The effect of trace elements and vitamins on hyperglycemia and other indicators in patients with type 2 diabetes mellitus

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Conflict of interest: none

BACKGROUND. Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by hyperglycemia, insulin resistance, and the development of multiple complications. In addition to standard pharmacotherapy, increasing attention in recent years has been paid to the role of micronutrients and vitamins in modulating metabolic disturbances associated with T2DM. This article summarizes current evidence from systematic reviews, meta-analyses, and randomized controlled

trials regarding the effects of magnesium, zinc, chromium, selenium, and vitamins D_3, C, and B_{12} on glycemic control, insulin resistance, and related metabolic parameters in patients with T2DM. The findings indicate that the effectiveness of nutritional supplementation is heterogeneous and largely dependent on baseline deficiency status, dosage, duration of intervention, and patient characteristics. Particular emphasis is placed on the clinically significant association between metformin therapy and vitamin B_{12} deficiency. Overall, the available evidence supports the need for an individualized approach to the assessment of nutritional status and highlights the necessity for further high-quality studies.

OBJECTIVE. To analyze and synthesize current scientific evidence on the effects of micronutrients and vitamins on hyperglycemia and other metabolic parameters in patients with T2DM, and to assess the clinical relevance of their supplementation.

MATERIALS AND METHODS. The object of the study is published systematic reviews, meta-analyses, and randomized controlled trials investigating the effects of magnesium, zinc, chromium, selenium, and vitamins D_3, C, and B_{12} on glycemic control and metabolic status in patients with T2DM.

RESULTS AND DISCUSSION. Analysis of the available literature indicates that vitamin D_3 supplementation is associated with a modest but statistically significant reduction in fasting plasma glucose, glycated hemoglobin (HbA1c), and HOMA-IR index, particularly in patients with vitamin D deficiency, obesity, or elevated baseline HbA1c levels. Oral magnesium supplementation demonstrates dose- and time-dependent effects and may contribute to improved long-term glycemic control, primarily through reductions in HbA1c during prolonged administration. High-dose and long-term vitamin C supplementation is associated with decreases in fasting glucose, fasting insulin, and HbA1c; however, the overall quality of evidence remains low. Data regarding zinc, chromium, and selenium are inconsistent. Zinc plays an important biological role in insulin synthesis and secretion, yet routine supplementation is not supported by sufficient clinical evidence. The effects of chromium and selenium remain controversial. Long-term metformin therapy is consistently associated with an increased risk of vitamin B_{12} deficiency, which may lead to clinically significant hematological and neurological complications and therefore requires regular monitoring.

CONCLUSIONS. Micronutrients and vitamins may modulate glycemic control and metabolic processes in T2DM; however, the strength of evidence varies substantially among different nutrients. The most robust evidence is available for vitamin D_3, magnesium, and vitamin C, with observed effects depending on baseline deficiency, dosage, and duration of supplementation. Evidence regarding zinc, chromium, and selenium remains inconclusive and does not support their routine use as therapeutic agents. Metformin-induced vitamin B_{12} deficiency represents a clinically significant issue that requires systematic screening and timely correction. Further large-scale, well-designed randomized controlled trials are needed to establish clear clinical recommendations.

KEY WORDS: type 2 diabetes mellitus, hyperglycemia, micronutrients, vitamins, vitamin D, magnesium, vitamin C, zinc, chromium, selenium, vitamin B_{12}, metformin.