Electromyography during upper body Wingate exercise

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Introduction

The specific muscles contributing to power production and/or stabilisation during incremental arm crank ergometry (ACE) have been examined (Smith *et al*., 2008: Journal of Electromyography & Kinesiology, 18, 598–605). To the authors' knowledge these muscles have not been examined during upper body Wingate anaerobic testing (WAnT). Therefore, the purpose of the research was to examine EMG during WAnT for ACE.

Methods

Following institutional ethical approval thirteen male students (Age *mean* 21.9, *s* = 7.0 years, body mass *mean* 78.3, *s = 9.2 kg)* volunteered to participated in this study. Following familiarisation each participant completed five seated upper body WAnTs using a table mounted cycle ergometer (Monark 894E, Monark Exercise AB, Sweden) using 2, 3, 4 and 5% body mass (BM) as resistive loads. The order of testing was randomised with a minimum of 24-h between tests. Before each test a standardised warm-up including three 3-4 s practice sprints against 4% BM was completed.

Corrected and uncorrected peak power (PP; over 1 s duration) and mean power (MP; over 29 s duration) were recorded (Cranlea Wingate software, v. 4.0). Peak EMG during the warm-up sprints was used to normalise the EMG data for each WAnT. Data were recorded using double-differential (16-3000Hz bandwidth, x300 gain), bipolar, active electrodes (MP-2A, Linton, Norfolk, UK). The average root-mean-square (RMS) value for each muscle was calculated over 250-ms, for each trial. The following sites were examined flexor carpi ulnaris (FCU), biceps brachii (BB), triceps brachii lateral (TB), anterior deltoid (AD), infraspinatus (I), external oblique (EO), vastus medialis (VM) and lateral soleus (LS).

Statistical analysis: EMG data at peak power and fatigue were analysed by general linear model ANOVA (SPSS 17.0) with Bonferroni correction. Significance was accepted with $P < 0.05$. Effect sizes (*eta squared*) ranged from.010 to 0.312.

Results

There were significant differences for uncorrected PP ($P < 0.01$) which increased with resistive load. At 5% loading PP was greater than for 2 and 3% ($P < 0.01$), no differences were observed between 4 and 5% loads ($P = 0.235$). End power (fig. 1) increased with resistive load ($P < 0.01$). End power at 5% loading was significantly different from 2 and 3 % loads ($P < 0.01$). No differences were observed between 4 and 5% loads ($P = 0.232$). At peak power normalised BB was significantly different at 5% versus 2% ($P = 0.012$). EO approached significance ($P = 0.068$) between loadings. At the end of each test (29 s) there were significant differences in normalised EMG responses for, BB at 5% versus 2% and 3% ($P = 0.006$ and $P = 0.027$ respectively), TB at 5% versus 2% ($P = < 0.01$) and 2% versus 3% ($P = 0.015$), AD at 5% versus 2% and 3% (both $P < 0.01$) and 4% (P = 0.036) and OE 5% and 4% versus 2% ($P = 0.001$ and $P = 0.038$ respectively) (fig. 2). FCU at 5% versus 2% and TB 2 versus 4% approached significance ($P = 0.057$ and $P = 0.081$ respectively).

