铅作业女工发铅等重金属含量分析

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提　要　本文报告了31名接铅正常产女工和32名不接铅正常产女工头发和血中铅、镉、铜、锌、铁五种金属含量水平。结果：接铅组女工发铅水平为54.16μg/g，血铅水平为0.55μmol/L；不接铅女工发铅为10.18μg/g，血铅为0.39μmol/L；前者均显著高于后者，差别显著。发中及血中其它重金属含量，两组没有显著区别。本文讨论了发铅可作为慢性铅接触指标问题及铅等五种重金属在发中含量的正常水平。

关键词　发铅　微量金属　生物监测

工业铅中毒目前仍为我国常见职业中毒之一。当前重症铅中毒虽已罕见，但轻度铅中毒及铅吸收者在接触者中仍屡屡发生。头发中铅等重金属含量已被用作评价职业性和环境性重金属污染的生物学监测指标(Lenihan, 1978)。据报告，铅经呼吸道吸入时，血铅于 4～5 小时达高峰，经胃肠道摄入时，于24小时达高峰。因此，一般认为血铅水平代表当前铅接触，而慢性长期铅接触则主张用发铅来衡量(Leker, 1982)。另外，头发中重金属含量是人体代谢重金属的一面镜子，铅与许多重金属密切相关 (Hammer, 1971)。因此，在观察发铅的同时，了解发中其它主要重金属水平及其相关性有重要的卫生学意义。本文报告了一组职业性接触铅女工和一组无铅接触史女工的头发中五种重金属含量水平。

1　材料与方法

1.1　对象选择　选某蓄电池厂接铅工龄一年以上，怀孕周期超过37周，无妊娠并发症的正常产女工作接触组，另选在相同医院分娩，无职业性铅接触史，其它条件相同的正常产女工作对照。全部受检者，包括接铅组和非接铅组女工的平均年龄为24.1岁（23～28岁），均为第一胎分娩，无烟、酒嗜好，但接铅组女工一般均有产前两个月脱离生产现场的历史。

1.2　样品的收集和处理　采集枕后部头发约2～5克，同时采肘静脉血约5毫升。所有采样和储存用玻璃和塑料器材都先经硝酸浸泡，然后用去离子水洗净，达到除铅后应用。发样根据国际原子能机构(IAEA)推荐的丙酮-无离子水清洗法洗净，以达到清除外源性沾污的目的，然后进行分析。

1.3　分析方法　精确称量一定量的发样，置入聚四氟乙烯制消解罐中，用超纯浓硝酸和过氧化氢，于150°C消解2小时，至样品呈无色透明液，供分析。铅、镉用Varian 40P原子吸收分光仪石墨炉法测定，锌、铜、铁用相同仪器，火焰法测定。

2　结果

从表1可见，接铅组女工发铅和血铅含量都显著高于不接铅组女工。发铅和血铅比值，接铅组为4.79，非接铅组为1.25，相差4倍，说明接铅女工体内铅蓄积于发，且经发排泄，对照组女工体内无铅蓄积，是形成两组发铅与血铅比值差异悬殊的主要原因，两组女工发及血中其它重金属含量无显著差别。

从表2可见发中铅、锌及铜、锌呈显著相关。

3　讨论

3.1　发铅能较好地反映慢性铅接触　根据捷克

表1　　　　　　　　　　　　接铅组和非接铅组女工头发和血中铅、镉、铜、锌、铁水平

| | 头发中金属含量(μg金属/g头发) | | 血中金属含量(μg金属/dl血) | |
	接铅组 GM±GSD	非接铅组 GM±GSD	接铅组 GM±GSD	非接铅组 GM±GSD
铅	54.16±3.55**	10.18±2.28	11.31±1.57**	8.13±1.49
镉	0.18±2.32	0.22±2.66	0.61±1.42	0.65±1.49
锌	193.86±1.37	208.26±1.50	651.03±1.20	584.52±1.32
铜	9.32±1.28	8.92±1.18	131.61±1.29	136.02±1.25
铁	37.94±1.77	31.05±1.95	34490±1.28	30370±1.24

注：GM±GSD 为几何均数±几何标准差
** 接触组和非接触组差别极显著P<0.01

表2　　　　　　　　　　　　头发中铅、镉、铜、锌、铁相关系数

	铅	镉	铜	锌	铁
铅	—	0.1531	0.1310	0.3754*	-0.0306
镉	—	—	0.2679	0.1937	0.1073
铜	—	—	—	0.3017*	-0.1867
锌	—	—	—	—	-0.0077
铁	—	—	—	—	—

注：表中数字为偏相关系数　　* 为显著相关P<0.05

的调查报告，布拉格蓄电池厂的铅作业操作工人血铅量为2.56μmol/L，发铅为80μg/g (Bencko, 1982)，二者似有平行关系。作者指出，发铅可作为工人接铅的一项指标。本例某蓄电池厂女工血铅为0.55μmol/L，发铅为54.16μg/g，血铅显著高于本地不接铅组女工，但与上述布拉格蓄电池厂工人比血铅似略低一些。考虑两国情况不同，本例接铅女工有一时性脱离生产现场史，因而血铅值呈现波动是属可能，而头发是铅的蓄积和排泄场所，含量相对稳定。文献指出，血铅反映当前铅接触，而发铅则能较好地反映慢性长期铅接触 (Rabinowitz, 1976)，本例可说明此问题。

