DETERMINATION OF MAXIMUM OUT-PUT POWER AS A FUNCTION OF BOTH ACTIVITY DURATION AND LOAD

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INTRODUCTION

Bicycle erogmeters for legs or cycle erometers for arms enable accurate measurement of out-put power in the time domains of a few seconds to hours. Depending on the activity duration, three energy conversion modes dominate the out-put power production: the immediate energy source (nonoxidative),glycolysis and glycogenolysis (nonoxidative), and the oxidative energy source [1]. For determination of the **Human Power Spectrum** [2] the Sprint Power (**SP**) test was developed for the time domain of a **few seconds** [3], and for oxidative endurance power assessment a maximal cycle ergometer step test is used [4], or a maximum lactate steady state test. Since the Wingate Test is associated with major methodical problems [5], a new test protocol for a test duration of **30s**, the Transition Power (**TP**) test, was introduced recently [6]. Data presented in [6] suggest to use a load (frictional force) of 11 % of body weight on the bicycle ergometer for leg tests, independently of the individual's power out-put ability. Here, a way to assess the individual's appropriate load for obtaining the maximum value of arms mean power over 30s ($P_{TP,\,A,\,max}$) is introduced.

METHODS

Maximal power values over **2s** were measured with a mechanical arm cycle ergometer (*Monark 891E*) and the electronic device *Power Analyze* (bewotech.com) at loads (friction force) of 3, 6, 7, 8, 9, and 10 % of body weight. In most cases series could be stopped before 10 % because the maximum power value (termed Sprint Power Arms Max., $\mathbf{P_{SP,\,A,\,max}}$) of the series was found at a lower percentage already. Analogously, Transition Power Arms Max. (30s), $\mathbf{P_{TP,\,A,\,max}}$, was measured at 5, 6, 7, 8, 9, and 10 % (with at least one day pause between). All measurements considered the rotational energy of the fly-wheel (I = 0.91 kgm^2). Power was measured at the fly-wheel (power at the pedal would be higher due to the chain friction). $P_{SP,\,A,\,max}$ ranged in the studied group from 4.9 Wkg^{-1} to 11.3 Wkg^{-1}, and $P_{TP,\,A,\,max}$ from 3.9 Wkg^{-1} to 8.5 Wkg^{-1}, respectively. 15 male and 10 female sport students participated in the study. Body mass ***m*** was (71.6 ± 13.4) kg. The tests for arms' out-put power described here are similar to those for legs described before [3, 5, 6].

RESULTS AND DISCUSSION

There was a significant correlation (τ =0.59; p=1.7·10^{-4}) between $(P/m)_{TP,A,\max}$ and the load L at which maximum occurred (this is in contrast to the results obtained with the Transition Power Legs test described recently [6]). Here, we also found a significant correlation between $(P/m)_{SP,A,\max}$ and the load L at which $(P/m)_{TP,A,\max}$ occurred (τ =0.54; p=5.9·10^{-4}). Fig. 1 shows a 2s SP test result (arms ergometer), Fig. 2 the 30s TP Arms values obtained at various loads, and Fig. 3 indicates the regression line which can be used for determination of appropriate load for the Transition Power Arms Max. test: The load L (in % of body weight) can be determined approximately by (equation 1):

$$L = 5 + k\left[(P/m)_{SP,A,\max} - 4\right], \text{ with } k = 0.5\ kgW^{-1}.$$

This results in Table 1 for the **choice of appropriate load for the Transition Power Arms Max test**:

Table 1: Load value L (in % of body weight) for testing maximum arms transition power over 30s, according to eq 1.

$(P/m)_{SP,A,\max}\left[Wkg^{-1}\right]$	4	5	6	7	8	9	10	11
L [%]	5	5.5	6	6.5	7	7.5	8	8.5

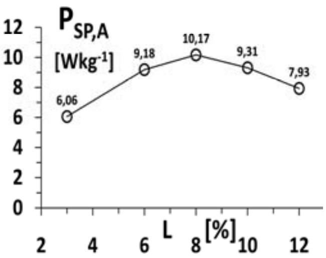

Figure 1: 2s SP Arms test of an elite paddler (athlete GS, 3rd at World Championship 2008, 2nd in team)

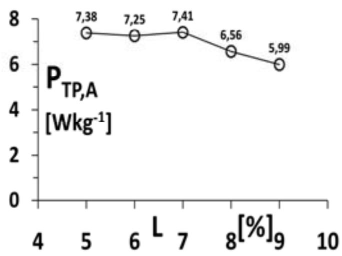

Figure 2: 30s TP Arms tests as a function of load. (GS) mean power value is v (in ms^{-1}) times L (in N) plus rotational energy of the fly-wheel at test end divided by 30s.

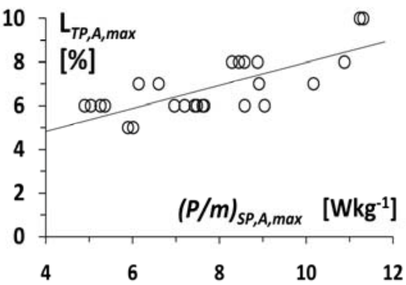

Figure 3: Dependency of load **L** (in % of body weight) for maximum arms out-put power over 30s ($P_{TP,A,max}$) on the individual's maximum arms power over 2s ($\mathbf{P_{SP,A,max}}$).

CONCLUSIONS

The Sprint Power Arms Max and the Transition Power Arms Max tests allow accurate determination of **maximum arms out-put power** over a few seconds (here, 2s) and for the time domain up to a few minutes (here, 30s), respectively. Correlation in Fig. 3 and values in Table 1 allow approximate determination of $\mathbf{P_{TP,\,A,\,max}}$ with just one trial.

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