In the name of GOD

Manganese Biomonitoring for assessment of Exposure to Airborne Manganese in Foundry Plants

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Introduction

INTRODUCTION

A foundry process is a technology that produces metal castings, and selected metals are cast into many shapes by melting them into a liquid phase and pouring the metal in a prepared.[1]

INTRODUCTION

During melting process plenty of airborne particles and fume included manganese generate around worker respiratory system area.

INTRODUCTION

Mn is generally accepted as essentials element for human, but for risk assessment related to exposure, it is need to consider both toxicity from high exposures and health effects as a result of deficiencies.

INTRODUCTION

Premature neurological effects that happen on exposed workers at low occupational exposure to manganese.

INTRODUCTION

Biological measurements such as blood or urine Mn reveal recent exposure.

INTRODUCTION

An academic issue for excretion and metabolism of manganese in human is the level of manganese evaluation in blood and urine as biomarker of exposure of this metal .

INTRODUCTION

The aim of the present study was to evaluate the levels manganese in exposed workers' blood serum.

Material and methods

Material and methods

Total workers of about 300 employees of whom the
170 workers exposed to MnO and Mn dust at present.
A group of 130 persons corresponding to control
workers not exposed to Mn or a related chemicals.

Material and methods

About 25% of the participants in every group were worked on a temporary night shift (10.00 pm-6.00 am) and 75% worked as day time shift.

Material and methods

Biomarkers of exposure should be evaluated in a period that reflects the half-life of Mn in the exposed human body.

Material and methods

The half-life of Mn is about 10-42 days in blood and more than 200 days in the brain.

Two groups of workers divided in cases (n= 35) and controls (n= 35). The case group was from the furnace, melting, pouring, surface cleaning and finishing sections.

Material and methods

A venous blood sample (20 ml) was collected on the day of the clinical assessment.

Material and methods

Sampling syringes and containers were formerly assessed for trace of heavy metal pollution.

Material and methods

Heparinized blood was gathered between 08.00 and 09.00 a.m. on the same day and the samples were stored at -20 ºC until analysis.

2.5 ml of ultra pure 65% nitric acid was added to 2 ml of whole blood for measurement of manganese (B-Mn).

Material and methods

The samples was analyzed for Mn serum
by atomic absorbsion spectroscopy (AAS, Perkin-Elmer).

Statistical Analysis

The sample volume was determined by the following statistical formula:

$$n = \frac{(Z_{1-\frac{\alpha}{2}} + Z1 - \beta)2 \times \lambda}{(\lambda - \lambda 0)2}$$

Which is; $Z_{1-\beta}=0.84$, $\lambda=1.31$, $\lambda_0=1$‘$Z_{1-\alpha/2}= 1.96$.

Simple regression analysis was performed to find signification of dependent variables in the current study.

The average of B-Mn values were compared using one way ANOVA and correlation analysis was performed to find possibly relationship between variables.

RESULTS

RESULTS

The subjects was classified into two groups; subjects who working from less than 3 months working experience as group one and workers have 3 to 12 months working experience as group two.

Table1: Characteristics of manganese exposed workers and controls

Parameters	Mn exposed subjects n= 35	Controls n= 35
Age (years)	38±9	34±6
Weight (kg)	70±12	71±8
Height (cm)	172±9	173±8
Working experience (months)	1-12	1-12

RESULTS

The highest mean value of manganese (Mn) concentration was 4.5 mg/m^3 from indoor air samples (Table 2). The average Mn concentration of the subject's blood serum (B-Mn) were 2.745 and 274.85 µg/l for less than three months (n=35) and 3 to 12 months working experience (n= 35), respectively.

Table 2: Characteristics of workstation and Mn airborne concentration NIOSH time weighted average for air-Mn: 1 mg/m^3

Symptoms	N	Mean air-Mn mg/m^3	Max air-Mn mg/m^3	Min air-Mn mg/m^3
Furnace men	7	3.04	4.5	2.1
Melting	7	1.95	1.92	1.614
Pouring	7	1.071	1.2	1
Surface cleaning	7	0.825	1	0.7
Finishing	7	0.478	0.61	0.5

NIOSH time weighted average for air-Mn: 1 mg/m^3

RESULTS

The results of blood analysis indicated high exposure with respect to Mn,
Because of the lowest concentration of Mn in their blood was 0.5 and 10µg/l for less than 3 months and 3 to 12 months working experience, respectively.

