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The Nervous System Effects of Occupational Exposure on Workers in a South African Manganese Smelter

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Abstract

Five hundred and nine production workers at a manganese (Mn) smelting works comprising eight production facilities and 67 external controls were studied cross-sectionally for Mn related neurobehavioural effects. Exposure measures from personal sampling included Mn in inhalable dust as cumulative exposure indices (CEI) and average intensity (INT). Biological exposure and biological effect measures included blood (MnB), urine (MnU) manganese and serum prolactin. Endpoints included items from the Swedish nervous system questionnaire (Q16), World Health Organisation neurobehavioural core test battery (WHO NCTB), Swedish performance evaluation system (SPES), Luriaâ€“Nebraska (LN), and Danish product development (DPD) test batteries, and a brief clinical examination. Potential confounders and effect modifiers included age, educational level, alcohol and tobacco consumption, neurotoxic exposures

in previous work, past medical history, previous head injury and home language. Associations were evaluated by multiple linear and logistic regression modelling. Modelling assumptions were tested. Average exposure intensity across all jobs ranged from near 0 ($0.06 \hat{=} 1/4 \text{g/m}^3$) for external controls to $5.08 \hat{=} \text{mg/m}^3$ for inhalable Mn, and was greater than the ACGIH TLV for 69% of subjects. Results from the large number of tests performed resolved into three groups. Group 1 shows differences between external unexposed referents and all the exposed and/or differences between internal low exposed referents and the rest of the exposed but no further exposureâ€™ response relationships. It includes the Santa Ana, Benton and digit-span tests from the WHO NCTB; the hand tapping and endurance tapping tests from the SPES; Luriaâ€™ Nebraska item 2L; questionnaire items tired, depressed, irritated, having to take notes in order to remember things, and subjectsâ€™ perception that they had sex less often than normal; a test of clinical abnormality; and increased sway under two conditions (eyes open without foot insulation, eyes open with foot insulation). Group 2 shows the presence of a more substantive exposureâ€™ response relationship. It consists of only two tests: and includes the WHO digit-symbol test (although the major impact is at low exposure and therefore counterintuitive, arguably placing this test in group 3) and the LN item 1R which has a step to a poorer score at high exposure. Group 3 contains the overwhelming majority of test results (almost all the questionnaire items, almost all the DPD tests including tremor, sway and diadochokinesia, and serum prolactin) which were either null or counterintuitive (did not make sense). The CEI was the strongest predictor of test abnormalities, except for the clinical test which was more strongly associated with blood manganese. Despite a comprehensive range of endpoints, and levels of exposure ranging from environmental to industrial, this large study of Mn workers found little convincing evidence for a continuum of effects, contributing further questions to current debates about the adequacy of the current ACGIH TLV.



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Keywords

Manganese; Neurotoxicity; Occupational; Exposure; Neurobehavioural

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