: monitoring to be established from 100 µg/L for women or 200 µg/L for men[2], threshold not to be exceeded of 300 µg/L for women or 400 µg/L for men[3].

1.Public Health France

2. Article R4412-160 of the French Labour Code states that reinforced medical surveillance of these workers is necessary if the concentration in the air is greater than 50 $\mu g.m^{-3}$ as a weighted average for an eight-hour period, or if the blood lead level is greater than 200 $\mu g.L^{-1}$ in men or 100 $\mu g.L^{-1}$ in women. Blood lead levels must not exceed 400 $\mu g.L^{-1}$ in men or 300 $\mu g.L^{-1}$ in women.

3. Article R4412-160 of the French Labour Code.

Regional health agencies (ARSs) and poison control centres are central to the scheme for monitoring and treating lead poisoning in children and adults. Occupational medicine takes care of monitoring workers exposed to lead.

**The alert**

Every year, cases of lead poisoning in children associated with the practice of shooting are recorded by the mandatory reporting scheme of *Santé Publique France*. The clustered cases reported here are noteworthy for their number. They concern both adults (for whom there is no surveillance) and children accompanying their parents during the shooting activity.

In 2019, the PCC of Nancy and the ARS Grand-Est became aware of 13 cases of adults attending the same shooting club in the Bourgogne-Franche-Comté region and presenting high blood lead levels, ranging from 172 to 565 µg/L. Five people experienced unspecific symptoms, which they attributed to lead poisoning (headaches, asthenia, abdominal pain), without this link being formally established. This club offers various disciplines at three different ranges. Measures were immediately taken by the club itself: closure of one of the ranges, recommendation that shooters get their blood lead levels measured, dissemination of information on the risk of lead exposure and the good practices to be implemented to limit it. The ARS drafted and distributed a document on risk and good prevention practices to all the presidents of the leagues in the region so that they, in turn, could circulate it to all shooting range managers.

In the same region, a child shooting at another club was identified by the national surveillance system for childhood lead poisoning, while at the same time, several adult members of this club were found to have high blood lead levels. The range was closed and dust sampling identified significant environmental contamination before cleaning (100,000 µg/$m^2$ in the shooting area and 10,000 µg/$m^2$ in the communal areas). As an indication, according to a study published in 2015 and cited in the recent ANSES report on lead contamination of outdoor public areas [3], the concentrations measured in samples of playground or indoor dust were less than 500 µg/$m^2$. In the United States, a maximum threshold of 108 µg/$m^2$ is proposed for dust in homes [4].

In 2020, clustered cases of lead poisoning in children were reported to the Lyon poison control centre and the ARS Auvergne-Rhône-Alpes, in children or adolescents practising competitive shooting in the same shooting gallery. This range hosted nearly 70 children, half of them under 10 years old (children can practice shooting from 7-8 years old depending on their morphology). Of the 18 children tested, eight had blood lead levels above the threshold of 50 µg/L, with a maximum of 129 µg/L. The others had blood lead levels between 18 and 50 µg/L. In addition, two children, aged 7 and 11 years, who were not shooting but were brothers of other children in the club, had blood lead levels in the vigilance zone (38 and 26 µg/L, respectively). The inspector sent to the site identified numerous failings with respect to the premises; the shooting gallery was therefore closed temporarily and work was initiated. An information campaign was conducted among parents and children, physicians in the *département* and the departmental shooting federation. It should be noted that the COVID-19 lockdown period (which began shortly after the site was closed) led to a strict cessation of exposure with a decrease in lead concentrations in the children tested.

**What is the source of the lead that accumulates in a shooter's body?**

Bullets in firearms are made mostly from lead, but a large quantity of lead is also found in the primer, which ignites in the barrel of the gun to provide propulsion for the projectile. Only jacketed bullets do not contain lead, whether in the powder or the primer. As it passes through the barrel, part of the lead bullet disintegrates into fine fragments. Lead particles, as well as dust and smoke from the primer and bullet fragments, are then ejected from the gun barrel at high pressure when fired. Inhalation of these fine lead particles by the shooter is one route of exposure. Fine or coarser particles emitted when a gun is fired can also settle on hands, clothing or other surfaces in the vicinity of the shooter: ingestion through hand-to-mouth contact (cigarettes, food, handling of mobile phones) is therefore a second route of contamination. Lead dust is also generated when the bullet hits its target or the bulletproof device, and accumulates in the dust on the ground. Shooters may take these particles home with them, on their equipment, clothing or footwear, thereby exposing their families. Lastly, another source of exposure is the home-made manufacture of ammunition, with a risk of pollution spreading from the garage or workshop to living areas, especially if the household vacuum cleaner is used to clean the room where the ammunition is produced. The use of recycled material – the collection of old warheads (which involves high exposure to dust) or purchase of lead from scrap metal dealers – increases the risk of poisoning.

