

The impact of age and sports experience on balance control: physiological and cognitive insights

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INTRODUCTION & AIM

Aging impairs the multisensory integration and cognitive control essential for posture regulation. Declining cerebellum–prefrontal cortex coordination disrupts attentional shifting, working memory, and executive flexibility, weakening balance responses, slowing adaptation, and increasing instability. The stabilometric target test on a force platform assesses cognitive–motor interaction by analyzing attentional load and sensorimotor updating during posture control. This study aimed to characterize age-related changes in cognitive–motor integration and evaluate whether athletic training mitigates cortical decline and optimizes sensorimotor–cognitive function.

METHOD

Participants: $n = 44$ (≤ 45 years, $n = 24$, median 36.5 years; >45 years, $n = 20$, median 55.5 years); athletic experience (nonathletic (NA), $n = 24$; athletic (A), $n = 20$). Stabilometry: Test of visual tracking of a moving target. Stabilan-01-2 platform (OKB Ritm, Taganrog, Russia) on firm and soft surfaces. Statistical analysis: Significance ($p < 0.05$, $q < 0.1$). Student's t-test or the Mann–Whitney U test with FDR-BH correction. Athletic experience effects were analyzed via regression, adjusting for age, sex, and athletic experience.

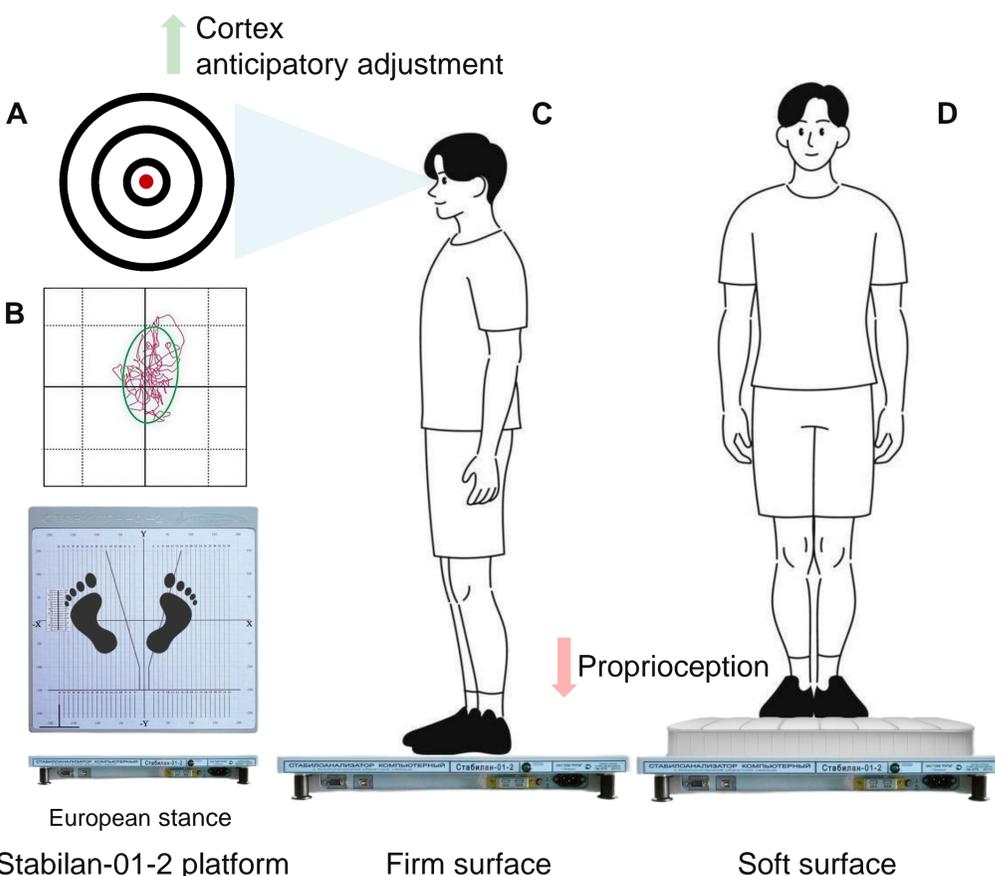


Figure 1. Stabilometry on firm and soft surfaces during target-following test: (A) Target-test paradigm; (B) Center-of-pressure (CoP) displacement on stabilometric platform - European stance; (C) Stabilometry on firm surface; (D) Stabilometry on soft surface.