3.2　发铅正常值初探　发样易采集，便于保存，且增加分析样品量可减少分析误差，因此近年来被推荐以发中微量金属含量作为评价职业性或环境性重金属污染的生物学指标。从而急需进行调查以确定各地各种重金属在发中的正常含量或本底水平。根据本次对沈阳地区无职业性铅接触女工发铅测定结果调查，发铅几何均数为 10.18±2.28μg/g，95% 单侧上限值为 40μg/g，供各地参考、验证。

3.3　其它重金属含量初探　根据本次对无职业性重金属接触女工测定结果，发镉的几何均数为0.22±2.66μg/g，95%单侧上限为1.1μg/g。锌、铜、铁三种重金属均属体内微量必需金属，如锌是多种酶的组成成分，据美国营养学会的规定，发锌值不得低于70μg/g(Committee on Nutrition, 1978)。因此，本文计算了此三种重金属的下限，发锌几何均数为208.26±1.5μg/g，95%单侧正常值下限为107.2μg/g；铜的几何均数为 8.92±1.18μg/g，95%正常值下限为6.82μg/g；铁的几何均数为31.05±1.95μg/g，95%正常值下限为10.43μg/g，供各地参考。

附表 头发中铅、镉、锌、铜、铁水平($\mu g/g$)各国数值比较

作 者	调查对象	人数	铅	镉	锌	铜	铁
Barlow (1980)	英国学生	86	6.02	0.49	132.6	30.03	21.96
Okamoto (1988)	日本市民	不详	6.00	0.20	169.0	16.30	125.00
Dipietro (1989)	美国市民	271	2.43	<0.15	152.0	15.7	9.35
Jamall (1990)	巴基斯坦城妇女	41	26.4	—	188.6	14.3	—
	孟加拉农村妇女	42	2.6	—	113.9	25.4	—
Ahmed (1990)	沙特居民	22	6.3	0.19	—	—	—
	苏丹居民	59	14.1	0.18	—	—	—
本文作者	接铅女工	31	54.16	0.18	193.86	9.32	37.94
	不接铅女工	32	10.18	0.22	208.26	8.92	31.95

注: 表中数字均为几何均数

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Abstracts of Original Articles

A Study on Effects of Occupational Exposure to Manganese Compounds on Neurobehavior of workers

Chen Ziqiang, et al

The effects of manganese compounds on the performances in neurobehavior of workers were reported. 83 workers engaged in manganese compounds operation in Shanghai Ferroalloy Factory were selected as an exposure group. 50 non-exposed subjects as control group. The distribution of age, sex and educational level of both groups were similar. Additionally, samples were taken from 17 representive operation sites of the workshops for consecutive two days and time-weighted average (TWA) of each worker were calculate According to the exposure level, the exposure group was subdivided into two, i. e. low level and intermediate level groups. The neurobehavioral function tests were carried out on all subjects with WHO Neurobehavioral Core Test Battery (WHO NCTB).

The data showed that when the air concentration of manganese (expressed as manganese dioxide) was $0.252mg/m^3$, the neurobehavioral functions of workers such as mood state, digit span, digit symbol, simple reaction time, Benten visual retention and pursuit aiming I had significant changes, as compared with the control group; with the increase of the exposure level, the changes of some behaviors such as mood state, digit span, digit symbol and pursuit aiming I more significant. There was a relationship between exposure level and alteration of some behavior, indicating that the current MAC of manganese ($0.2mg/m^3$) was safe, so far as the performances in neurobehavior were concerned, needs to be further studied.

Key words: neurobehavior, mood state, manganese exposure

Metals Content in Hair and Blood in Occupationally lead Exposed Pregnant Women

Wan Bojian, et al

The present study examines trace metals in the hair and blood from 31 occupational lead exposed pregnant women from a storage battery plant and 32 from non-exposed women. There was a significant difference between mean hair lead and blood levels between the exposed and unexposed. The exposed mean hair lead level was 54.16 ug/g comparing with 10.18ug/g in the unexposed. There was no significant difference between the two groups in relation to Cd, Zn, Cu, and Fe levels. The ratio of hair lead versus blood lead concentration was 4.79 and 1.25 in the exposed and unexposed group respectively. Comparisons are drawn between this population and data from eight other countries.

Key words: lead, trace metals, biomonitoring

Interventional Epidemiological Studies on Etiology of Worker Lung Cancer in the Mine

Liu Yutang, et al

Using the methods of interventional epidemiology, a cohort study was conducted on tin miners to verify the hypothesis of lung cancer induced by arsenic or radon.

In order to prevent pneumoconiosis, wet drilling was introduced into mine since middle of 1950s. The average underground air concentration of arsenic dropped from $0.29mg/m^3$ for 1950s to $0.01mg/m^3$ for 1980s with decreasing of arsenic exposure, the incidence of lung cancer decreased from $150/10^5$ to $20/10^5$ respectively. For the same period, radon concentration of underground air kept high level and the average accumulated dose of radon for the exposed miners was 400 WLM, which was 3 times than the dose of causing long cancer. The results of this study demonstrated