

# COPPER AND CADMIUM LEVELS IN HAIRS & NAILS;

An indicator of heavy metal pollution.

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**SUMMARY...** Heavy metals ingested or inhaled can affect liver, Brain, Bone and lungs. Raised copper and cadmium levels have been seen in ischemic heart disease. A level of trace elements varies in blood among population. In this study Copper & Cadmium levels were determined in hairs and nails; easy to sample and store. Purpose of this study is to find out relationships with heavy metals pollution and try to develop as a screening test. Such work is not yet done in our population. 86 male subjects and 20 controls (male) were selected for determination of Cu & Cd concentrations in hairs and nails. Medical history was noted. 3-4 fingernails and 1 tbsp of hair cut from the nape of neck close to root were obtained. Samples were analyzed by atomic absorption spectrophotometer. Highly significant ( $p < 0.001$ ) raised copper levels were seen in hairs and nails of subjects ( $110.79 \pm 26.01$  &  $99.34 \pm 7.81 \mu\text{g/gm}$  respectively) compared with control ( $80.76 \pm 7.81$  &  $77.65 \pm 2.48$ ). Similarly significantly ( $p < 0.001$ ) raised Cadmium levels were found in subjects (hairs  $143.57 \pm 62.03$  & nails  $104.71 \pm 74.52$ ) compared with control ( $89.20 \pm 12.98$  &  $77.54 \pm 12.32$ ). Highly significant ( $p < 0.001$ ) raised values of Cd & Cu indicate that hairs and nails concentration may indicate heavy metals pollution & it can be easy sampling test for screening of pollution about heavy metal exposure.

**Key words:** Cu & Cd, hair, nail, heavy metal pollution, screening test.

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## INTRODUCTION

Trace elements play an important role in human health and disease. These elements participate in tissue, cellular and sub-cellular functions, including immune regulation, nerve conduction, muscle contraction, membrane potential, mitochondrial activity etc. The concentration at which metals may be considered important vary as some are essential at low level yet toxic at other<sup>1</sup>. When metals are ingested or inhaled in excessive amount, heavy metals can affect liver, brain, bone and lungs although each metal also causes its own characteristic symptoms<sup>2</sup>. Prolong exposure to low doses can cause chronic lung disease, cancer, nervous impairment, bone abnormalities, sterility<sup>3</sup>.

Copper is an essential substance to human life, however its critical dose can cause anemia, adrenal hyperactivity and insufficiency, allergies, hair loss, arthritis, depression, elevated cholesterol, tooth decay, vitamin C and other vitamin deficiencies<sup>4,5</sup>.

Elemental copper may be a source of toxicity when

leached from copper piping into water supplies or inhaled occupationally as dust or fumes<sup>6</sup>. Short term copper exposure can cause gastrointestinal distress while long term exposure can damage liver or kidney<sup>7</sup>. Cadmium is a cumulative toxic agent having half life in blood 2-3 months<sup>8</sup>. Cadmium also causes a rise of copper kidney concentration; the content of latter in liver as well as activity of some copper dependant coenzymes undergoes transient changes. The effect of cadmium greatly depends on its dose and exposure time as well as dietary content of iron, zinc and copper<sup>9</sup>. Nagra et al; study data shows higher serum cadmium concentration associated with ischemic heart disease and hypertension<sup>10</sup> and treatment with cadmium (0.4 mg/kg wt.) significantly increased lipid per oxidation in heart within 3 hours of cadmium injection<sup>11</sup>. Raised serum copper remains high in all ischemic heart disease patients<sup>12</sup>.

Above mentioned data clearly indicate dangerous status of heavy metals to health. So, toxic status should be evaluated to protect human health. Since

last decade there are number of studies investigated metals level in body fluid of trace elements in blood varies considerably among global population and normal range for typical population were different<sup>13</sup>. Blood minerals levels are kept within a very tight range. An alternative is to measure minerals directly in the body tissue or cell, a body tissue that is painless to sample and easy to store & transport are hairs and nails<sup>14,15,16</sup>.

