

Pregnant ewes exposed to multiple endocrine disrupting pollutants through sewage sludge-fertilized pasture show an anti-estrogenic effect in their trabecular bone



P. Monica Lind^a, Denise Öberg^b, Sune Larsson^c, Carol E. Kyle^d, Jan Örberg^b and Stewart M. R

^a Department of Medical Sciences, Occupational and Environmental Medicine, Uppsala University, Ulleråker

^b Department of Environmental Toxicology, Uppsala University, Uppsala, Sweden

^c Department of Orthopaedics, Uppsala University, Uppsala, Sweden

^d Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen AB15 8QH, UK

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Abstract

Pregnant ewes were maintained on pastures fertilized, twice yearly, with either sewage sludge (2.25 tonnes dry matter/ha; Treated; T) or inorganic fertilizer containing equivalent amounts of nitrogen (Control; C), to determine effects on maternal and fetal bone structures, density and mechanical properties of exposure to environmental concentrations of multiple endocrine disrupting compounds (EDCs) and heavy metal pollutants. The ewes were maintained on the respective pastures from the age of about 8 months until they were 4–6 years of age and they were slaughtered at 110 d gestation. Metaphyseal parts of adult ewe femurs exhibited a significantly reduced mean, total cross sectional area (CSA, -4% ; $p < 0.05$), lower trabecular bone mineral content (BMC, mg/mm; -18% ; $p < 0.05$), trabecular bone mineral density (BMD, mg/cm³, -8.0% ; $p < 0.05$) and trabecular CSA, mm², -11.1% ; $p < 0.05$) in T compared with C animals. Femurs of T ewes were stronger than those of C ewes but this may reflect greater body weights.

At the mid-diaphyseal part of the fetal bones, there was a reduction in endosteal circumference (-6.7% , $p < 0.05$) and marrow cavity area (-13.8% , $p < 0.05$) in the female T fetuses compared with female C fetuses. In the male fetuses the mid-diaphyseal part total bone mineral content was higher ($+3.0\%$, $p < 0.05$) in T than in C animals. No treatment difference in biomechanical bending was detected in the fetuses.

It is concluded that ewes grazing pasture fertilized with sewage sludge exhibited an anti-estrogenic effect on their trabecular bone in the form of reduced mineral content and density, despite increased body weight. It is suggested that human exposure to low levels of multiple EDCs may have implications for bone structure and human health.

Keywords: Sewage sludge; Trabecular bone; Sheep; EDCs; Gestation; Pollutants