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Opinion Article

Nutrigenomics and Neurohormonal Pathways in Pregnancy-Specific Urinary Incontinence

Luis Pascon Barbosa*

Department of Gynecology and Obstetrics, São Paulo State University (UNESP), São Paulo, Brazil

DESCRIPTION

Gestational Diabetes Mellitus (GDM) affects a significant proportion of pregnant women, posing both short-term and long-term health challenges for mothers and their offspring. Among the many complications associated with GDM, Pregnancy-specific Urinary Incontinence (PSUI) emerges as a notable yet often overlooked condition. PSUI is characterized by involuntary leakage of urine due to the physiological and hormonal changes of pregnancy. In women with GDM, this condition is compounded by metabolic dysregulation, inflammation and hormonal imbalances, making it a complex issue that demands a multifactorial approach to understanding its pathophysiology.

Emerging research highlights the complex interaction between nutrigenomics, melatonin, serotonin and inflammatory cytokines in the development of PSUI in GDM-affected pregnancies. Nutrigenomics, the study of how nutrients interact with genes, provides critical insights into the metabolic and hormonal pathways influenced by diet. Simultaneously, melatonin and serotonin two key neurohormones along with inflammatory cytokines, play pivotal roles in the regulation of pelvic floor function, oxidative stress and immune responses. Understanding these interconnections is essential for unraveling the mechanisms underlying PSUI in women with GDM and developing targeted interventions.

Nutrigenomics offers a personalized approach to understanding how genetic predispositions interact with dietary factors to influence health outcomes. In the context of GDM, nutrigenomics provides insights into how genetic variations in metabolic and hormonal pathways affect glucose metabolism, oxidative stress and inflammation all of which are crucial in the development of PSUI.

For example, polymorphisms in genes such as *TCF7L2* (associated with glucose metabolism) and *SOD2* (involved in antioxidant defense) have been linked to altered metabolic responses in GDM. These genetic variations can exacerbate oxidative stress and inflammation, contributing to the weakening of pelvic floor muscles and connective tissues, which are critical for urinary continence. Additionally, nutrient-gene interactions, such as the influence of omega-3 fatty acids on inflammatory cytokine gene expression, can modulate the immune response and mitigate tissue damage in the pelvic region.

Tailored nutritional interventions based on nutrigenomic profiles could therefore help reduce the metabolic and inflammatory burden in women with GDM, potentially alleviating the severity of PSUI. For instance, diets rich in anti-inflammatory nutrients like polyphenols, omega-3 fatty acids and vitamins C and E can enhance antioxidant defenses and reduce inflammation, thereby improving pelvic floor integrity.

Melatonin, a hormone primarily known for its role in regulating circadian rhythms, has significant implications for oxidative stress and inflammation. During pregnancy, melatonin levels naturally increase, providing antioxidant protection for both the mother and fetus. However, in women with GDM, melatonin secretion may be dysregulated due to hyperglycemia and metabolic disturbances.

Melatonin's antioxidant properties are particularly relevant for the pelvic floor tissues, which are exposed to increased mechanical stress and oxidative damage during pregnancy. By scavenging Reactive Oxygen Species (ROS) and upregulating antioxidant enzymes, melatonin can protect against the degradation of collagen and elastin fibers, which are essential for maintaining pelvic floor function. Additionally, melatonin's anti-inflammatory effects mediated through the suppression of pro-inflammatory cytokines like TNF-α and IL-6 can further mitigate tissue damage and support pelvic floor resilience.

Moreover, melatonin influences the expression of genes involved in muscle repair and regeneration. For instance, it can upregulate myogenic regulatory factors that promote muscle integrity, which is critical for urinary continence. Enhancing melatonin levels through dietary and lifestyle modifications,

Correspondence to: Luis Pascon Barbosa, Department of Gynecology and Obstetrics, São Paulo State University (UNESP), São Paulo, Brazil, E-mail: lpb@gmail.com

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such as consuming melatonin-rich foods (e.g., cherries and walnuts) and maintaining a consistent sleep schedule, may offer therapeutic benefits for PSUI in women with GDM.

Serotonin, another key neurohormone, is integral to mood regulation, gastrointestinal function and muscle contractility. During pregnancy, serotonin levels fluctuate due to hormonal changes and increased demands for neurotransmitter synthesis. In women with GDM, dysregulated serotonin pathways may contribute to PSUI by impairing neuromuscular control of the pelvic floor.

Serotonin's role in pelvic floor function is mediated through its action on serotonin receptors in smooth and skeletal muscles. These receptors regulate the contractility and tone of the pelvic floor muscles, ensuring effective urinary continence. Reduced serotonin availability or receptor sensitivity, as observed in metabolic disorders like GDM, can lead to decreased muscle tone and increased risk of incontinence.

CONCLUSION

The integration of nutrigenomics, melatonin, serotonin and inflammatory cytokines provides a comprehensive framework for understanding the complex pathophysiology of pregnancy-specific urinary incontinence in women with gestational diabetes mellitus. By highlighting the interconnections between metabolic, hormonal and immune pathways, this approach underscores the need for personalized and multi-faceted interventions.