Purpose of study is to find out base line information about levels of copper and cadmium in hairs and nails in our population as previously such work has not been done. Significant result may lead to develop a better and easy diagnostic measure about metal toxicity particularly as screening program.

### METHODS AND MATERIALS

Eighty six subjects and 20 controls were selected for study. Subjects were from different occupations and area of living i.e. jewelers, automobile workshops, and person living in agricultural field, pica factory workers and ternaries.

Control subjects were approximately healthy and non-smokers. History about smoking, occupation and diet were noted and examined by a medical officer for any sign and symptoms. Hairs and nails texture, age and blood pressure were also noted. Hairs and nails were the study sample to determine the copper and cadmium concentration. With nail clipper 3-4 fingers nails were taken. One tablespoon of hair of each person was cut from nape of neck close to the root using a stainless steel scissors, every nail and hairs sample was kept in a plastic bag. These samples were weighed by analytic balance and transferred to a beaker adding 5ml nitric acid. After 5 minutes 2ml H<sub>2</sub>O<sub>2</sub> was added then transferred to the condenser flask and reflux it for 1/2 hour. After cooling the samples to room temperature volume was making up to 25 ml with deionized water. Then samples were analyzed on atomic absorption spectrophotometer A1800 Hitachi

Japan. The instrument was calibrated periodically using copper and cadmium standard solutions. Each solution was measured twice. Mean concentrations were computed using an IBM compatible computer.

### RESULTS

In this survey 86 subjects having mean age 32.65+9.59 year and 20 controls were sampled for copper and cadmium level in hair and nails 56 subjects were smoker with mean smoking period 8.5 years. In control group (20) copper cone in hair and nail sample were 80.76 ±7.81 and 77.65±2.48 respectively, while cadmium levels were 89.20 ±12.98 and 7.54±12.32 respectively. Copper levels in hairs and nails of 86 subjects were significantly raised 10.79±26.01 µg/g p<0.001 and 99.34 ±28.27 µg/gm p<0.001 respectively when compared with control.

Similarly cadmium level I hairs and nails were highly significant p<0.001 143.57 ±62.03 and 104.71±74.50 respectively compared with control (table-I) out of 86 subjects nail cadmium level in 21 subject were >200µg/gm, 19 have cad level b/w 100-200 µg/gm while 46 have 84-99 µg/gm cadmium level. On the other hand 22 out of 86 subjects nail cadmium level in hair >200 µg/gm 25 have 100-200 µg/gm while in 39 subjects cadmium level were in the range of 77.6-99 µg/gm. Pattern of copper level in the hairs and nails was not similar to the cadmium level. Only 18 out of 86 copper level > 100µg/gm in hair and 10 out of 86 have nail cu level of >100µg/gm. Table-II shows various sing and symptoms noted in subjects only 17 out of 86 were symptoms and sign free. Blood pressure noted was 118.67± 1.45/ 82.97±7. Table-III shows number of subjects belongs to different area or occupation.

### DISCUSSION

Metals are toxic these bind with ligand of biological structure<sup>17</sup>. One of the major ever-increasing problems is the influence of pollution especially heavy metals contaminants. When such toxic metals accumulate &

Parameter	Control (20) male [ $\mu\text{g/gm}$ ]	Subjects (86) male [ $\mu\text{g/gm}$ ]
Hair copper	80.76 $\pm$ 7.81	110.79 $\pm$ 26.01*
Nail copper	77.65 $\pm$ 2.48	99.34 $\pm$ 28.27*
Hair cadmium	89.20 $\pm$ 12.98	143.57 $\pm$ 62.03*
Nail cadmium	77.54 $\pm$ 12.32	104.71 $\pm$ 74.52*
Age	27 $\pm$ 8.10	32.65 $\pm$ 9.59*

**Table-I. Copper & cadmium level in hair and nails**  
\* $P < 0.001$

Symptoms	No. of subjects (n=86)
Skin irritation	2
Joint / bone pain	4
Headache	16
Anemia	17
GIT disturbance	9
Muscle cramp	9
Chest distress	4
Weakness	17

**Table-II. Sign /Symptoms noted during sampling**

Jewelry workshop workers	22
Automobile workshop workers	21
Rice factory workers	10
Agriculture area	18
Lather tanneries	5
General population	10

**Table-III. Distribution of Subjects (n=86 Male)**

become threat to the human health then determination of their levels become important in term of easy & effective diagnosis. Hairs and nails act as an indicator of body stores of heavy metals<sup>18</sup>.

