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Chronic manganese exposure: The assessment of psychological symptoms among manganese mineworkers

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Abstract

Manganese is an essential micronutrient for humans and animals as a cofactor are exists in enzymatic reactions. The main target organ of manganese is central nervous system. This study have been implemented in Iran for the first time in the assessment of the psychological symptoms among manganese mineworkers. The mines are located in the central state of Iran. Mn-exposed (n=35) and control group (n=35) were selected. In this study the SCL-90-R questionnaire was used to evaluate psychological disorder. The obtained results from this study exhibits that psychological disorder include somatization, obsessive–compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism in manganese mineworkers are significantly higher than workers in control group (p-Value < 0.05). To prevention of psychological disorder in mineworkers; work-shift change periodically, using filtered masks and ventilation tunnels and also psychological counseling are recommended.

Keywords: Manganese, Chronic exposure, Mineworkers, SCL-90-R, Psychological disorder

Introduction

Manganese (Mn) is an essential micronutrient for humans and animals as a cofactor are exists in enzymatic reactions. Mn is naturally in the vegetables, cereals, tea, fruits, egg and drinking water. It also plays a key role in the various enzymatic reactions involved in the growth and development of the skeletal system, metabolism of lipids, carbohydrates, amino acids, immune function, nervous system function, reproductive function and blood clotting. Manganese is an important component of superoxide dismutase (SOD) enzyme which are needed in all aerobic cells and detoxification of oxygen metabolites (ROS). List of manganese dependent on enzyme family are included Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases and Ligases (Klaassen, 2013). Manganese can be used as Production of dry batteries, oxidizing agents in the coating of welding electrodes, paint industry and in the preparation of other chemicals such as fungicides. There are many reports about the lack of this micronutrient in human societies and what is more important aspects of manganese toxicity in normal functioning of the body (ATSDR, 2012). Inhalation or ingestion is the major way to entry of manganese to body. Ingested manganese conjugates to bile in the Liver and then excreted into the intestine. Feces is the main way of Mn excretion. Manganese bound with various proteins such as plasma macroglobulin, albumin and citrate that spread throughout the body. Manganese also crossing the blood-brain barrier and then accumulates in the brain and long half-life is in there. Occupational exposures and chronic exposure to manganese in mines and industrial sites that are somehow involved with manganese, mostly through Inhalation (Levy & Nassetta, 2003). The main target organ of manganese toxicity is Central Nervous System (CNS). High levels of manganese accumulate in different parts of the brain as globus pallidus, striatum, substantia nigra that will be leading to motor deficits and decreased levels of neurotransmitters. Manganese is a component in the synthesis of antioxidant enzymes and the metabolism of neurotransmitters. Manganese ions can be easily production free radicals and then leading to auto oxidation of the neurotransmitters. Manganese also changes the cycle of intracellular catecholamines that causes the disturbance on the antioxidant levels. Several mechanisms are involved in manganese toxicity which induction of oxidative stress via ROS production and other secondary oxidants such as superoxide, H_2O_2, or peroxynitrite (ONOO-) that more dangerous leads to the failure of mitochondrial metabolism, neurotransmitter metabolism and changes in iron homeostasis. Thus, oxidative stress plays a major role in the detection of toxic demonstration induced by manganese. Inhibition of GSH synthesis and Damage to neuronal antioxidant system plays major role in manganese neurotoxicity (Nordberg, 2014). High concentrations of manganese in the brain is called “Manganism” that creates neurological syndromes like Parkinson's disease, it can be clinically distinguished from Parkinson. Manganism patients having a hypokinesia and tremor that is different from Parkinson’s patients. General symptoms related to Mn exposure such as, behavioral changes, anger , memory loss, lack of concentration, bradykinesia or move slowly, less frequent resting tremor, rigidity, frequent dystonia of the trunk and extremities and extrapyramidal movement disorder with characteristic " cock-walk "; and difficulty in walking backwards is observed (Olanow, 2004). Other studies showed that manganese has been affected on reproductive system, cardiovascular, hematological and immunological (Nordberg, 2014; Santos et al., 2012; Antonini et al., 2012). Psychological disorder occurs in relation to dysfunction of the biological, social, genetic, physical, or chemical. The suffering and limitations are associated with psychological disorder because the persons having suffer from discrimination in social and professional activities. Care of patients, physical and

emotional support to their families and also the economic burden should not be ignored (Sadock & Sadock, 2008).

