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Biological Maturation And Neuromuscular Performance In Youth Soccer Players: A Mediation Analysis Approach

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The interactive effects of biological growth and sprinting and jumping abilities should be jointly examined to evaluate their impact on youth soccer performance. **PURPOSE:** To investigate the link of maturity status with linear and change of direction (COD) sprinting abilities and the potential mediating effect of jumping performance. **METHODS:** One hundred-seventeen soccer players (age: 9-15 years) from an Italian elite academy were assessed for countermovement jump (CMJ) height, 15 m (15mLIN) and 40 m (40mLIN) linear sprint times, and 15 m 60° COD (15mCOD) sprint time. Prior to testing, maturity offset (MO) was calculated using the Mirwald equation. A series of mediation analysis was conducted to evaluate the effect of MO on sprint tests (15mLIN, 40mLIN, 15mCOD) and the mediating effect of jumping ability. **RESULTS:** A greater MO was associated with a higher CMJ (b=2.17; p<0.001), as a higher CMJ corresponded to shorter times for 15mLIN (b=-0.015; p<0.001), 40mLIN (b=-0.036; p<0.001), 15mCOD (b=-0.021; p=0.0004). Jumping height resulted a significant mediator for each sprint test. The mediation analysis showed significant direct, indirect, and total effects for each sprint test. For 15mLIN, the total effect (b=-0.085; p<0.001) resulted from the following direct (b=-0.053; p<0.001) and indirect (b=-0.033; 95%CI=-0.047; -0.018) effects. For 40mLIN, the total effect (b=-0.187; p<0.001) was the results of the direct (b=-0.187; p<0.001) and indirect effects indirect (b=-0.079; 95%CI=-0.111; -0.046). For the 15mCOD, the total effect (b=-0.079; p<0.001) resulted from the current direct (b=-0.033; p=0.034) and indirect (b=-0.045; 95%CI=-0.075; -0.018) effects. **CONCLUSIONS:** The mediation analysis showed that maturation is associated with the improvement in sprinting performance, with and without COD tasks, and further strengthened by vertical jumping ability. While maturation mostly drives 40 m sprints, its influence diminishes in shorter sprints and with COD task, where jumping ability becomes dominant. These results suggest that maturation cannot fully explain the improvement in sprinting and COD ability. Therefore, training and evaluation processes in youth should consider an integrated approach including biological growth and several components of the neuromuscular performance.

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Different Adaptation Patterns To Aerobic Training Despite Similar Performance Improvements

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PURPOSE: Aerobic training improves exercise performance through multiple physiological adaptations, including changes in maximal capacity and ventilatory thresholds (VT1). However, the relative contributions of submaximal efficiency versus threshold-related adaptations remain unclear. Therefore, this study examined inter-individual variability in VT1 responses after 8-week training and identified baseline predictors of training responsiveness.
METHODS: Eleven healthy young adults (age: 23.7 ± 2.6 yr; BMI: 25.0 ± 3.1 $kg \cdot m^{-2}$; body fat: 20.2 ± 5.9%; VO_2max: 49.2 ± 6.2 $mL \cdot kg^{-1} \cdot min^{-1}$) completed an 8-week aerobic training intervention.
VT1 was determined using the ventilatory equivalent method (VE/VO_2). Participants were classified as Responders (R, n = 5) or Non-Responders (NR, n = 6) based on changes in VT1 (ΔVT1). A logistic regression model was constructed using baseline BMI, age, and initial VT1 to predict training responsiveness.
RESULTS: VT1 significantly improved across participants, with substantial inter-individual variability. The logistic regression model identified BMI as a strong negative predictor of responsiveness (β = −0.459). Although both groups significantly increased exercise duration after training (p = 0.030), the underlying physiological adaptation patterns differed according to baseline status. NR increased from 709 ± 52.7 s to 795 ± 111 s (Δ86.3 ± 109 s), while R improved from 729 ± 50.1 s to 771 ± 30.4 s (Δ42.2 ± 50.9 s). At baseline, NR exhibited higher BMI and lower metabolic efficiency, reflected by a higher baseline energy expenditure (EE) slope (0.1949 ± 0.02) compared with R (0.1602 ± 0.01; p = 0.082). Following training, NR showed greater improvements in EE slope (Δ0.0115 ± 0.02), whereas R showed minimal change (Δ0.0001 ± 0.01).
CONCLUSIONS: Aerobic training adaptations differ according to baseline physiological status. Individuals with lower BMI and lower baseline VT1 demonstrated a significant VT1 improvement. In contrast, individuals with higher BMI and higher baseline VT1 exhibited an exhibited improvements in energy efficiency without significant changes in VT1. These findings suggest that the logistic equation may serve as a preliminary screening tool for identifying individuals who are more likely to benefit from similar training programs.
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Sex Differences In 100-mile Ultramarathon Performance Are Similar Across Full And Sex-balanced Samples

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The sex difference in endurance performance has been reported to be 10-12%, with men outperforming women. The magnitude of this difference has been reported to decrease with increasing age and race distance. However, the sex difference for 100-mile ultramarathon performance has been reported to vary considerably, in part due to unequal participation rates between women and men. **Purpose:** To determine if balanced participation between sexes influenced the sex difference in age-related changes in 100-mile ultramarathon performance. **Methods:** 100-mile ultramarathon performances between 2000 and 2023 (https://www.ultra-marathon.org/) were compiled and analyzed. A sex-balanced subset was created via randomized extraction. Performance time (min) was modeled as a function of sex (coded 0 = women, 1 = men) and age (continuous) using multiple linear regression for both the full and sex-balanced samples. Percent differences were calculated to quantify sex differences across 10-yr age groups. **Results**: A total of 48,793 performances (10,856 women, 37,937 men) were analyzed, and the sex-balanced subset included 10,856 performances per sex. Women and men had similar mean ages (40.8 ± 8.4 vs. 41.5 ± 8.9 years) and performance times (1,715.6 ± 304.7 vs. 1,689.7 ± 341.8 min). Regression models for the full sample (Performance = (-27.94 * Sex) + (3.16 * Age) + 1586.81, $R^2 = 0.008$) and sex-balanced sample (Performance = (-29.71 * Sex) + (2.82 * Age) + 1600.61, $R^2 = 0.008$) were statistically significant (p<0.001) but explained <1% of the variance in performance. Mean sex differences were 1.5% (full sample) and 1.7% (sex-balanced). Across age groups, sex differences were largest among athletes aged 60-69 years (4.9%) and smallest in the 70-79 group