

# Data-Driven Optimization of Carbohydrate Intake for Enhanced Performance and Recovery in Sports Dance

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## ABSTRACT

Sports dance demands both high metabolic efficiency and precise nutritional support because of its combination of physical exertion and artistic performance. The author examined energy metabolism patterns in sports dance athletes and proposes a data-driven model to optimize carbohydrate intake on the basis of individual needs. Through experimental tracking and multidimensional analysis, the author evaluated the impact of dynamic dietary adjustments on energy utilization and recovery. The results demonstrated that the optimized carbohydrate intake model significantly enhanced metabolic efficiency, lactate clearance, and perceived performance, outperforming traditional intake strategies. By incorporating real-time feedback and adaptive regulation, this approach transcends static guidelines, better addressing athletes' fluctuating energy demands. The findings provide a scientific foundation for personalized nutrition in sports dance, highlighting the potential of data-informed dietary strategies to enhance both performance and recovery.

## KEYWORDS

Sports Dance, Energy Metabolism, Carbohydrates, Individualized Nutrition, Optimization Model

## INTRODUCTION

In recent years, sports dance has evolved from a performance art into a globally influential competitive discipline, with its competitive standards and athletic demands rising steadily across both domestic and international arenas (Pessali-Marques, 2021; Saenz et al., 2024). What distinguishes sports dance from other athletic pursuits is its unique fusion of artistic expression and high-intensity intermittent physical exertion: Athletes must not only execute complex, rhythmically precise steps and rapid limb transitions but also maintain aesthetic coherence—all while enduring repeated bursts of maximal effort (e.g., jumps, spins) interspersed with brief recovery phases. This hybrid nature places extraordinary demands on physical conditioning, particularly on the body's energy metabolism system, which undergoes rapid, dynamic fluctuations during performance. Enhancing energy supply efficiency, therefore, is not merely a matter of boosting stamina—it is critical to preserving the stability of technical execution, avoiding fatigue-induced errors, and sustaining the artistic quality of movement, making it a core scientific challenge in modern sports dance training (Chen & Liu, 2024; Mphafudi et al., 2024; Rigoli et al., 2024).

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Against this backdrop, the shift toward evidence-based training methodologies and precision nutrition has revolutionized how athletes optimize performance and recovery—and carbohydrates stand out as the primary energy substrate for meeting sports dance’s high-intensity demands. Unlike fats or proteins, carbohydrates are rapidly mobilized to fuel anaerobic bursts (e.g., quick directional changes) and replenish glycogen stores that get depleted during prolonged training, directly influencing an athlete’s ability to sustain effort and recover between sessions. However, traditional carbohydrate intake strategies—which often take the form of static, generalized protocols designed for either endurance sports (e.g., long-distance running) or short-duration maximal efforts (e.g., sprinting)—fail to account for the variable loads of sports dance: the distinct energy demands of training versus competition, the differences between dance styles (e.g., the explosive power of Latin dance vs. the sustained elegance of Standard dance), and individual variations in metabolic rate and glycogen storage capacity (Moore et al., 2023; Zhou et al., 2024). These one-size-fits-all approaches thus struggle to address athletes’ real-time energy needs, limiting their effectiveness.

This research gap is further highlighted by our direct observations during elite sports dance athletes’ precompetition preparation: consistent suboptimal energy utilization, including delayed lactate clearance, inconsistent glycogen replenishment, and inadequate posttraining recovery. Over time, these inefficiencies not only compromise competitive performance (e.g., reduced precision in late-performance routines) but also elevate the risk of overtraining and long-term health issues, such as relative energy deficiency in sport (REDS) syndrome. Although scholars have developed robust models for energy metabolism and nutritional supplementation in endurance and short-duration high-intensity sports (e.g., cycling, track and field), there remains a dearth of comprehensive, sport-specific frameworks tailored to sports dance’s unique blend of technical artistry and variable physical exertion (Burke & Hawley, 2018; Jeukendrup et al., 2024).

To address this critical gap, the present study focused on two core objectives: (a) to systematically analyze the dynamic characteristics of energy metabolism in sports dance athletes across distinct training and competition stages and (b) to develop targeted, individualized carbohydrate intake optimization strategies that are based on these metabolic insights. By bridging the divide between general sports nutrition research and the specific needs of sports dance, this work aims to provide a scientific basis for enhancing athletic performance, accelerating recovery, and supporting the long-term well-being of elite sports dance athletes.

## **LITERATURE REVIEW**

Energy metabolism has long been a central focus in the field of exercise physiology, in particular when it comes to high-intensity intermittent sports such as competitive dance (Galea & Jones, 2024; Hajian & Mohaghegh, 2024). Understanding how the body generates and utilizes energy during physical activity is crucial for optimizing performance and recovery—a connection that has been repeatedly emphasized in foundational sports nutrition research (Burke & Hawley, 2018). In recent years, significant progress has been made in modeling metabolic responses under various exercise conditions, especially in disciplines that require both technical precision and intense physical output (Vardardottir et al., 2024).

One of the most influential contributions to this area was the development of a dynamic metabolic model based on the synergistic interaction of multiple energy systems (Grabia et al., 2024; Kuhlman et al., 2024). This model marked a departure from earlier static or isolated assessments of energy use, instead proposing a more integrated framework that accounts for real-time shifts between aerobic and anaerobic pathways. The findings laid an important theoretical foundation for analyzing energy supply and demand fluctuations in complex sports like sports dance, where movement patterns are highly variable and technically demanding—characteristics that distinguish it from both endurance and traditional strength sports.

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