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Título artículo: Integrating active and passive monitoring to assess sublethal effects and mortality from lead poisoning in birds of prey.

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RESUMEN: The ingestion of lead (Pb) ammunition is the most important exposure pathway to this metal in birds and involve negative consequences to their health. We have performed a passive monitoring of Pb poisoning in birds of prey by measuring liver (n=727) and blood (n=32) Pb levels in individuals of 16 species found dead or sick in Spain between 2004 and 2020.We also performed an active monitoring by measuring blood Pb levels and biomarkers of haem biosynthesis, phosphorus (P) and calcium (Ca) metabolism, oxidative stress and immune function in individuals (n=194) of 9 species trapped alive in the field between 2016 and 2017. Passive monitoring results revealed some species with liver Pb levels associated with severe clinical poisoning (>30 µg/g d.w. of Pb): Eurasian griffon vulture (27/257, 10.5%), red kite (1/132, 0.8%), golden eagle (4/38, 10.5%), and Northern goshawk (1/8, 12.5%). The active monitoring results showed that individuals of bearded vulture (1/3, 33.3%), Eurasian griffon vulture (87/118, 73.7%), Spanish imperial eagle (1/6, 16.7%) and red kite (1/18, 5.6%) had abnormal blood Pb levels (>20 µg/dL). Blood Pb levels increased with age, and both monitoring methods showed seasonality in Pb exposure associated with a delayed effect of the hunting season. In Eurasian griffon, blood Pb concentration was associated with lower δ-ALAD activity in blood and P levels in plasma, and with higher blood lipid peroxidation and plasma carotenoid levels in agreement with other experimental and field studies in Pb-exposed birds. The study reveals that Pb poisoning is a significant cause of death and sublethal effects on haem biosynthesis, P metabolism and oxidative stress in birds of prey in Spain.

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