Research methodology

The population, sample and sampling

The case-control study was chosen. Inclusion criteria were manganese and control group who work experience more than 5 years. The two mines are located in the central state of Iran. 35 manganese mineworkers were selected as Mn-exposed group. These workers in mining tunnels directly are exposed to manganese dust. Demographic information were include age, level of education, work experience, marital status, smoking and history of cardiovascular disease. Workers who were illiterate to filling out the questionnaires, interview method was used.

Research tools

One of the most widely used for assessment of psychological disorder is Symptom Checklist-90-Revised or SCL-90-R. The first questionnaire by Derogatis, Lipman and Covi was built in 1973 and then revised (Derogatis et al., 1973). It is designed to evaluate a broad range of psychological disorder and symptoms of psychopathology. The questionnaire are include ninety questions to assessment of psychological symptoms. SCL-90-R is self-report questionnaire and in the many studies as a concise index of psychological health (Koh et al. and Preston et al., 2002). Participant gives answer to each questions that measure in a five scale points. Ninety questions test based on nine items have classified. The nine items are include somatization, obsessive–compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Scoring and interpretation of the test with the aid of three index, Global Severity Index (GSI), Positive Symptom Distress Index (PSDI) and Positive Symptom Total (PST) have been done. Global Severity Index (GSI); the best indicator for depth or level of problems at present time that needed briefly measure is used. Also it indicates information about the count of the number and severity of problems symptoms. Positive Symptom Distress Index (PSDI); a pure measure of the severity of problems. Positive Symptom Total (PST); simply counting the number of positive signs that the patient's own reports. Derogatis confirmed SCL-90-R internal consistency and test-retest reliability between 0.77 and 0.99 have been reported (Derogatis, 1994).

The Analysis of Data

Results of the descriptive statistics, t-test, Chi-square and Fisher exact test was performed. The gained results from this study have been analyzed by SPSS V.20. In all analyzes, the significance level test p-Value < 0.05 has been considered.

Research Findings

Demographic information from the Mn-exposed group and control group using statistical analysis are shown in Table 1.

Table 1: Demographics of Mn-exposed mineworkers and control group

Variable	Status	Exposed (*N = 35*)	Control (*N = 35*)	p-Value
Age	-	39.2 (S.D. 8.1)	36.6 (S.D. 5.8)	0.1
Work experience	-	15.4 (S.D. 3.9)	11.5 (S.D. 4.5)	< 0.001
Marital status	Single	1.0 (2.9%)	12.0 (34.3%)	0.001
	Married	34.0 (97.1%)	23.0 (65.7%)	
Current smoking	Smoker	17.0 (48.6%)	10.0 (28.6%)	0.1
	Non-smoker	18.0 (51.4%)	25.0 (71.4%)	
History of cardiovascular disease	Yes	9.0 (25.7%)	2.0 (5.7%)	0.04
	No	26.0 (74.3%)	33.0 (94.3)	
Level of education	Illiterate	1.0 (2.9%)	0.0 (0.0%)	< 0.001
	Rudimentary	18.0 (51.4%)	3.0 (8.6%)	
	Junior high school	7.0 (20.0%)	8.0 (22.9%)	
	Diploma	8.0 (22.9%)	17.0 (48.6%)	
	Collegiate	1.0 (2.9%)	7.0 (20.0%)	

Independent t-test showed that, there is a significant difference between the two groups in terms of work experience while there was no significant difference between the two groups in terms of age. Chi-square test showed that between two groups in terms of marital status and history of cardiovascular disease, there is a significant difference whereas two groups in terms of smoking status, there is no significant difference. And Fisher exact test showed that, there is a significant difference between the two groups in terms of educational level.

Psychological symptoms between exposed and control groups were compared. According to the obtained results suggest that the incidence of psychological disorder among Mn-exposed group in comparison with control group (non- exposed to Mn), was significantly higher (Fig. 1).