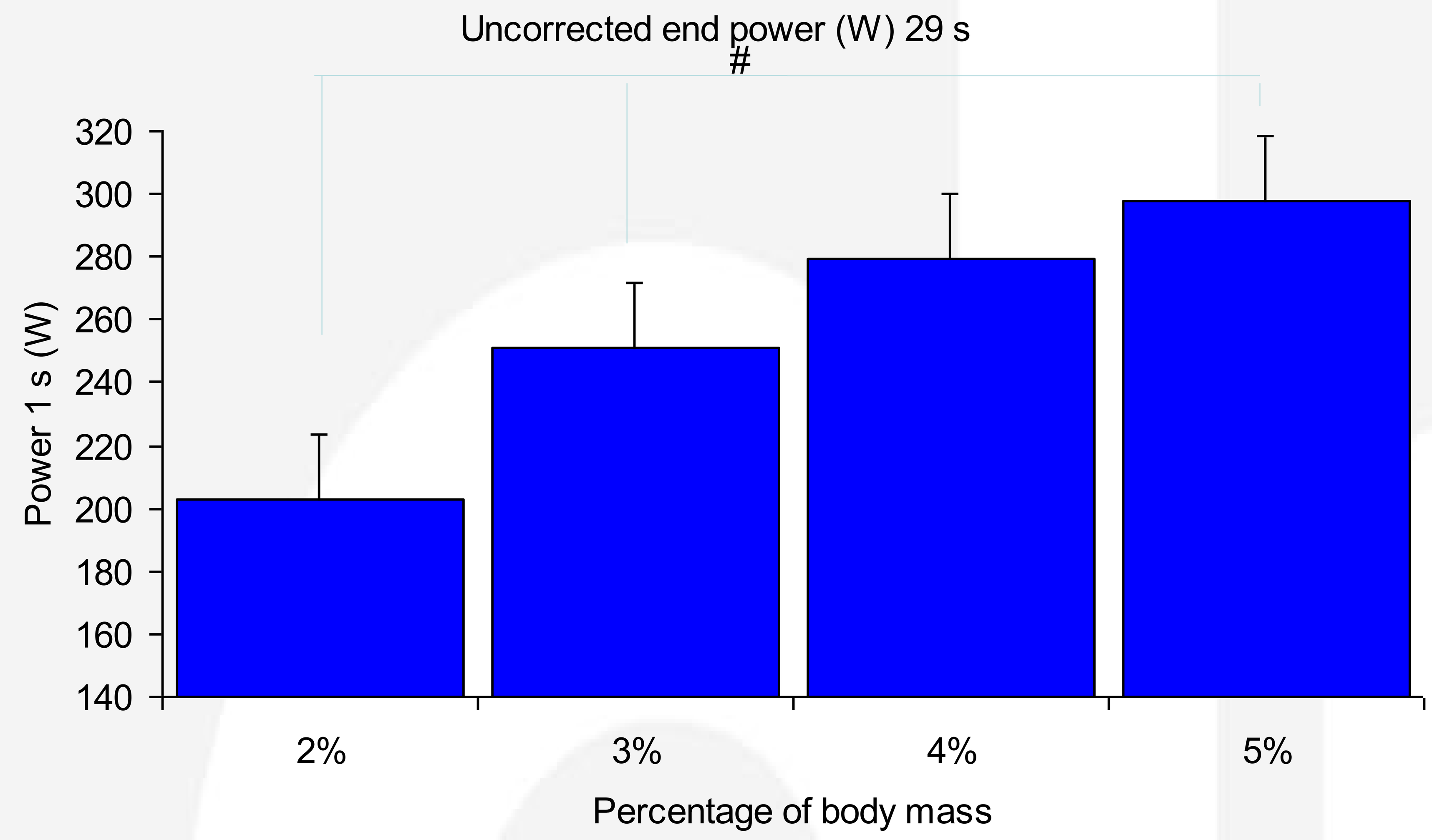

Figure DFD. Uncorrected WAnT end power (W; 1 s) with resistive load as percentage of body mass. #Significant difference from 5% loading ($P < 0.01$).

