The effect of active versus passive legs on fixed-seat ergometer rowing performance

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Summary

In the PR2 class in Paralympic rowing, depending on their impairment, some athletes can use their legs to generate force and stabilize the movement, while others cannot. This study shows that rowing without being able to generate force or stabilize with the legs can reduce submaximal ergometer rowing performance by ~30%.

Introduction

Athletes in the PR2 class in Paralympic Rowing use a fixed-seat due to impairment related functional limitations. These athletes have various impairments to their legs, such as limb deficiency, impaired muscle power in the legs, and impaired coordination [1]. While all PR2 athletes use a fixed-seat, the extent to which they are able to engage their legs can differ drastically depending on the impairments. While the force generated at the handle likely is increased when the legs are active, since no power is generated by the legs when the seat is fixed, it is uncertain how fixed-seat rowing performance differs depending on whether the legs are engaged or not. This paper aimed to examine the effects of performing fixed-seat ergometer rowing with active or passive legs.

Methods

Ten non-disabled individuals (3F/7M, 28±6 yrs.) with rowing ergometer experience performed 4 minutes of fixed-seat ergometer rowing in two different setups. In the first, they had their feet on the foot stretchers (active legs [AL]) and rowed "as normal" with the ergometer seat fixed. In the second setup, their legs were placed on cushions to the side of the foot stretchers with the feet "free in space" (passive legs [PL]), and participants were strapped to the seat with a belt across the pelvis. They rowed at an intensity set to maintain a respiratory exchange ratio (RER) ~1.0, which was controlled through ergospirometry (Vyaire, Medical GmbH, Germany). Kinematics were collected with 11 infrared cameras (Oqus, Qualisys AB, Stockholm, Sweden, 100Hz), and the force exerted on the ergometer chain was recorded using a load cell (N-DTS-FS5, Noraxon USA Inc., Scottsdale, Arizona, 1500Hz). Three-dimensional kinematics [2] and inverse dynamics [3] were calculated and processed in a custom Matlab script (MathWorks inc., Nantick, MA, USA). Paired t-tests were used to compare the setups.

Results and Discussion

Both rowing power output (114±50 W vs 79±32W, $p < 0.001$, ES 2.1) and cycle rate were higher in AL versus PL, with no difference in RER (Table 1). PL placed slightly higher demands on the shoulder, as indicated by increased joint power, while elbow power remained similar. The combined power from the trunk and pelvic region was higher in AL . This shows the importance of being able to use the legs for stabilization during the rowing stroke, even if the seat is fixed. Combined, these findings show that submaximal performance in fixed-seat ergometer rowing with active versus passive legs differs significantly.

Conclusions

The role of the legs remains important even during fixed-seat ergometer rowing. Performing fixed-seat ergometer rowing at a submaximal intensity without the ability to generate force or stabilize with the legs reduces performance by approximately 30%**.**

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References

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Table 1. Mean ± SD of the assessed variables between the two setups. ES was calculated using Cohen's D.

	Active legs	Passive legs	P-value	ES
Cycle rate (Hz)	0.6±0.1	0.7±0.1	0.011	-1.02
Elbow power (W)	12±7	13±7	0.361	-0.30
Shoulder power (W)	21±10	24±10	0.017	-0.93
Trunk & pelvic power (W)	82±30	42±19	0.000	2.37
Elbow sagittal ROM (°)	104±8	106±7	0.363	-0.30
Shoulder sagittal ROM (°)	126±13	119±14	0.046	0.73
Shoulder frontal ROM (°)	22±7	22±6	0.660	0.14