

## BIOCHEMICAL PARAMETERS OF WORKERS EXPOSED TO MANGANESE

**P. Nikolova, B. Kavaldzhieva**

*Department of Hygiene and Ecology, Medical University, Varna*

*The study covered 34 workers from a manganese mine (group one) and 33 workers from a flux manufacture (group two). The following parameters were examined: total protein, protein fractions, immunoglobulins A, M, and G, total cholesterol, the enzyme activity of ASAT, ALAT, GLDH, LDH, and CE in the serum, as well as manganese in the blood by using the method of atomic absorption spectrophotometry. Blood manganese concentration was reliably elevated. There was reduction of total protein and albumin contents while alpha<sub>2</sub>-globulins were enhanced for the second group only. The immunoglobulin A was increased which was more outlined for the group two whilst the total cholesterol increase was more manifested for the group one. All the enzymes were significantly activated. The necessity for dynamic follow-up of the parameters examined during the evaluation of the health risk and monitoring the health status of workers from manganese-dangerous projects was emphasized.*

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**Key-words:** Manganese, occupational exposure, serum protein profile, immunoglobulins, total cholesterol, enzymes

### INTRODUCTION

Enlarging the application of and environmental pollution with manganese increases the opportunity for manifestation of its unfavourable action. This circumstance determines the permanent interests in manganese and the search for sensitive parameters for evaluation of the health status of individuals exposed to its

action as well as for means influencing upon its biotransformation and excretion from the organism (12, 14, 21, 22).

The changes of biochemical parameters in accessible biological materials present commonly the most sensitive indicators of health status of workers exposed to the action of unfavourable factors from the occupational environment (2).

Having in mind this circumstance we decided to investigate some biochemical parameters of workers from two manganese manufactures with proved professional risk with the view of their usage as toxicodynamic exposure tests in

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*Address for correspondence:*

*Assoc. Prof. P. Nikolova, Dept. of Hygiene and Ecology, Medical University, Varna, 55 Marin Drinov St, BG 9002 Varna, BULGARIA*

case of occupational exposition to manganese.

## MATERIAL AND METHODS

The examination covers 34 miners from a manganese mine with mean age of 43,1 years and length of service of 7,7 years (group one) as well as 33 workers from a flux manufacture with mean age of 43,4 years and length of service of 8,5 years (group two). Workers from both groups do not demonstrate any clinical manifestations of manganese toxicosis.

Air manganese concentration in mine galleries varies from 0,6 till 1,6 mg/m<sup>3</sup>, i.e., it is by 2-5 times higher than the utmost permissible concentration (UPC) (the latter being of 0,3 mg/m<sup>3</sup>). The manganese oxide presents the cardinal harmful factor in flux manufacture and its concentration at different places varies from 0,55 till 2,82 mg/m<sup>3</sup>, i.e., by 2-9 times higher than UPC.

The following parameters are examined in workers' serum: total protein - after the biurette method; protein fractions - by paper electrophoresis with veronal buffer; immunoglobulins A, M, and G - after the turbidimetric method; total cholesterol (TC) - after the enzymatic method; the activity of the enzymes such as aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT), glutamate dehydrogenase (GLDH), lactate dehydrogenase (LDH), and cholinesterase (CE) - after an optimized method with Bohringer test on autoanalyzer. Blood manganese concentration, is estimated by using a "Varian Tehtron" atomic spectrophotometer. Results are compared with these of a control group of 25

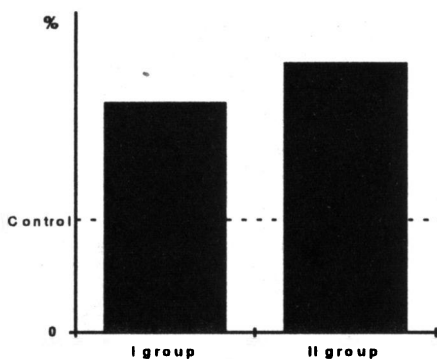


Fig. 1. Manganese blood level (in % towards control).

clinically healthy age-matched individuals without any occupational harmful factors. The variation analysis and Student-Fisher's *t*-criterion are used for data processing and evaluation.

## RESULTS

Our investigation demonstrates that blood manganese concentration has increased when the workers from both groups are concerned ( $p < 0,001$ , Fig. 1).

The concentration of both total protein and albumins is statistically reliably lower than the control one when the second group is concerned only (Table 1). Data about globulin fractions indicate certain differences between both groups. Alpha<sub>2</sub>-globulins are elevated in group two ( $p < 0,001$ , Table 1) while their mean value is lower than the control one in group one ( $p < 0,001$ ) without any significant aberrations of individual values. Immunoglobulin A level is higher which is more outlined in group two as the relative share of persons with anomalies is similar in both groups.