Table-I clearly shows that copper conc. in hairs & nails were significant ( $p < 0.001$ ) raised level (110.79 $\pm$ 26.01 & 99.33 $\pm$ 28.27 respectively) found

in subjects when compared with control group. Benson<sup>19</sup> also found significant difference ( $P < 0.01$ ) of copper in hairs, in school children when compare with standards. Result of cadmium conc. were similarly highly significant ( $p < 0.001$ ). However subjects have wide standard deviation of hairs and nails Cd conc. (143.57 $\pm$ 62.03 & 104.71 $\pm$ 74.52). Reason of wide standard deviation is presence of group with very high Cd conc. e.g. 21 out of 86 have Cd conc.  $> 200 \mu\text{g/gm}$ , 19 have Cd conc. between 100-200  $\mu\text{g/gm}$  and 46 show conc. 84-99  $\mu\text{g/gm}$ . Such group fluctuation was not seen in copper conc. In 86 male subjects.

One obvious reason for raised cadmium level in subjects may be due to presence of 56 smokers out of 86 subjects. In a study no significant effect on Cd conc. could be detected in children exposed to environmental tobacco smoking<sup>20</sup>. Cause of raised copper and cadmium levels in hairs may be environmental pollution. Metal cleaning operation, leather tanneries, copper pipe, electronic instrument, jewelry and copper welding are source of copper and cadmium pollution. Considerable level of copper maybe present in municipal sewage bulk of this originates from industrial discharge<sup>21</sup>. Excessive Cd exposure has been occurred in general population through ingestion of contaminated food and water<sup>22</sup>.

Our study data shows that in jewelry worker hairs and nails Cu conc. (91.75 $\pm$ 15.2 & 84.72 $\pm$ 9.52) and automobile worker (112.47 $\pm$ 58.56 & 89.9 $\pm$ 37.7  $\mu\text{g/gm}$  respectively) were raised compared with Cu level in hair and nail of subject living in agricultural area (84.9 $\pm$ 8.57 & 81.09 $\pm$ 7.57  $\mu\text{g/gm}$  respectively). Highly raised level of Cd found in rice factory workers nails and hairs (249.27 $\pm$ 7.81 & 244.1 $\pm$ 8.05  $\mu\text{g/gm}$  respectively.) than any other group. When we compare our control subjects Cu and Cd concentration in hair and nail with WHO criteria (hair/ nail copper 20  $\mu\text{g/gm}$  and cadmium hair/nail 0.2  $\mu\text{g/gm}$ ) raised level of Cu and Cd were found in hairs and nails of control. This shows that our control have been exposed to

generalized Cu and Cd pollution. Overall our occupational group clearly shows highly significant raised values, which indicate burden of occupational pollution.

Table-II shows that different numbers of subjects have some sign and symptoms only 17 subjects were sign/symptom free. Many studies data have shown the effects of copper and cadmium accumulation on body health more or less similar signs/symptoms mentioned in this study<sup>23,24,25 and 26</sup>.

Our study data show highly significant ( $P < 0.001$ ) raised level of copper and cadmium in hairs and nails compared with control. It also indicates of generalized and occupational Cu and Cd pollution. History of subject also indicates sign/symptoms may be related to Cu and Cd. Toxicity which may be further evaluated finally hair and nail sampling prove not only easy but also extant good diagnostic and may be used for Cu and Cd toxicity screening program.

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The ignorance of one voter in a democracy  
impairs the security of all.

John F. Kennedy