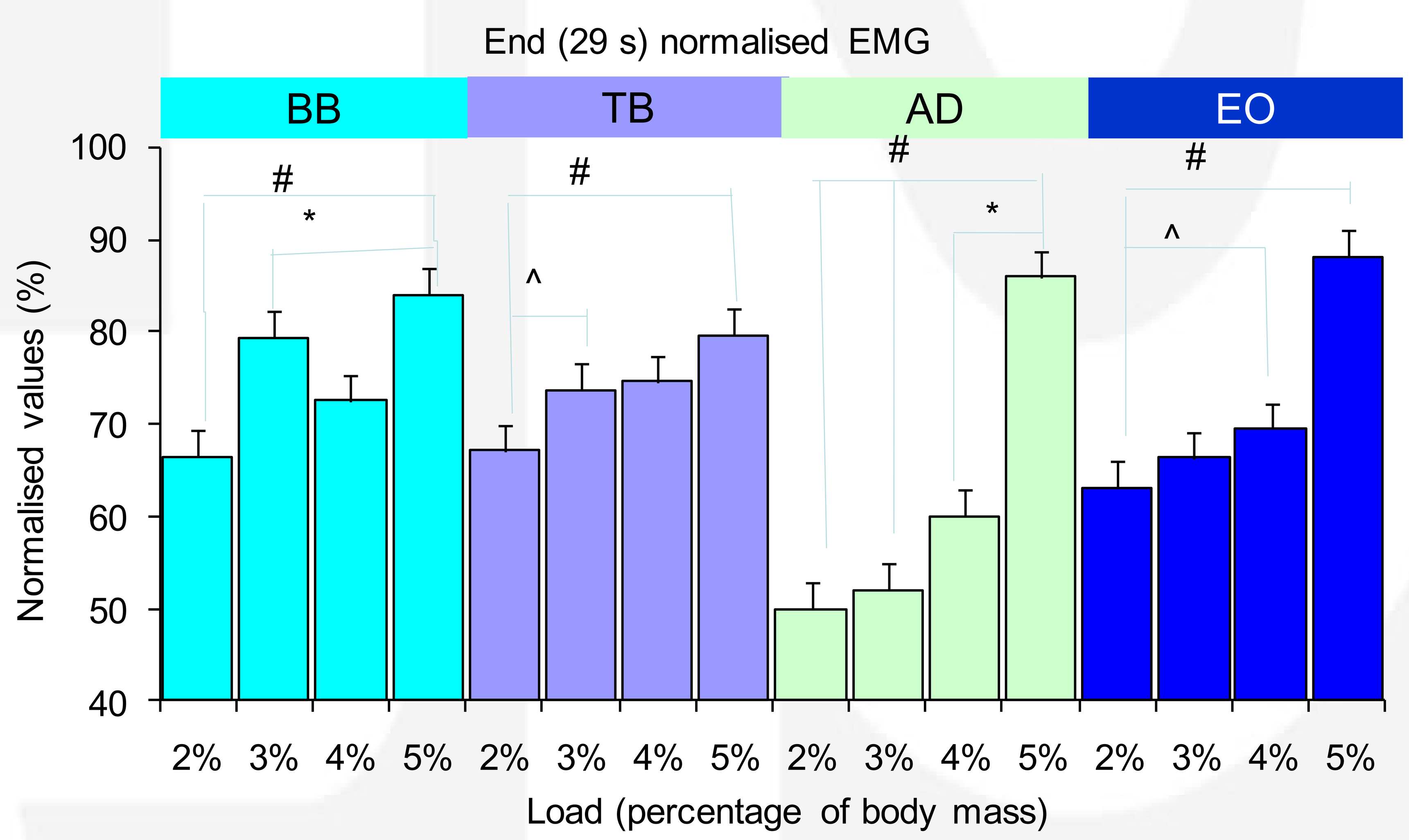

Figure 2. Normalised EMG values for biceps brachii (BB), triceps brachii (lateral (TB), anterior deltoid (AD) and external obliques (EO) at end (29 s) of WAnT with resistive load as percentage of body mass. #Significant difference from 5% loading ($P < 0.01$). *Significant difference from 5% loading ($P < 0.05$).). ^Significant difference from 2% loading ($P < 0.05$).

Summary and conclusions

The greater EMG activity during upper body WAnT at 5 vs 2% BM loads represents greater muscular effort for the BB and EO muscle groups, most likely relating to greater force production of the upper limb and body stabilisation, respectively. At 29 s the majority of muscle groups contributed to either an increase in joint stabilisation and/or power production proportional to the loading used.

The results suggest lower loads (2% BM), may be better for shoulder injury rehabilitation, whereas, a 4 or 5% BM load is suggested for power training.