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# THE EFFECTS OF CERTAIN D-BLOCK METALS ON THE HUMAN BODY: A CASE STUDY OF COPPER

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**Abstract:** This article provides an extensive overview of copper, a d-block metal, and its role in human health. It explores the physical and chemical characteristics of copper, its distribution in natural sources, industrial applications, and biological significance. The study discusses how copper enters the human body and the negative health effects of its deficiency or excess accumulation. Particular attention is paid to diseases linked to copper, including damage to the kidneys and liver, hemolysis, and jaundice. Additionally, cases of copper poisoning in South Asian countries (India, Bangladesh, Pakistan) are analyzed statistically. The findings highlight the need to consume copper in controlled and safe amounts.
**Keywords**: copper, isotopes, poisoning, kidney failure, drinking water, biological role, health, food.

## Introduction:

Copper, a d-block element, occurs in its pure form as a reddish-brown, easily drawn and flattened metal with high electrical and thermal conductivity. These properties make it widely used in various technological fields. Copper has an atomic weight of 63.54, a density of 8.94 g/cm³, a boiling point of 2595°C, and a melting point of 1083°C. Its most important natural isotopes are $^{63}Cu$ (69.2%) and $^{65}Cu$ (30.8%).

While major copper mines are located in the United States, Peru, Zambia, and the Democratic Republic of the Congo, the largest reserves are found in Chile. In nature, copper is mainly found in sulfide (90%) and oxide (9%) forms, and only rarely in its pure form (<1%) [1].

Copper ores are processed in industrial zones to extract the pure metal. In the human body, copper usually exists as the $Cu^{2+}$ ion, which is active in acidic environments and inactive in alkaline ones.

## Research Findings:

### Biological Importance of Copper and Its Health Effects:

Copper is an essential element for living organisms — including plants, animals, and humans. It is involved in metabolic processes such as blood formation, immune system function, and enzyme activity.

Globally, issues related to copper — such as deficiency, overconsumption, or hereditary disorders — are commonly observed. In the US, Europe, and South Korea, average daily copper intake ranges from 0.9 to 2.3 mg [2,3].

According to the WHO, the recommended daily intake is 1.2 mg for men and 1.3 mg for women. For pregnant women, it is 1.0 mg, and for lactating women — 1.3 mg. European studies have shown a copper deficiency risk in 11–20% of cases.

Wilson's Disease is an autosomal recessive disorder caused by pathogenic variants in the ATP7B copper-transporting gene, leading to hepatocellular copper accumulation.

Mutations in the ATP7B gene result in a deficiency of the ATPase enzyme, leading to copper buildup in liver cells, which exerts toxic effects on various organs. Symptoms include tremors, ataxia, psychiatric disturbances, and diseases such as hepatitis, cirrhosis, liver failure, and the appearance of Kayser–Fleischer rings (copper deposits) in the eyes. Treatment typically involves copper-chelating agents, zinc reduction, and liver transplantation in severe cases [9].

**Copper Metabolism in the Human Body:**

Adults typically consume 2–3 mg of copper daily through food. Pregnant women, infants, and children require slightly more.

In infants and children under 5 years of age, the daily requirement is around 20 µg/kg, and the maximum can reach up to 300 µg. For children over 5, the requirement is 0.3–0.5 mg.

Foods rich in copper include vegetables, legumes, nuts, mushrooms, cereals, liver, beef, dairy products, seafood, and chocolate.

Copper is excreted from the body in various ways depending on need: through bile (0.5–1.3 mg/day), urine (10–60 µg/day), saliva (0.38–0.47 mg/day), menstruation, and skin.

**Drinking Water and Poisoning Risk:**

Copper primarily leaches into drinking water from pipes in the water supply system. Higher acidity in the water increases copper concentration. Water that remains stagnant in pipes tends to have higher copper levels.

According to WHO (1998), copper levels in drinking water can range from a few micrograms to several milligrams per liter. If the level is below 0.1 mg/L, food is the main source. However, if it exceeds 1–2 mg/L, up to 50% of copper may come from water.

**Cases and Consequences of Copper Poisoning:**

Copper poisoning incidents have been frequently reported in South Asian countries — India, Bangladesh, and Pakistan.

For example, in southern Bangladesh, 123 poisoning cases were reported over six years, 25% of which were fatal [6].

In India, 23% of 35 patients died [7].

In severe cases, functions of the kidneys, liver, heart, and other vital organs were impaired. Notably, blood copper levels in patients with severe symptoms were not significantly different from those with mild symptoms (~1 mg/L).

Common symptoms of copper poisoning include:

1. Disruption of the circulatory system
2. Gastrointestinal bleeding
3. Blood clotting disorders
4. Pancreatitis (inflammation of the pancreas)

**Conclusion:**

Copper is a widely used industrial metal and biologically essential element. It plays a vital role in enzyme activity, blood formation, and immune system function. However, its excessive accumulation in the body poses health risks — including kidney and liver damage, poisoning, and even death. Therefore, it is important to regularly monitor copper levels in drinking water and food.

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