

Manganese Health Research Program: Recent published literature

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Introduction

This report presents the bibliographic details of papers identified as being first published during the period January 2011 to March 2011.

The papers were selected because they address research areas that are considered of direct relevance to the health effects of manganese (Mn); in order to aid review, the papers are presented under the following categories:

Section 1 - EXPOSURE MEASUREMENT AND MODELLING: Papers relating to the measurements or modelling of environmental and occupational Mn exposure, the development of biomarkers of exposure or effect.

Section 2 - HEALTH EFFECTS: Papers on the influence of Mn on health, disease and dysfunction.

Section 3 - MECHANISM: Papers on the physiological, biochemical and cellular mechanisms underlying the toxic effects of Mn.

Section 4 - HUMAN SUSCEPTIBILITY: Papers relating to assessment of the influence of genetic and epigenetic factors on human susceptibility to the effects of Mn.

Section 5 - TREATMENT AND IMAGING: Papers on the development and implementation of new medical approaches to the treatment of excessive Mn exposure.

Section 6 - MISCELLANEOUS: Other papers considered of interest or potential relevance to the study of the health effects of Mn.

The papers presented herein were identified using a series of structured searches of the following on-line databases: Medline, Toxline, Biological Sciences and Scopus. The paper abstracts were reviewed and categorised by an experience Scientist to confirm their relevance before inclusion in this report.

1. EXPOSURE MEASUREMENT AND MODELLING

Al-Rmalli, S., Jenkins, R. & Haris, P. (2011) Betel Quid Chewing as a Source of Manganese Exposure: Total Daily Intake of Manganese in a Bangladeshi Population. *BMC Public Health [Online Journal]*, 11(1), 85. Available at: <http://www.biomedcentral.com/1471-2458/11/1/85>.

Arora, M., Hare, D., Austin, C., *et al.* (2011) Spatial Distribution of Manganese in Enamel and Coronal Dentine of Human Primary Teeth. *The Science of the Total Environment*, 409(7), 1315-1319.

Batterman, S., Su, F., Jia, C., *et al.* (2011) Manganese and Lead in Children's Blood and Airborne Particulate Matter in Durban, South Africa. *Science of the Total Environment*, 409(6), 1058-1068.

Bocca, B., Mattei, D., Pino, A., *et al.* (2010) Italian Network for Human Biomonitoring of Metals: Preliminary Results from Two Regions. *Annali Dell'Istituto Superiore Di Sanita*, 46(3), 259-265. Available at: http://www.iss.it/binary/publ/cont/ANN_10_03_06.pdf

Bouchard, M.F., Sauve, S., Barbeau, B., *et al.* (2011) Intellectual Impairment in School-Age Children Exposed to Manganese from Drinking Water. *Environmental Health Perspectives*, 119(1), 138-143. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3018493/pdf/ehp-119-138.pdf>

Chen, Y., Liao, H., Hwang, Y., *et al.* (2011) In Utero Exposure to Neurotoxic Metals and Neurodevelopment at 2 Years of Age. *Epidemiology*, 22(Suppl. 1), S168. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Environmental Health Effects on Susceptible Populations.

Chung, S.E., Cheong, H., Kwon, H., *et al.* (2011) The Effect of Blood Manganese Level on Neurobehavioral Function in Early School Age Children. *Epidemiology*, 22(Suppl. 1), S283. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Children's Environmental Health - National and International Children's Studies.

Chung, S., Cheong, H., Kwon, H., *et al.* (2011) The Effect of between Blood Manganese Level and Attention Deficit/Hyperactivity Disorder Index in Early School Age Children. *Epidemiology*, 22(Suppl. 1), S69-S70. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Dydak, U., Jiang, Y., Long, L., *et al.* (2011) In Vivo Measurement of Brain GABA Concentrations by Magnetic Resonance Spectroscopy in Smelters Occupationally Exposed to Manganese. *Environmental Health Perspectives*, 119(2), 219-224. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3040609/pdf/ehp-119-219.pdf>

Eum, J., Cheong, H., Ha, E., *et al.* (2011) Maternal Manganese Exposure and Infant Birth Weight. *Epidemiology*, 22(1), S70. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Gil, F., Hernández, A.F., Márquez, C., *et al.* (2011) Biomonitorization of Cadmium, Chromium, Manganese, Nickel and Lead in Whole Blood, Urine, Axillary Hair and Saliva in an Occupationally Exposed Population. *Science of the Total Environment*, 409(6), 1172-1180.

