Title: Mitigation of Metabolic Diseases Through Personalized Nutrition: A Critical In-Depth Review

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Abstract: Obesity, cardiovascular disease, and type 2 diabetes mellitus (T2DM) represent major global health and economic concerns. Traditional dietary recommendations frequently overlook individual heterogeneity in metabolic health. Personalized nutrition will provide a more focused approach to preventing chronic diseases by tailoring dietary recommendations according to lifestyle, metabolic, and genetic factors. This review examines the role of personalized nutrition in preventing metabolic diseases, with a focus on key components of nutrient-gene interactions, including nutrigenomics, nutrigenetics, the gut microbiome, and biomarker-based therapies. The main aim of this article is to investigate how variation within the microbiome and among genes impacts nutrient metabolism and make a case for successful evidence of individualized dietary intervention for obesity, diabetes, and cardiovascular disease. Future advancements in artificial intelligence, and genetic testing may make personalized nutrition more accessible, but there are questions about the price, feasibility, and ethics of its widespread use. The scope for personalized nutrition is wide and has strong potential to impact preventative health. An independent assessment calls for sustained scientific research, equitable accessibility, and ethical considerations that can make public health policies clinically relevant.

Key words: dietary intervention; gut microbiome nutrigenomics; machine learning; nutrigenomics.

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