Age-related Changes in Trunk Movement Strategy Contributes to Power Loss During Countermovement Jumping

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Summary

Age-related losses in muscular power are often measured with countermovement jumps, which can be affected by movement strategy. Force plates and motion capture measured the extent to which differences in hip and trunk angle could predict power output across the age-span. Participants were able to generate greater power with greater trunk flexion movement during the jump. However, on average this strategy was not adopted by adults aged >70y who showed less trunk flexion. Therefore, at least some of the loss in power output in older adults can be explained by movement strategies (which appear to affect the trunk primarily) rather than other declines.

Introduction

Age related losses in muscular power have critical implications on function in older adults [1,2]. Power across the lifespan is often measured with a countermovement jump (CMJ)[3,4]. However, power production during the CMJ can be affected by movement strategies such as altered hip flexion and trunk flexion [5]. This research aims to investigate the relationship between age, hip and trunk flexion, and power output measured in a maximal CMJ.

Methods

59 participants (20F and 39M) aged 22.4-85.2y (mean 55.8y) performed three maximal CMJs with trunk and lower-body motion capture (NDI 3D-Investigator, 80Hz) and force plates (AMTI OR6-7, 1200Hz), facilitating the calculation of hip and trunk postures at the instant of peak ground reaction force (GRF) and peak power (computed in Visual3D, HAS-Motion). Peak lower body power was calculated as the product of net GRF and the vertical velocity of the pelvis centre of mass (both quantities low pass filtered at 10Hz). A neutral standing reference position was used to calculate the change in joint position.

Results and Discussion

Trunk. A multiple linear regression analysis revealed a significant predictive model of lower-body power ($F_{3,57} = 16.526$, $R^2 = .692$, $p < .001$) with significant contributions from age ($r = -.661$, $\beta = -.299$, $p < .001$) and trunk flexion angle at peak GRF ($r = -.130$, $\beta = .310$, $p = .050$). Trunk flexion angle at peak power did not contribute significantly to the model ($p = .180$). Additional age-group analysis via one-way ANOVA ($F_{3,58} = 6.035$, $p<.001$) revealed that adults aged >70y demonstrated significantly less trunk flexion at the instant of peak GRF production compared to <30y ($\Delta = 14.028°$, $p < .001$; Figure 1).

Hip. A multiple linear regression analysis revealed a statistically significant predictive model of lower-body power, (F3,57 = 16.331, R2 = .471, p < .001) with significant contributions from age only ($r = -.662$, $\beta = -.284$, $p < .001$). Hip angle at peak GRF or at peak power did not significantly contribute to power production during the CMJ ($p > .076$; Figure 1).

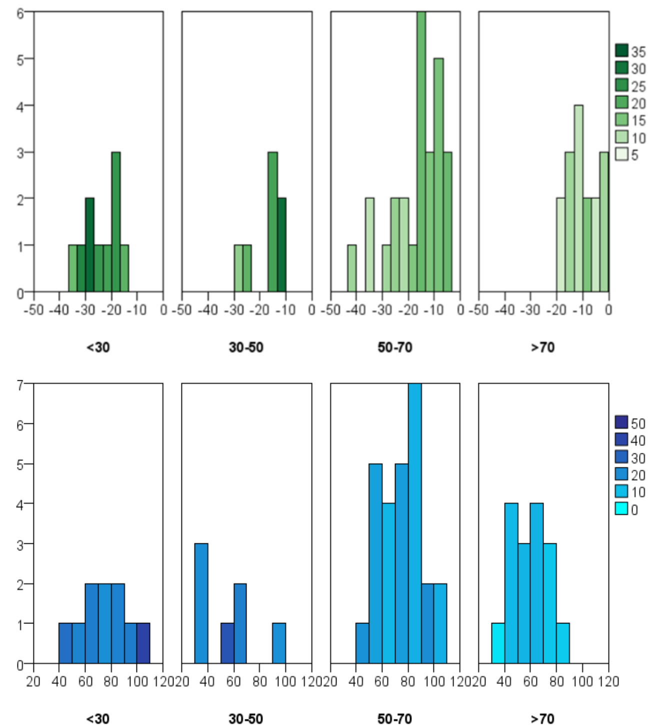

Figure 1: Histogram of trunk flexion (green) and hip flexion (blue) used by participants in the various age groups at the instant of peak GRF. The darker the shading, the higher the lower-body muscular power output (W/kg); frequency of angle is on the y-axis.

Conclusions

Each degree of trunk flexion during the CMJ showed a predicted benefit of ~0.3W/kg ($r = -.130$, $\beta = .310$, $p = .050$). This strategy was not adopted by older adults aged (>70y) who showed 14° less trunk flexion than younger adults (<30y; $F_{3,58} = 6.035$, $p<.001$). When measuring power in older adults, some of the changes observed with age may result from altered movement strategy, particularly reduced trunk flexion. Therefore, consideration of kinematics must be included in examination of kinetics of CMJ.

References

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