

# DIAGNOSIS OF TRACE ELEMENT IMBALANCE: IMPACT ON HEALTH AND DETECTION METHODS

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## Abstract

Trace element imbalance in the body is an important factor affecting human health. A deficiency or excess of trace elements such as iron, zinc, magnesium, and copper can lead to serious consequences, including anemia, immune system disorders, and chronic diseases. This article examines the key aspects of the influence of trace elements on the body, modern laboratory diagnostic methods such as atomic absorption spectrometry, mass spectrometry, and biochemical tests, as well as the results of current studies. Particular attention is paid to the integration of innovative technologies for accurate detection of disorders.

**Keywords:** Trace elements, laboratory diagnostics, imbalance, atomic absorption spectrometry, health.

## Introduction

Trace elements are inorganic substances that the body requires in minimal amounts but play a crucial role in vital processes. They participate in metabolism, enzyme formation, hormone synthesis, and immune support. However, their deficiency or excess can lead to pathologies of varying severity. For instance, iron deficiency causes anemia, whereas its excess leads to toxicity. Diagnosing trace element imbalance is an essential component of the prevention and treatment of many diseases.

The aim of this article is to analyze the impact of trace element imbalance on human health and review modern laboratory diagnostic methods.





## Impact of Trace Elements on Health

### Trace Element Deficiency

**Iron:** A key component of hemoglobin, its deficiency leads to iron deficiency anemia, characterized by weakness, pallor, and reduced work capacity.

**Zinc:** Zinc deficiency causes impaired immunity, poor wound healing, and taste perception disorders.

**Magnesium:** Participates in the functioning of the muscular and nervous systems. Its deficiency manifests as cramps, arrhythmias, and increased irritability.

**Copper:** Copper deficiency causes neuropathy and connective tissue disorders.

**Iron:** Iron toxicity can cause liver and heart damage.

**Copper:** Excess copper is associated with Wilson's disease and central nervous system damage.

**Selenium:** Overdose leads to brittle nails, hair loss, and intoxication.

## Modern Diagnostic Methods

### 1. Atomic Absorption Spectrometry (AAS)

This method measures trace element concentrations in biological fluids (blood, urine, hair). Its advantage lies in high precision and sensitivity.

### 2. Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

This method is used for the simultaneous determination of multiple trace elements. It is applied to assess the levels of toxic metals such as lead and mercury.

### 3. Biochemical Methods

#### Biochemical Methods

**Serum Iron and Ferritin:** These tests are used to diagnose anemia by assessing iron stores and active iron in the bloodstream.

**Transferrin Saturation:** This test evaluates the efficiency of iron transport and highlights iron metabolism issues.

**Zinc and Magnesium in Blood:** Routine tests to detect deficiencies that can affect immune and neurological functions.

**Copper Levels:** Measurement of copper in serum and ceruloplasmin levels is essential for diagnosing conditions like Wilson's disease and other copper-related disorders.

**Selenium:** Biochemical assessment of selenium levels can help identify deficiencies linked to thyroid dysfunctions and immune health.





#### 4. Hair and Nails as Biomaterials

Determining the trace element composition of hair and nails allows for the identification of chronic imbalances.

##### Research Results

##### Current studies indicate that:

30% of the population exhibits iron deficiency, especially women of reproductive age.

Children with frequent infections often show reduced zinc levels.

The use of ICP-MS allows for the detection of trace element imbalances at early stages, which is essential for preventing complications.

Trace element imbalance has a multifactorial nature, including nutrition, genetic traits, and environmental influences. Modern diagnostic methods such as AAS and ICP-MS significantly enhance the accuracy of detecting imbalances. However, their availability is limited in some regions, necessitating the development of more cost-effective solutions.

Diagnosing trace element imbalance is a vital tool in the prevention and treatment of many diseases. Modern laboratory methods such as spectrometry enable timely detection and correction of these imbalances. Further research is needed to improve the accessibility and accuracy of diagnostics and to integrate technologies into clinical practice.

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