This value was higher than the guideline value (1-4 µg/l)

RESULTS

The relationship validates Mn as an initial indicator of a preceding exposure of workers to Mn with *R*=0.543 (according to Table 6).

Table 6: Regression model test by ANOVA for correlation between B-Mn results of 3-10 months exposed subjects and air-Mn exposure

	R	R^2	Eta	Eta^2
Mn Concentration of Air Mn-B 3-12 months- Case	0.543	0.295	0.879	0.773

RESULTS

The results reveals that a group of workers involved in pouring, surface cleaning and finishing workstations had the lowest Mn exposure (0.825 and 0.478 mg/m^3, respectively) and also the highest Mn concentration were seen in furnace and melting workstations at 4.5 and 1.92 mg/m^3.

Table 3: Statistical descriptive for B-Mn of foundry workers (μg/l)

Parameters	Max Concentration n= 35	Min Concentration n= 35	Average Concentration n= 35
Mn-B for less 3 months for subjects	23.5	0.5	2.745
Mn-B 3to12 months for subjects	590	100	274.85
Mn-B for less 3 months for control	0	1	0.314
Mn-B 3to12 months for control	0	2	0.398

Standard level for B-Mn: 1-4 μg/l

RESULTS

Only workers group with 3 to 12 months experience demonstrated a straight correlation between indoor air-Mn pollution and Mn in the blood samples.

Table 4: Regression model test by ANOVA[a] for B-Mn results correlation with air-Mn exposure

Model		Sum of Squares	Df	Mean Square	F	P-value
	Regression	10.067	4	2.517	3.428	0.02[b]
	Residual	22.025	30	0.734		
	Total	32.092	34			

a. Dependent Variable: Mn Concentration of Air

b. Predictors: (Constant), B-Mn 3-12 months- Control, B-Mn 0-3 months-Case, Mn-B 3-12 months- Case, B-Mn 0-3 months- Control

Table 7: Multiple regression analysis for B-Mn evaluation and air-Mn concentration

Variables			Sum of Squares	df	F	P-value	
Air-Mn Concentration B-B-Mn 3-12 months- Case	Between Groups	(Combined)	24.793	21	2.102	0.085	
		Linearity	9.471	1	16.867	0.001	
		Deviation from Linearity	15.321	20	1.364	0.287	
	Within Groups		7.300	13			
	Total		32.092	34			

DISCUTION

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There was a linear relationship between accumulation level in blood and concentrations in air.

Other researchers have shown that increasing manganese concentration increases Mn level in blood serum.

DISCUTION

(1995) studied on 122 workers that exposed to Mn during the melting process in the foundry factory, their finding is close to the results of the current study which they revealed that, there are a straight relationship between air concentration of Mn and concentration of Mn in the exposed workers or Fe/Mn is significant ($r=0.77$, $p<0.$ 0.01).

DISCUTION

The corresponding Mn concentration are found in the blood, the regression correlation tests showed the relationship of these values Mn concentration would cause a corresponding Mn accumulation level in the workers blood .[3,26]

There was a positive association between estimated exposure to Mn and concentration of that accumulated dose as Mn in blood.

DISCUTION

The linear multiple regression models obtained in this study are comprehensive and widen for biological assessment in foundry factories or other similar factories which have equivalent condition.

DISCUTION

Scientists suggested that one of the best ways to assess manganese exposure for workers who exposed to manganese particles and fumes is biomonitoring with emphasis on blood serum evaluation to determine Mn level and the best period for measurement is more than three months exposure experience but not more two years .[31]

DISCUTION

The current evaluation method was well-matched with the above suggested way . according to the current study results it reported that there is a significant different between subject and control blood monitoring result for Mn level .[29]

DISCUTION

The research results found that two of the participants as subjects had some exhibited specific neurological symptoms in this study. The entire subjects showed the highest B-Mn levels, i.e., around 210±30 µg/l including two subjects (had neurological disease symptoms).

DISCUTION

A straight correlation between neurological symptoms and B-Mn levels has been reported in some studies in the literature.

CONCLUSION

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The indoor air quality evaluation in foundry factory reveals that increase of indoor air exposure to manganese particles or fumes in the workplaces caused increasing of manganese level in the exposed workers’ blood.

CONCLUSION

It can be seen from the study finding the air-Mn concentration is directly related to B-Mn concentration for workers with an ANOVA coefficient at r^2=0.295 (with significance level less than 0.001).

The finding of the current study is helpful for neurologists to find the exposed subjects and taking the best decision for the disease treatment.

Any question?

THANK YOU