

Disrupted Contraction-Relaxation Dynamics in Obesity: A Potential Barrier to Active Living

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Purpose: Obesity has been associated with impaired muscle contractile function, potentially compromising daily movement and increasing injury risk. This study aimed to investigate obesity-related alterations in contraction–relaxation dynamics during plantar flexor maximal voluntary isometric contractions and a calf raise exercise.

Methods: Fifty male young adults (aged 30–50 years), 25 within a healthy weight range (CN; BMI: 18.5–24.9 kg/m²) and 25 classified as class I obese (OB; BMI: 30–34.9 kg/m²), voluntarily participated in the study. To assess muscle contraction–relaxation behaviour, participants performed maximal voluntary isometric contractions (MVCs) of the plantar flexors, and a calf raise test with ankle joint motion captured. A two-step analysis approach was applied: (1) Statistical Parametric Mapping (SPM) was used to identify time-resolved group differences in the torque–time curves, and (2) targeted curve-phase analysis was conducted in regions identified as statistically different.

Results: SPM analysis of isometric time–force curves from MVCs revealed significant differences between OB and CN groups ($p < 0.05$), affecting both the contraction and relaxation phases. OB subjects exhibited slower contractile behaviour, as indicated by a reduced rate of torque development relative to peak force (RFD/PT) and body mass divided by maximal voluntary isometric torque ($p < 0.05$). A double exponential decay analysis further showed altered relaxation dynamics in OB, with a biphasic pattern emerging compared to the monophasic profile observed in CN, resulting in significantly slower relaxation in OB ($p < 0.05$), especially in the second phase. OB subjects demonstrated slower movement during the concentric phase of the calf raise, with an even more pronounced delay observed in the eccentric phase ($p < 0.05$).

Conclusion: Obesity-related impairments appear to extend beyond muscle weakness, also affecting the muscle’s ability to rapidly relax. This dysfunction results from a combination of structural–mechanical, metabolic, and neuromuscular factors, ultimately compromising the efficiency and safety of daily movements. Muscle weakness, slower force production, and delayed relaxation may hinder quick, coordinated actions, increasing the risk of injury, joint overload, and movement-related pain. Such limitations can discourage individuals with obesity from engaging in physical activity, creating a barrier to recovery and health improvement.

