LABORATORY DIAGNOSTICS OF VITAMIN AND MINERAL DEFICIENCIES

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Abstract; Vitamin and mineral deficiencies remain a global public health concern, affecting individuals of all ages and contributing to a wide range of clinical disorders. Laboratory diagnostics plays a crucial role in the early detection, differential diagnosis, and monitoring of micronutrient deficiencies. This article reviews current laboratory methods used to assess vitamin and mineral status, including biochemical, immunological, and molecular approaches. Accurate laboratory evaluation enables timely intervention, prevents complications, and supports personalized nutritional management.

Keywords; Vitamin deficiency, mineral deficiency, laboratory diagnostics, micronutrients, biochemical markers

Introduction

Vitamins and minerals are essential micronutrients required for normal growth, metabolism, immune function, and neurological activity. Deficiencies may arise due to inadequate dietary intake, malabsorption, chronic diseases, increased physiological demands, or drug interactions. Clinical manifestations of micronutrient deficiencies are often nonspecific and may overlap with other medical conditions, making laboratory diagnostics essential for accurate identification.

Laboratory assessment provides objective evidence of micronutrient status and allows differentiation between primary nutritional deficiencies and secondary metabolic or absorption disorders. Advances in laboratory technology have improved sensitivity and specificity of diagnostic assays, enabling early detection even before overt clinical symptoms develop.

Materials and Methods

This study is based on a review of contemporary laboratory diagnostic techniques used for the evaluation of vitamin and mineral deficiencies. Laboratory parameters analyzed include serum and plasma concentrations of vitamins and minerals, functional biomarkers, enzyme activity assays, and metabolite measurements. Analytical methods reviewed include spectrophotometry, immunoassays, high-performance liquid chromatography, and mass spectrometry. Pre-analytical and analytical factors affecting test accuracy were also considered.

Results

Laboratory evaluation demonstrated that direct measurement of circulating vitamin and mineral levels remains the primary diagnostic approach. Fat-soluble vitamins such as vitamins A, D, E, and K are commonly assessed using chromatographic techniques, while water-soluble vitamins including vitamin B12 and folate are measured by immunoassays or chemiluminescence methods.

Mineral status assessment commonly involves measurement of serum iron, ferritin, transferrin saturation, calcium, magnesium, zinc, and copper. Functional biomarkers, such as methylmalonic acid for vitamin B12 deficiency and parathyroid hormone for vitamin D

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deficiency, provide additional diagnostic accuracy. Inflammatory markers were found to influence micronutrient levels, highlighting the importance of clinical context in result interpretation.

Discussion

The findings emphasize that laboratory diagnostics is indispensable for the accurate assessment of vitamin and mineral deficiencies. Reliance solely on clinical symptoms may lead to underdiagnosis or misdiagnosis, particularly in subclinical cases. Functional biomarkers and combined testing strategies improve diagnostic reliability, especially in complex clinical scenarios such as chronic inflammation, liver disease, or renal impairment.

Standardization of laboratory methods and awareness of pre-analytical variables, including sample handling and patient preparation, are critical for ensuring reliable results. Emerging technologies, such as mass spectrometry–based assays, offer enhanced precision and may become the gold standard for micronutrient analysis in the future.

Conclusion

Laboratory diagnostics plays a central role in the detection and management of vitamin and mineral deficiencies. Accurate measurement of micronutrient levels, combined with functional biomarkers and clinical correlation, enables early diagnosis and targeted intervention. Ongoing advances in laboratory technologies will further improve diagnostic accuracy and support personalized nutritional and therapeutic strategies.

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