Graziano, J., Parvez, F., Liu, X., *et al* (2011) Arsenic and Manganese Exposure and Children's Intellectual Function in Bangladesh. *Epidemiology*, 22(Suppl. 1), S49. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Arsenic Crisis in the Ganges Delta: What Have We Learned? (Part I).

Hobson, A., Seixas, N., Sterling, D., *et al.* (2011) Estimation of Particulate Mass and Manganese Exposure Levels among Welders. *The Annals of Occupational Hygiene*, 55(1), 113-125. .

Ikeda, M., Ohashi, F., Fukui, Y., *et al.* (2011) Cadmium, Chromium, Lead, Manganese and Nickel Concentrations in Blood of Women in Non-Polluted Areas in Japan, as Determined by Inductively Coupled Plasma-Sector Field-Mass Spectrometry. *International Archives of Occupational and Environmental Health*, 84(2), 139-150.

Kim, Y. & Lee, B. (2011) Iron Deficiency Increases Blood Manganese Level in the Korean General Population According to KNHANES 2008. *Neurotoxicology*, 32(2), 247-254.

Laohaudomchok, W., Lin, X., Herrick, R.F., *et al.* (2011) Neuropsychological Effects of Low-Level Manganese Exposure in Welders. *Neurotoxicology*, 32(2), 171-179.

Laohaudomchok, W., Lin, X., Herrick, R., *et al* (2011) Toenail, Blood and Urine as Biomarkers of Occupational Exposure to Manganese. *Epidemiology*, 22(Suppl. 1), S93-S94. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Exposure Assessment by Various Media and Pathways.

Lin, Y., Leon Guo, Y., Chen, P., *et al.* (2011) Associations between Petrol-Station Density and Manganese and Lead in the Cord Blood of Newborns Living in Taiwan. *Environmental Research*, 111(2), 260-265.

Marreilha dos Santos, A.P., Lopes Santos, M., Batoréu, M.C., *et al.* (2011) Prolactin is a Peripheral Marker of Manganese Neurotoxicity. *Brain Research*, 1382, 282-290.

Menezes-Filho, J.A., Novaes, C.d.O., Moreira, J.C., *et al.* (2011) Elevated Manganese and Cognitive Performance in School-Aged Children and their Mothers. *Environmental Research*, 111(1), 156-163.

Turos, O., Markevych, Y., Petrosian, A., *et al* (2011) Case Study on Risk Assessment from Manganese Inhalation Impact on Children's Health. *Epidemiology*, 22(Suppl. 1), S69. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Weiss, B. (2011) Lead, Manganese, and Methylmercury as Risk Factors for Neurobehavioral Impairment in Advanced Age. *International Journal of Alzheimer's Disease*, Article ID 607543. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3014718/pdf/IJAD2011-607543.pdf>

Willis, A.W., Evanoff, B.A., Lian, M., *et al.* (2010) Metal Emissions and Urban Incident Parkinson Disease: A Community Health Study of Medicare Beneficiaries by using Geographic Information Systems. *American Journal of Epidemiology*, 172(12), 1357-1363.

Zheng, W., Fu, S.X., Dydak, U., *et al.* (2011) Biomarkers of Manganese Intoxication. *Neurotoxicology*, 32(1), 1-8.

2. HEALTH EFFECTS

Bouchard, M.F., Sauve, S., Barbeau, B., *et al.* (2011) Intellectual Impairment in School-Age Children Exposed to Manganese from Drinking Water. *Environmental Health Perspectives*, 119(1), 138-143. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3018493/pdf/ehp-119-138.pdf>

Chang, Y., Song, H.J., Lee, J.J., *et al.* (2010) Neuroplastic Changes within the Brains of Manganese-Exposed Welders: Recruiting Additional Neural Resources for Successful Motor Performance. *Occupational and Environmental Medicine*, 67(12), 809-815.

Chen, Y., Liao, H., Hwang, Y., *et al.* (2011) In Utero Exposure to Neurotoxic Metals and Neurodevelopment at 2 Years of Age. *Epidemiology*, 22(Suppl. 1), S168. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Environmental Health Effects on Susceptible Populations.