## Biochemical Parameters of Workers Exposed to Manganese

**Table 1**  
Total protein, protein fractions, and immunoglobulins in the serum

Parameter	Controls	I <sup>st</sup> group	P <sub>C/I</sub>	II <sup>nd</sup> group	P <sub>C/II</sub>
Total protein g/l	89,3±4,2	87,0±5,2	> 0,05	77,4±1,06	< 0,02
Albumins	0,56±0,06	0,57±0,05	> 0,05	0,47±0,01	> 0,05
Globulins					
alpha <sub>1</sub>	0,057±0,001	0,06±0,002	> 0,05	0,06±0,001	> 0,05
alpha <sub>2</sub>	0,093±0,001	0,083±0,002	< 0,001	0,13±0,004	< 0,001
beta	0,14±0,018	0,13±0,014	> 0,05	0,16±0,004	> 0,05
gamma	0,176±0,017	0,140±0,011	> 0,05	0,18±0,007	> 0,05
Immunoglobulins g/l					
A	1,27±0,11	2,41±0,10	< 0,001	3,63±0,32	< 0,001
M	1,84±0,24	1,82±0,50	> 0,05	1,33±0,16	> 0,05
G	11,53±1,18	10,14±0,23	> 0,05	13,28±0,86	> 0,05

There exist changes of different degree in the activity of the enzymes investigated, too (Table 2). Both ASAT and ALAT activities are enhanced more demonstratively manifested in group one where 38,7 per cent of the persons show some anomalies while this percentage is only 3,05 for ASAT and 9,09 for ALAT, respectively, in group two. LDH is activated almost equally in both groups ( $p < 0,001$ ). Anomalies are established in 61,3

per cent of the cases in the first group and in 78,9 per cent of the cases in the second one. GLDH is also activated, however, without any significant differences between the mean values in both groups although individuals with anomalies amount to 50 per cent in the first group but the percentage of such individuals is of 36,4 in the second one.

TC which control value is of  $4,46 \pm 0,39$  mmol/l increases up to  $5,87 \pm 0,16$

**Table 2**  
Enzyme activity (U/l)

Enzymes	Controls	I <sup>st</sup> group	P <sub>C/I</sub>	II <sup>nd</sup> group	P <sub>C/II</sub>
ASAT	10,5±1,46	24,70±2,04	< 0,001	12,51±0,81	> 0,05
ALAT	13,35±1,37	22,80±2,95	< 0,001	14,39±1,65	> 0,05
LDH	142,72±7,97	203,98±9,94	< 0,001	200,85±8,45	< 0,001
GLDH	2,48±0,41	6,0±0,58	< 0,001	5,63±0,58	< 0,001
CE	3928,25±71,61	4593,9±88,0	< 0,001	6337±30,14	< 0,001

mmol/l for the first group ( $p < 0.001$ ) and up to  $5.08 \pm 0.14$  mmol/l for the second one ( $p > 0.05$ ). It is found out that workers with TC over 6.22 mmol/l, i.e., with a high and even very high risk for ischemic heart disease amount to 41.08 per cent in group one but to 3.4 per cent only in group two. There exists a certain tendency towards TC elevation with advancing length of service the mean age being almost equal for both groups.

## DISCUSSION

Manganese as an industrial poison induces disturbances of protein metabolism. Our results concerning the diminution of total protein and albumins along with elevation of alpha<sub>2</sub>-globulins for the second group are in concordance with data reported by other authors (10, 13). Dysproteinemia which is more manifested for the second group as compared with the enhanced activity of ASAT, ALAT, and GLDH is an evidence of parenchymatous liver lesions. The changes of immunoglobulins can testify to damages of hepatic mesenchyma and present the proof of an immunochemical effect (5). The increase of both serum immunoglobulins A and M has been detected in workers from manganese salt manufacture (6). Our results indicate a considerable immunoglobulin A elevation particularly for the second group along with insignificant alterations of the concentration of the immunoglobulins M and G. On the other hand, however, it is known that salts of heavy metals, and manganese ones inclusive, are capable to alter the humoral and cellular components of the immune response and thus play an

essential role in the development of immunological disorders (8, 19, 23). This fact outlines the necessity to perform more profound investigations and immunological monitoring of workers from the manganese manufacture.

The changes of enzyme activity belong to the sensitive indicators of toxic liver damages (5). Our data about a significant activating the ASAT, ALAT, and GLDH as already reported by other investigators (9, 10, 13), too, emphasize their significance as toxicodynamic exposure tests for workers from manganese-dangerous productions. The unidirectional alteration of the activity of aminotransferases and GLDH activation although to a different extent supports the assumption of some parenchymatous hepatic lesions and thus requires a purposeful investigation of the liver function in workers exposed to manganese. According to some authors (20), CE activity in the serum of workers in contact with manganese remains unchanged or at least insignificantly increased. We establish CE enhanced activity more outlined for the second group. The enhanced CE activity is considered an early indicator of toxic liver lesions. It seems probably that CE activity increase is due to a disturbed lipid metabolism, too. The presence of serum TC elevation in both workers' groups in combination with a proved overconsumption of fats (4) allows the presumption of existing steatotic alterations in the liver.

