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Muscle-derived Estrogen: metabolism, mechanisms, and exercise-induced changes

With the global increase in aging populations, the decline in skeletal muscle mass and function, along with associated metabolic disorders, has emerged as a pressing health concern. In women, the menopausal transition exacerbates this issue due to declining circulating estrogen levels. However, recent research has demonstrated that skeletal muscle tissue possesses the requisite steroidogenic enzymes to produce estrogen locally. This "myogenic estrogen" acts in an autocrine or paracrine manner to directly modulate muscle physiology and metabolism, independent of ovarian hormone production. Exercise is widely recognized as an effective non-pharmacological strategy for preserving muscle health. Accumulating evidence suggests that its beneficial effects may be partially mediated through the modulation of this local hormonal system. Specifically, physical activity appears to upregulate the expression of estrogen precursors and key steroidogenic enzymes within skeletal muscle, thereby enhancing local estrogen synthesis. By promoting myogenic estrogen production, exercise may offer a targeted mechanism to improve muscle function and metabolic outcomes. This review synthesizes recent findings to detail the relationship between exercise and the synthesis and metabolism of myogenic estrogen. We first examine the expression and functional roles of estrogen receptors in skeletal muscle, followed by a discussion of the biosynthetic pathway and metabolic fate of locally derived estrogen. We then explore the physiological roles of myogenic estrogen in regulating muscle function and metabolism. Finally, we discuss the mechanisms by which exercise influences estrogen synthesis within skeletal muscle, thereby providing a theoretical framework and experimental basis for understanding how physical activity optimizes female muscle health through local estrogen regulation.

Keywords: Estrogen · Skeletal muscle · Exercise · Aromatase · Postmenopausal females

Biography

Professor at Shanghai University of Sport, Ph.D., Doctoral Supervisor. Registered Dietitian of the Chinese Nutrition Society, Standing Committee Member of the Special Nutrition Branch of the Chinese Nutrition Society. Currently principal investigator of three projects funded by the National Natural Science Foundation of China. Authored or co-authored over 70 research papers, and served as editor-in-chief or contributing editor for 10 textbooks and monographs. Main research areas and interests: Exercise and health management, sports nutrition, cellular and molecular mechanisms of exercise and skeletal muscle adaptation, sarcopenia in the elderly and exercise/nutrition interventions.