

Acylcarnitines in health and disease

S-05.1-1

M. Dambrova^{I,II}, E. Liepins^I

^ILatvian Institute of Organic Synthesis, Riga, Latvia, ^{II}Riga Stradins University, Faculty of Pharmacy, Riga, Latvia

Acylcarnitines, derivatives of fatty acid metabolism in mitochondria and peroxisomes, are essential for cellular energy homeostasis. Their plasma concentrations fluctuate dynamically between fasted and fed states, reflecting shifts in metabolic activity. Classified by acyl-chain length into short-, medium-, long-, and very-long-chain species, acylcarnitines play diverse physiological roles. Advances in metabolomics have linked altered acylcarnitine profiles to various physiological and pathological conditions, providing insights into metabolic regulation and disease mechanisms.

Dysregulated acylcarnitine metabolism is implicated in inborn errors of fatty acid oxidation, cardiovascular and neurological diseases, ischemic conditions, metabolic syndromes, and cancer. Elevated long-chain acylcarnitines, in particular, are associated with mitochondrial dysfunction and metabolic stress, impairing insulin signaling and increasing oxidative stress—effects that can be reversed by lowering their levels. In cardiac tissue, excessive acylcarnitine accumulation contributes to arrhythmias and ischemic injury, while in neurodegenerative diseases, altered levels suggest a role in brain energy metabolism and mitochondrial function.

Drugs, dietary supplements, and nutritional interventions also influence acylcarnitine profiles. As potential biomarkers, acylcarnitines provide valuable insights into nutrient utilization, mitochondrial efficiency, insulin resistance, heart failure, and inherited metabolic disorders. Their profiling aids in assessing metabolic health and guiding personalized therapeutic approaches.

A deeper understanding of acylcarnitine regulation and function is crucial for advancing metabolic research and clinical applications. Their dual role as biomarkers and potential therapeutic targets presents new opportunities for precision medicine. However, interpreting acylcarnitine profiles requires expertise in the complex regulatory mechanisms governing metabolism.