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Bone and renal effects of low-level environmental exposure to cadmium in postmenopausal women: a cross-sectional study in Brazil

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Abstract

Background: It is widely recognized that exposure to high levels of the hazardous heavy metal cadmium (Cd) leads to renal and bone damage [1], but the association with low-level environmental exposure remains less clear. **Objective:** To assess the effect of environmental Cd exposure on bone and kidney function in postmenopausal women, who may already be at heightened risk of bone and kidney-related complications. **Methods:** A cross-sectional study with 380 postmenopausal women aged 50-70 years, living in the region of Cascavel, Paraná, Brazil was conducted. These participants had no history of occupational exposure to Cd. Information on demographic, clinical, and health behavior factors was obtained. Urinary Cd (UCd), a marker of lifetime exposure to this metal, was measured through inductively coupled plasma mass spectrometry. Renal tubular function was assessed by measurement of urinary beta-2-microglobulin (b2-MG). Bone mineral density (BMD) at the lumbar spine, femoral neck, and total hip was assessed by dual-energy x-ray emission. Data were analyzed using univariate and multivariate statistics. **Results:** UCd concentrations were generally low in this population, with a median concentration of 0.30 µg/g creat (P25=0.15; P75=0.55 µg/g creat). Univariate analysis showed a significant negative correlation between BMD and age at all measured sites ($p < 0.001$), whereas a significant positive correlation with body mass index (BMI, $p < 0.001$) was found. For both lumbar spine and femoral neck sites, we observed a trend to higher UCd levels from normal to osteoporosis groups ($p = 0.110$ and $p = 0.067$, respectively). A statistically higher percentage of women with UCd levels above the P95 of the Brazilian women reference level [2] was observed in osteopenia and particularly in osteoporosis groups versus normal group (7.2% and 20% vs 7.7%, $p = 0.012$; 12% and 16% vs 5.3%, $p = 0.024$, respectively). In multivariate analyses, after controlling for confounding variables, age and prior fractures were negatively associated with BMD at all measured sites ($p < 0.001$ and $p < 0.05$, respectively), whereas a positive association was found for BMI ($p < 0.001$), and no significant association was found for UCd. UCd was found to be a significant predictor of renal tubular damage ($p < 0.001$), with higher UCd concentrations associated with increased urinary b2-MG levels. **Conclusions:** These findings suggest a strong association of environmental Cd exposure with renal tubular dysfunction in this population. However, the association with BMD appears to be weak, suggesting nuanced effects of low-level Cd exposure on bone health.

Keywords: cadmium; bone mineral density; postmenopausal; beta-2-microglobulin; osteoporosis

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