Chung, S.E., Cheong, H., Kwon, H., *et al.* (2011) The Effect of Blood Manganese Level on Neurobehavioral Function in Early School Age Children. *Epidemiology*, 22(Suppl. 1), S283. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Children's Environmental Health - National and International Children's Studies.

Chung, S.E., Park, H., Chang, N., *et al.* (2011) Effect of in Utero Exposure to Manganese on the Neurodevelopment of the Infant. *Epidemiology*, 22(Suppl. 1), S70. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Chung, S., Cheong, H., Kwon, H., *et al.* (2011) The Effect of between Blood Manganese Level and Attention Deficit/Hyperactivity Disorder Index in Early School Age Children. *Epidemiology*, 22(Suppl. 1), S69-S70. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Ding, D., Roth, J. & Salvi, R. (2011) Manganese is Toxic to Spiral Ganglion Neurons and Hair Cells in Vitro. *Neurotoxicology*, 32(2), 233-241.

Dydak, U., Jiang, Y., Long, L., *et al.* (2011) In Vivo Measurement of Brain GABA Concentrations by Magnetic Resonance Spectroscopy in Smelters Occupationally Exposed to Manganese. *Environmental Health Perspectives*, 119(2), 219-224. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3040609/pdf/ehp-119-219.pdf>

Eum, J., Cheong, H., Ha, E., *et al.* (2011) Maternal Manganese Exposure and Infant Birth Weight. *Epidemiology*, 22(1), S70. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Graziano, J., Parvez, F., Liu, X., *et al.* (2011) Arsenic and Manganese Exposure and Children's Intellectual Function in Bangladesh. *Epidemiology*, 22(Suppl. 1), S49. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Arsenic Crisis in the Ganges Delta: What Have We Learned? (Part I).

Jain, S. & Ferrando, S.J. (2011) Manganese Neurotoxicity Presenting with Depression, Psychosis and Catatonia. *Psychosomatics*, 52(1), 74-77.

Laohaudomchok, W., Lin, X., Herrick, R.F., *et al.* (2011) Neuropsychological Effects of Low-Level Manganese Exposure in Welders. *Neurotoxicology*, 32(2), 171-179.

Menezes-Filho, J.A., Novaes, C.d.O., Moreira, J.C., *et al.* (2011) Elevated Manganese and Cognitive Performance in School-Aged Children and their Mothers. *Environmental Research*, 111(1), 156-163.

Turos, O., Markevych, Y., Petrosian, A., *et al* (2011) Case Study on Risk Assessment from Manganese Inhalation Impact on Children's Health. *Epidemiology*, 22(Suppl. 1), S69. Abstract presented at the ISEE 22nd Annual Conference, Seoul, Korea, 28 August-1 September 2010: Manganese and Children's Health.

Weiss, B. (2011) Lead, Manganese, and Methylmercury as Risk Factors for Neurobehavioral Impairment in Advanced Age. *International Journal of Alzheimer's Disease*, Article ID 607543. Available at:
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3014718/pdf/IJAD2011-607543.pdf>

3. MECHANISM

Cai, T., Che, H., Yao, T., *et al.* (2011) Manganese Induces Tau Hyperphosphorylation through the Activation of ERK MAPK Pathway in PC12 Cells. *Toxicological Sciences*, 119(1), 169-177.

Crittenden, P.L. & Filipov, N.M. (2011) Manganese Modulation of MAPK Pathways: Effects on Upstream Mitogen Activated Protein Kinase Kinases and Mitogen Activated Kinase Phosphatase-1 in Microglial Cells. *Journal of Applied Toxicology*, 31(1), 1-10.

Fordahl, S.C., Anderson, J.G., Cooney, P.T., *et al.* (2010) Manganese Exposure Inhibits the Clearance of Extracellular GABA and Influences Taurine Homeostasis in the Striatum of Developing Rats. *Neurotoxicology*, 31(6), 639-646.

Leitch, S., Feng, M., Muend, S., *et al.* (2010) Vesicular Distribution of Secretory Pathway Ca²⁺-ATPase Isoform 1 and a Role in Manganese Detoxification in Liver-Derived Polarized Cells. *BioMetals*, 24(1), 159-170.

Parkel, S., Töntson, L. & Rinke, A. (2011) Millimolar Mn²⁺ Influences Agonist Binding to 5-HT_{1A} Receptors by Inhibiting Guanosine Nucleotide Binding to Receptor-Coupled G-Proteins. *Neurotoxicology*, 32(1), 25-30.

