

## NEUROMUSCULAR PERFORMANCE PROFILES IN HANDBALL PLAYERS: COMBINED ISOMETRIC MID-THIGH PULL – COUNTERMOVEMENT JUMP ASSESSMENT AND BODY COMPOSITION CHARACTERISTICS

*Peter Bakonyi<sup>1</sup>, Gergo Simon<sup>1</sup>, Tamas Dobronyi<sup>1</sup>, Bettina Beres<sup>1</sup>, Fanny Zselyke  
Ratz-Sulyok<sup>1,2,3</sup>, Csilla Jang-Kapuy<sup>1,2,3</sup>, Annamaria Zsakai<sup>1,2</sup> and Tamas Szabo<sup>1</sup>*

<sup>1</sup>Hungarian Handball Federation, Directorate of Sport Science and Diagnostics, Budapest, Hungary; <sup>2</sup>Eotvos Lorand University, Faculty of Science, Department of Anthropology, Budapest, Hungary; <sup>3</sup>Eotvos Lorand University, Faculty of Science, Doctoral School of Biology, Budapest, Hungary

**Background:** Handball requires repeated high-intensity actions, rapid changes of direction, jumping, and high levels of strength and power. The isometric mid-thigh pull (IMTP) assesses maximal force production, while the countermovement jump (CMJ) evaluates explosive performance. Although both tests are widely used, little is known about the neuromuscular performance profiles emerging from their combined interpretation. This study aimed to identify distinct IMTP-CMJ performance profiles in handball players and examine their associations with age category and playing position.

**Subjects and methods:** Elite male and female handball players aged 13–25 years (n=432) from youth and senior categories completed IMTP and CMJ testing on a force platform. Relative IMTP peak force (N/kg) and relative CMJ peak power (W/kg) were studied by using z-score analysis. The distribution of the resulting profiles was then compared across age categories and playing positions.

**Results:** Only a weak relationship was found between relative IMTP force and CMJ power, indicating that greater isometric strength did not necessarily correspond to superior dynamic performance. Three distinct profiles were identified: (1) low relative strength and power; (2) strength-dominant (high relative strength with comparatively lower dynamic performance); and (3) power-dominant (moderate relative strength with high dynamic performance). Profile distribution differed across age groups and playing positions. Strength-dominant athletes were less frequent among younger players, while some positions showed a lower prevalence of power-dominant characteristics.

**Conclusions:** Combined IMTP and CMJ assessment identifies distinct neuromuscular profiles in handball players, demonstrating that maximal isometric strength and explosive performance represent complementary aspects of athletic ability. A profile-based approach may improve individualized strength and power training and optimize load management, particularly in youth athletes. Future studies incorporating surface electromyography (sEMG) may further clarify the neuromuscular mechanisms underlying these performance profiles.

**Keywords:** Handball; Isometric mid-thigh pull; Countermovement jump; Neuromuscular profiling; Body composition; DEXA.