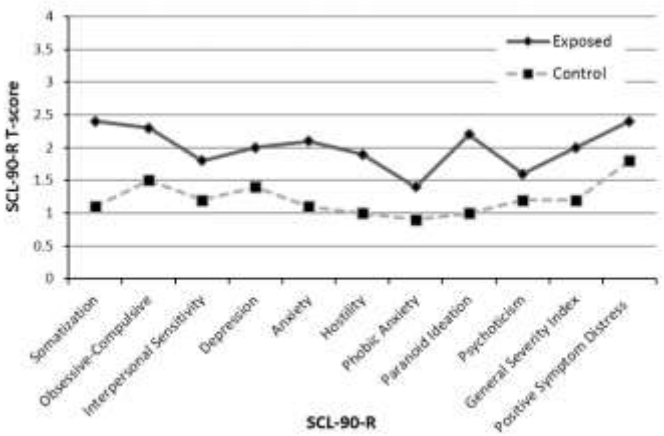


Fig. 1. SCL-90-R T-scores in of Mn-exposed mineworkers and control group

Logistic regression models to obtain the adjusted odds ratio were used. Odds ratios with respect to the four variables were adjusted as work experience, marital status, history of cardiovascular disease and level of education that are shown in Table 2. The odds ratio of somatization, anxiety, hostility, paranoid ideation and General Severity Index (GSI) was significant.

Table 2: Presence of psychological symptoms and odds ratios in Mn-exposed mineworkers and control group

	Exposed (*n = 35*)		Control (*n = 35*)				
Domain	n	%	N	%	Estimated adjusted odds ratio	95% CI	p-Value
Somatization	15	42.9	2	5.7	15.9	2-129	0.01
Obsessive–Compulsive	14	40.0	5	14.3	4.3	1.1-20.1	0.06
Interpersonal Sensitivity	5	14.3	2	5.7	2.6	0.3-20.4	0.3
Depression	9	25.7	4	11.4	2.6	0.5-12.4	0.2
Anxiety	10	28.6	2	5.7	8.7	2.2-60.8	0.02
Hostility	12	34.3	2	5.7	7.6	1.1-49	0.03
Phobic Anxiety	2	5.7	2	5.7	1.05	0.09-12	0.9
Paranoid Ideation	17	48.6	6	17.1	4.7	1.1-19.2	0.02
Psychoticism	3	8.6	2	5.7	2.02	0.2-18.6	0.5
Global Severity Index	33	94.3	17	48.6	7.5	1.07-52.4	0.04

The odds ratio for somatization, anxiety, hostility, paranoid ideation and GIS were estimated as 15.9, 8.7, 7.6, 4.7 and 7.5 respectively which means, the risk of somatization, anxiety, hostility, paranoid ideation disorder and GIS who are Mn-exposed than those who non-exposed will be 15.9, 8.7, 7.6, 4.7 and 7.5 respectively.

According to recent years the assessment of the psychological disorder using SCL-90-R on manganese mineworkers have not been implemented in Iran hence in this study for the first time it has been investigated. In this study the psychological effects of chronic exposure to manganese in 35 manganese mineworkers (mean age = 39.2) and control group (mean age = 36.6) were assessed. Recent research exhibits that even low concentrations of manganese leading to neuropsychological effects may manifest particularly with respect to attention, mood, and fine motor control (Laohaudomchok et al., 2011). In another study, neuropsychological and neurological symptoms in welders exposed to manganese fumes were measured. Psychological symptoms such as anxiety, depression and sleep disorder were done (Bowler et al., 2006). There are many studies that confirmed the neurological and neuropsychological symptoms of manganese (Rodier, 1995; Martinez-Finley et al., 2013 and Dobson et al., 2004). The obtained results from this study showed that psychological disorder include somatization, obsessive–compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism and Global Severity Index (GSI) in manganese mineworkers are significantly higher than

workers in control group (p-Value<0.05) that confirms all results of the last researches about manganese exposure.

Conclusion

In this study, the SCL-90-R test for the first time to assess psychological disorder in manganese mineworkers was used that obtained results confirmed all of previous studies. Between somatization in Mn-exposed workers with a history of cardiovascular disease, there is a significant difference, in other words that probably cardiovascular disease can be considerable effect on their somatization. As mentioned most workers were at the same rudimentary education level and married, it is possible that family life, marital problems and lack of appropriate life skill in solving these issues can led to increased anxiety and hostility. A review of previous studies on neurological, neurobehavioral and neuropsychological problems of Mn exposure and according to the gained results from present study, maybe using the term of "Psycho-Toxicity" to exposure of manganese and other metals that leads to same psychological disorder associated with Mn exposure. To prevention of psychological disorder in manganese mineworkers; work-shift change periodically, using filtered masks and ventilation tunnels and also psychological counseling are recommended.

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