RESULTS & DISCUSSION

Age and athletic experience significantly explained the variation in stabilographic data ($R = 0.08$, $p < 0.05$ and $R = 0.12$, $p < 0.01$, respectively) on a firm surface. On a soft surface, no intergroup differences were observed ($p > 0.05$) in stability profiles, as support deprivation triggers adaptive mechanisms that maintain posture regardless of athletic training level (Fig. 2). Age was negatively associated with stability parameters, while athletic experience showed positive associations during the stabilometric target test engaging attention and postural control (Fig. 3). Regression analysis, revealed that athletic experience was significantly associated with increased stability in both age groups (Fig. 4).

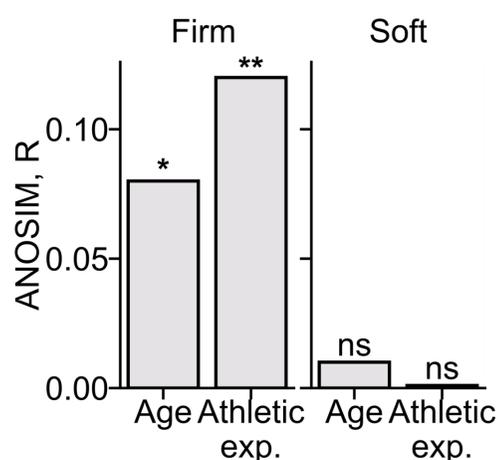


Figure 2. Age and athletic experience significantly affect stability profiles. Barplot showing the significance of stability data grouping by different factors in stability tests on solid (left) and soft (right) surfaces. ANOSIM, 999 permutations. * $p \leq 0.05$, ** $p \leq 0.01$.

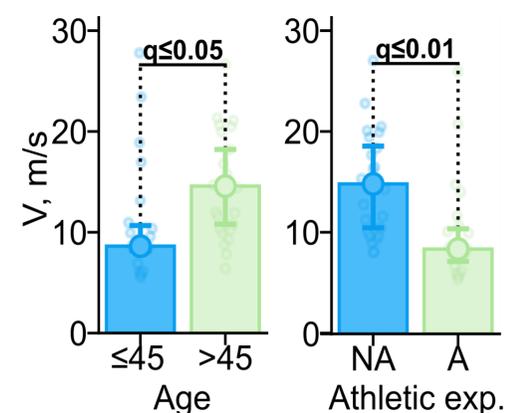
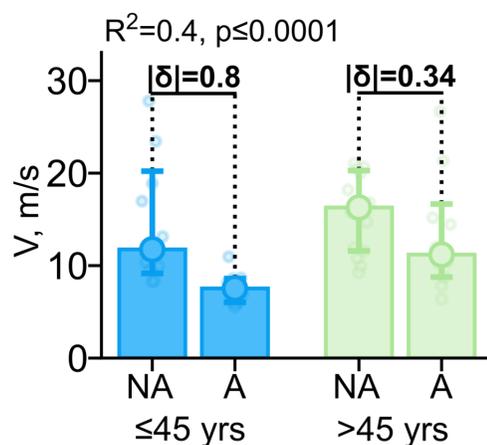


Figure 3. Age and athletic experience show an inverse correlation with stability. V = velocity of center of pressure (CoP) shift; lower values of V indicate greater stability.

Figure 4. Athletic experience significantly enhances stability in both younger (≤ 45) and older (>45) individuals. Regression analysis was performed adjusting for age, sex, and athletic experience. The p-value is reported for athletic experience. δ = Cliff's delta effect size.



CONCLUSION

Athletic experience enhanced stabilometric performance, improving visual–postural control and compensating for age-related decline. These results suggest stabilometric improvements are linked to training cognitive mechanisms, particularly attention and spatial orientation.

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