

Homogeneity of the Inverse Relationship between Motor Unit Recruitment Threshold and Firing Rate Across the Lifespan

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ABSTRACT

It is well understood that there is an inverse relationship between the recruitment thresholds and firing rates for a group of motor units. In other words, at any given force level, earlier-recruited, low-threshold motor units have higher firing rates than later-recruited ones. The majority of previous investigations that have examined this relationship have done so in healthy, young adults. While some evidence suggests that aging may result in decreased maximal firing rates, it is unclear if the control scheme which governs the recruitment and firing behavior of motor units is consistent across the lifespan. Therefore, the purpose of this study was to examine the motor unit recruitment threshold versus mean firing rate relationship in children and younger and older adults. Eight boys (mean \pm SD age = 12 ± 2 years; body mass = 49.9 ± 13.2 kg) and five younger (age = 26 ± 3 years; body mass = 68.6 ± 5.5 kg) and six older (age = 72 ± 4 years; body mass = 79.5 ± 9.6 kg) men participated in this investigation. Subjects performed isometric, constant-force contractions at 50% of their maximal voluntary contraction (MVC) force while bipolar surface electromyographic (EMG) signals were detected from the vastus lateralis muscle. A surface EMG signal decomposition algorithm was used to determine the recruitment thresholds and firing rates of motor units that demonstrated accuracy levels $\geq 93\%$. For each subject, the relationship between the recruitment thresholds and the mean firing rates was examined using linear regression. Two separate one-way analyses of variance (ANOVA) were used to examine age-related differences in the linear slope coefficients (pulses per second [pps]/% MVC) and y-intercepts (pps) from the recruitment threshold vs. firing rate calculations. The mean \pm SD slope coefficients for the boys and younger and older men were -0.33 ± 0.12 , -0.49 ± 0.32 , and -0.60 ± 0.38 pps/%MVC, respectively. The mean \pm SD for the y-intercepts for the boys and younger and older men were 21.17 ± 4.16 , 26.80 ± 4.68 , and 27.60 ± 6.77 pps, respectively. The ANOVAs did not reveal any significant age-related differences in the linear slope coefficients ($F = 1.700$, $p = 0.214$) or y-intercepts ($F = 3.150$, $p = 0.070$). Although larger studies with additional subjects may be required to verify these findings, the results of the present investigation suggested that the inverse relationship between motor unit recruitment thresholds and firing rates is fixed across the lifespan.