Sidoryk-Wegrzynowicz, M., Lee, E.S., Ni, M., *et al.* (2010) Manganese-Induced Downregulation of Astroglial Glutamine Transporter SNAT3 Involves Ubiquitin-Mediated Proteolytic System. *Glia*, 58(16), 1905-1912.

Verina, T., Kiihl, S.F., Schneider, J.S., *et al.* (2011) Manganese Exposure Induces Microglia Activation and Dystrophy in the Substantia Nigra of Non-Human Primates. *Neurotoxicology*, 32(2), 215-226.

4. HUMAN SUSCEPTIBILITY

No relevant papers identified.

5. TREATMENT AND IMAGING

Chtourou, Y., Fetoui, H., Sefi, M., *et al.* (2010) Silymarin, a Natural Antioxidant, Protects Cerebral Cortex Against Manganese-Induced Neurotoxicity in Adult Rats. *Biometals*, 23(6), 985-996.

Jackson, S.J., Hussey, R., Jansen, M.A., *et al.* (2011) Manganese-Enhanced Magnetic Resonance Imaging (MEMRI) of Rat Brain After Systemic Administration of MnCl₂: Hippocampal Signal Enhancement without Disruption of Hippocampus-Dependent Behavior. *Behavioural Brain Research*, 216(1), 293-300. Available at: <http://www.psychology.nottingham.ac.uk/staff/lpztb1/Jackson%20et%20al%202011%20Behav%20Brain%20Res.pdf>

6. MISCELLANEOUS

- Brown, D.R. (2010) Prions and Manganese: A Maddening Beast. *Metallomics*, 3(3), 229-238.
- Colin-Barenque, L., Souza-Gallardo, L.M. & Fortoul, T.I. (2011) Toxic Effects of Inhaled Manganese on the Olfactory Bulb: An Ultrastructural Approach in Mice. *Journal of Electron Microscopy*, 60(1), 73-78.
- Fitsanakis, V.A., Zhang, N., Avison, M.J., *et al.* (2011) Changes in Dietary Iron Exacerbate Regional Brain Manganese Accumulation as Determined by Magnetic Resonance Imaging. *Toxicological Sciences*, 120(1), 146-153.
- Fujishiro, H., Kubota, K., Inoue, D., *et al.* (2011) Cross-Resistance of Cadmium-Resistant Cells to Manganese is Associated with Reduced Accumulation of both Cadmium and Manganese. *Toxicology*, 280(3), 118-125.
- Galvez-Gastelum, F.J., Garcia-Banuelos, J.J., Beas-Zarate, C., *et al.* (2011) Combinatorial Gene Therapy Induces Regression of Hepatic Encephalopathy. *Gene Therapy*, 18(1), 88-94.
- Hackbart, K.S., Ferreira, R.M., Dietsche, A.A., *et al.* (2010) Effect of Dietary Organic Zinc, Manganese, Copper, and Cobalt Supplementation on Milk Production, Follicular Growth, Embryo Quality, and Tissue Mineral Concentrations in Dairy Cows. *Journal of Animal Science*, 88(12), 3856-3870.
- Jacobsen, F.E., Kazmierczak, K.M., Lisher, J.P., *et al.* (2011) Interplay between Manganese and Zinc Homeostasis in the Human Pathogen *Streptococcus Pneumoniae*. *Metallomics*, 3(1), 38-41.
- Khajeh, M. (2010) Silver Nanoparticles for the Adsorption of Manganese from Biological Samples. *Biological Trace Element Research*, 138(1-3), 337-345.
- Mukhopadhyay, S. & Linstedt, A.D. (2011) Identification of a Gain-of-Function Mutation in a Golgi P-Type ATPase that Enhances Mn²⁺ Efflux and Protects Against Toxicity. *Proceedings of the National Academy of Sciences of the United States of America*, 108(2), 858-863.
- Sikk, K., Haldre, S., Aquilonius, S.M., *et al.* (2011) Manganese-Induced Parkinsonism due to Ephedrone Abuse. *Parkinson's Disease*, , Article ID 865319. Available at: <http://downloads.sage-hindawi.com/journals/pd/2011/865319.pdf>
- Stepens, A., Stagg, C.J., Platkajis, A., *et al.* (2010) White Matter Abnormalities in Methcathinone Abusers with an Extrapyrmidal Syndrome. *Brain*, 133(12), 3676-3684.