Different EMG normalization methods and implications for field-based data acquisition of muscle activity

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Background. New semi-automated mobile harvesting platforms have been introduced where workers stand on the platform as it slowly moves through the trees. This method may replace the traditional method of picking fruit by climbing ladders. The goals of this study were to use electromyography (EMG) to compare shoulder muscle activity between the two harvesting methods and to compare two EMG normalization methods.

Methods. Trapezius EMG was measured on 16 orchard workers during their actual harvesting throughout the entire day: eight workers harvested apples from a moving platform, and eight used ladders. EMG was normalized in two ways: (1) using sub-maximal reference voluntary electrical activation (%RVE), and (2) using the peak muscle activity during the first 1.5 hours of work (95%tile dynamic EMG). To compare the normalization methods, EMG amplitudes were characterized in terms of the 10^{th}, 50^{th} and 90^{th} percentiles, representing static, median and peak muscle activity, respectively. EMG signals were first analyzed in frequency domain to identify shifts in frequency; this indicated when the electrodes were losing contact with the skin. Then, the subsequent data was analyzed in the time domain to characterize muscle activity levels.

Results. Normalizing EMG to peak dynamic contractions gave substantially less between-subject variation than the %RVE normalization — this yielded better statistical power for the comparison of the two groups of workers. The frequency domain EMG calculations were helpful to indicate when electrodes came off the skin, a challenge in field studies.

Discussion. This study characterized muscle activity in a very challenging field environment. The frequency-domain analysis first indicated the good portions of data for the subsequent time-domain analysis. The substantially lower between-subject variation with the dynamic normalization may have important and practical implications for the future collection and interpretation of field collected EMG data.

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