**Workers also exposed**

Professional or amateur shooters are not the only ones exposed to lead. Anyone involved in picking up casings, handling bullets, cleaning shooting ranges, including the removal of lead particles from floors and surfaces, targets and ventilation systems (for indoor ranges) is at risk, especially if they have been performing this work for a long time at the club.

A retrospective study of data from the National Network for Monitoring and Prevention of Occupational Diseases (RNV3P), which is coordinated by ANSES, identified the cases of lead poisoning associated with shooting ranges recorded by the 30 occupational disease consultation centres (CCPPs) in France between January 2010 and December 2018. These concerned both occupational exposure (21 cases) and non-occupational exposure of recreational shooters (37 cases). Only six centres had recorded cases and one centre accounted for 80% of cases.

The professionals exposed were predominantly men (19 men and two women), with a median age of 50, working in a variety of occupations such as police officers, trainers, instructors, sport shooting coaches, bullet collectors, cleaning and maintenance workers, and receptionists. In half of the cases they had been referred to the CCPPs by their occupational physician, and in one third of cases by their general practitioner. The blood lead levels were reported and entered in the RNV3P database in 13 cases. They ranged from 100 µg/L to nearly 1000 µg/L with a median of 445 µg/L (above the threshold not to be exceeded[1]).

The non-professionals also tended to be men (33 men out of 37), with a median age of 45 years. For the 31 cases where it was reported, their blood lead levels ranged from 100 µg/L to 750 µg/L, with a median of 300 µg/L, lower than those of the occupationally exposed workers. They were mainly referred by their general practitioner (40%) and 19% of them came on their own initiative. It should be noted that two men were consulting for fertility problems.

**How can poisoning be prevented?**

This contamination is not inevitable. The recommendations of the French National Research and Safety Institute (INRS) primarily concern professionals [5] but can also help reduce the risks for amateurs. The French Labour Code defines the occupational exposure limit (OEL) for lead in air of 0.1 mg/m$^3$ as an average value for an eight-hour period. It requires ventilation systems to be checked annually and compliance with the OEL. If the limit is exceeded, activities must cease until the shooting range has been decontaminated. Professionals assigned to positions exposing them to lead must be informed of this risk, the hygiene rules to be observed and the means of prevention. In particular, they must not eat, drink or smoke while dressed for work. In addition, the Labour Code prohibits pregnant or nursing women from being assigned to or kept in a job that exposes them to lead.

The INRS recommends that all shooting ranges should have adjoining premises, including two changing rooms (one for street clothes and one for work clothes), shower facilities, an office for instructors, a waiting room for shooters, and an equipment room for targets and bullet traps. This list is not exhaustive. Indoor ranges must be equipped with a ventilation and filtration system, which must be maintained in good condition and checked regularly.

For professionals and amateurs alike, it is imperative that they wash hands and face with soap and water after shooting, handling spent shell casings or cleaning weapons, especially before eating, drinking or smoking. Wipes for cleaning the skin without water should be used if access to soap and water is limited. Clothes and shoes should be changed before leaving the range and washed separately from other family clothes back home.

Anyone melting their own ammunition should heat the lead under optimal ventilation conditions, if possible in the open air, and in any case wear a mask with a suitable filter cartridge. Again, hand washing afterwards is imperative.

4. For a description of the RNV3P: https://www.anses.fr/en/content/rnv3p-national-network-monitoring-and-prevention-occupational-diseases

5. Article R 4412-149 du Code du travail

While special medical supervision is provided for professionals, with regular monitoring of blood lead levels, nothing is provided for amateur users, including children. Each shooting licence is awarded subject to an annual medical check-up (as opposed to every 3 years for most other sports). The High Council for Public Health (HCSP) recommends screening for young people aged 6 to 17 when they are exposed to one or more sources of lead or have signs that suggest lead poisoning [2]. General practitioners and paediatricians should therefore be made aware of this problem and prescribe tests to measure blood lead levels when in doubt. The French National Authority for Health (HAS) could be asked to consider whether or not to make the measurement of blood lead levels mandatory, according to procedures that have yet to be defined. Suitable information for shooters or the parents of adolescents who practice shooting could help raise awareness and bring about the necessary changes in behaviour.

**Conclusion**

These recent cases of lead poisoning in shooting enthusiasts, especially children or the adults accompanying them, highlight the problem of exposure to a substance whose high toxicity has long been known. Although the Labour Code organises the management of this risk for professionals working at shooting ranges, these cases show that the regulations and preventive measures are still insufficiently applied, and that both adult shooters and parents of children practising shooting underestimate or are unaware of the risk. The seriousness of this exposure, particularly in children, warrants measures to be taken in communication, prevention and screening, together with enforcement of the regulations by shooting galleries.

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