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Title: **The influence of the strength of selected lower limb muscles on maintaining balance in the frontal plane.**

Abstract

Introduction and Objective. Damage at any stage of the stimulus transmission results in balance-related dysfunctions in both the sagittal and frontal planes. To maintain an upright posture, a small but constant tension of the antigravity muscles is needed, as well as symmetry in muscle tension and strength between agonists and antagonists. The strongest stabilizers of the pelvis, both in both two-legged and one-legged standing positions, are the gluteus medius, gluteus medius, small gluteus medius and broad fascia flexor muscles. This function of the aforementioned muscles indicates that the muscles that invert the hip joint and stabilize the pelvis can significantly affect a person's balance. The purpose of this study was to determine the relationship between the activity of the hip adductor muscles, assessed under isometric and isokinetic conditions in healthy subjects, and the ability to maintain balance under static conditions.

Material and methods. The study included 96 healthy subjects (59 women and 37 men) aged 19 to 59. Each person filled out a questionnaire to check if any exclusion criteria persist. The Waterloo Footedness questionnaire was used to determine the dominant lower limb. Further, a balance assessment was performed using the BIODEX Balance System platform. The balance testing protocol included three consecutive tests: M-CTSIB (Modified Clinical Test of Sensory Interaction in Balance), PST- BI (Postural Stability Test - bilateral) and PST (Postural Stability Test). A 10-minute warm-up equal for all subjects preceded the last part of the test. The isokinetic and isometric test of the hip joint abductors was conducted using the Humac Norm system. Angular velocities of 60°/s and 180°/s were selected for isokinetic evaluation, while measurement under isometric conditions lasted 5 seconds. The force, power and time parameters were evaluated. Statistical analysis was performed using R statistical software. The level of statistical significance was set at 0.05.

Results. There were no reproducible relationships between limb dominance and balance parameters in the study group. It was observed that older age was associated with worse balance in both univariate and multivariate analysis ($\beta = 0.06$, $p = 0.018$), while higher body mass was associated with better balance in multivariate analysis only ($\beta = -0.07$, $p < 0.001$). Strength training had a positive effect on balance in these subjects in all conditions showing a lower stability index, which means better balance (closed eyes, stable surface: $\beta = -1.17$, $p = 0.005$; open eyes, unstable surface: $\beta = -1.66$, $p = 0.007$; closed eyes, unstable surface: $\beta = -1.86$,). Strength parameters appeared to be significant predictor of balance abilities most often for concentric contractions and 60°/s velocity. Significant and larger effects on balance were noted for time parameters. The time parameters obtained for eccentric contractions were significant for all test conditions. Significant results for concentric contractions were observed only in the most challenging test conditions. In the multivariate analysis, significant isokinetic and isometric testing results were recorded only for some time parameters and under difficult testing conditions (eyes closed or unstable surface). It was observed that longer force decay time, especially for eccentric contractions, was associated with a lower value of the stability index (closed eyes, stable surface: $\beta = -6.65$, $p = 0.031$; closed eyes, unstable surface: $\beta = -10.61$, $p = 0.040$). Under the most challenging conditions, it was also observed that the longer reciprocal delay during an eccentric contraction was associated with a higher stability index value and, therefore, worse balance ($\beta = 8.26$, $p = 0.040$).

Conclusions. 1. The observed deterioration of balance parameters during various sensory disturbances affects coordination, increases wobbling, and changes postural strategies. 2. The dominance of the lower extremities does not affect the disproportion of muscle strength, and the symmetry of strength between the sides is a physiological condition in healthy young adults. 3. Based on the results, there was no significant effect of hip abductor muscle strength on static balance among healthy subjects under 60. 4. Univariate and multivariate analysis showed that proper activation of the hip abductor muscles is important for good balance in people under 60 when standing with both feet and one leg standing. 5 There is a lack of studies in the literature evaluating the temporal parameters associated with proper lower limb muscle activation in different age groups. Therefore, further studies are needed.