It is known that manganese influences upon lipid metabolism and induces an increase of TC and triglycerides in the serum and liver (1, 16). According to the data reported by Talakin et al. (7), there is

no statistically significant difference between the mean TC values of the control group and those of the workers from the manganese salt manufacture. However, TC abnormalities have been found out in 30 per cent of the workers in contact with manganese. We reveal TC enhancement which is more manifested for the first group where the relative share of individuals with TC over the so-called "riskless level" (15) is rather considerable. The facts that significant alterations of lipid metabolism along with TC elevation in the serum and organs have been observed in manganese-treated animals (3, 11, 18, 19) together with the data about the workers from the manganese productions (7, 17) outline the role of manganese for the alterations detected by us of the serum TC contents of these workers as well as the necessity for a more precise evaluation of

lipid metabolism in case of occupational exposure to manganese.

## CONCLUSION

The alterations detected in the course of examinations of the workers exposed to manganese suggest certain early disturbances of both protein and lipid metabolism and of liver parenchyma as well which emerge under the influence of manganese. The activities of some enzymes such as ASAT, ALAT, GLDH, LDH, and CE, as well as the concentrations of the immunoglobulin A and TC are unidirectionally, if to a different extent, changed. This fact determines the necessity for their dynamic follow-up in combination with the established routine parameters in order to evaluate the professional risk and to control the health status of the workers from manganese-dangerous projects.

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### **Biochemische Parameter bei Arbeitern, die dem Mangan ausgesetzt sind**

**P. Nikolova, B. Kawaldzhiewa**

*Lehrstuhl für Hygiene und Ökologie, Medizinische Universität Varna*

**Zusammenfassung:** Es wurden 34 Arbeiter in einem Manganbergwerk (erste Gruppe) und 33 Arbeiter in der Manganflußproduktion (zweite Gruppe) untersucht. Die folgenden Parameter wurden studiert: im Serum - das gesamte Protein, die Proteinfractionen, die Immunglobuline A, M und G, das gesamte Cholesterol, wie auch die Aktivität der Enzyme ASAT, ALAT, GLDH, LDH und CE, und im Blut - das Mangan mit Hilfe der atomischen Absorptionsspektrophotometrie. Der Blutmanganspiegel ist zuverlässig gestiegen. Das gesamte Protein und die Albumine sind gesunken, während die Alpha<sub>2</sub>-Globuline lediglich bei der zweiten Gruppe erhöht sind. Die Erhöhung des Immunglobulins A ist in der zweiten Gruppe stärker ausgeprägt, während die Steigerung des gesamten Cholesterols in der ersten Gruppe deutlicher erscheint. Die Enzyme sind bedeutend aktiviert. Es wird die Notwendigkeit einer dynamischer Verfolgung der untersuchten Parameter bei der Einschätzung des Gesundheitsrisikos und bei der Kontrollierung des gesundheitlichen Zustandes der Arbeiter in den mangan-gefährlichen Produktionsobjekten betont.

**Indices biochimiques chez des ouvriers exposés au manganèse**

**P. Nicolova, B. Kavaldjieva**

*Chaire d'hygiène et d'écologie, Université de médecine à Varna*

**Résumé:** L'étude porte sur 34 mineurs d'une mine de manganèse (I<sup>er</sup> groupe) et sur 33 ouvriers d'une production de flux (II<sup>ème</sup> groupe). On a exploré: dans le sérum - la protéine totale, les fractions protéiniques, les immunoglobulines A, M, G, le cholestérol total, l'activité des enzymes ASAT, ALAT, GLDH, LDH et CE, et dans le sang - le manganèse, étudié par une spectrophotométrie d'absorption atomique. La concentration du manganèse a sûrement augmenté. La protéine totale et les albumines ont diminué tandis que les alpha<sub>2</sub>-globulines ont augmenté seulement dans le II<sup>ème</sup> groupe. L'accroissement de l'immunoglobuline A est beaucoup plus manifesté pour le II<sup>ème</sup> groupe, et celui du cholestérol total - pour le I<sup>er</sup> groupe. Les enzymes sont considérablement activées. On montre la nécessité d'une étude dynamique des indices analysés en appréciant le risque de santé et le contrôle de la santé des ouvriers qui travaillent dans des conditions dangereux des chantiers de manganèse.