Power-load relationship of bench press, ballistic bench press, and prone bench pull in Italian international canoeists and kayakers

Fortunati, Matteo; Gemelli, Tiziano; Puci, Mariangela; Drid, Patrik; Owen, Julian; Bianco, Antonino; D'Antona, Giuseppe; Rama, Stefano

Published: 10/10/2021

Publisher's PDF, also known as Version of record

Power-load relationship of bench press, ballistic bench press, and prone bench pull in Italian international canoeists and kayakers

Matteo Fortunati[1], Tiziano Gemelli[1], Mariangela V. Puci[2], Patrik Drid[3], Julian A. Owen[4], Antonino Bianco[5], Giuseppe D'Antona[2/6], Stefano Ramat[6/7]

[1]Department of Sport and Exercise Science, University of Pavia, Italy; [2] Unit of Biostatistics and Clinical Epidemiology, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, Italy; [3]Faculty of Sport and Physical Education, University of Novi Sad, Serbia; [4]School of Sport, Health and Exercise Sciences, Bangor University, Bangor, United Kingdom; [5]Department of Psychology, Educational Science; and Human Movement, University of Palermo, Italy; [6]CRIAMS-Sport Medicine Centre Voghera, University of Pavia, Italy; [7]University Sport Centre Pavia (CUS).

Purpose

Athletes of kayak and canoe must have a high level of strength and power in the upper body and excellent muscular endurance and anaerobic capacity (1). Indeed, from a recent investigation, it was found that international medal-winning canoe sprinters have a slightly higher average power output (P_{avg}) than their non-trophy counterparts in bench press and bench pull (2). Therefore, the aim of our research was to describe the power-load (P-L) relationship through a comprehensive incremental test in the guided eccentric-concentric bench press (BP), guided eccentric-concentric ballistic bench press (BBP) and guided concentric-only prone bench pull (PBP) in international canoeist and kayaker athletes.

Methods

Nine international athletes (21,0±1,5years; 80,3±4,8kg; 183,3±4,6cm) were monitored during two complementary sessions (48h apart) of a comprehensive incremental testing protocol with a 5kg increase from an absolute load of 30kg to 100kg in the BP, 15kg to 60kg in the BBP, and 30kg to 95kg in the PBP. Mean velocity and average power output during the concentric phase were measured at a sampling frequency of 200Hz using a linear position transducer. ***One Repetition maximum (1RM)***. The direct measurement of 1RM in the BP and PBP was out of the scope of the present investigation. Therefore, if athletes had not reached their true 1RM during the incremental protocol, it was indirectly calculated through the load-velocity (L-V) relationship (3). Specifically, a function "(=TREND)" in Microsoft Excel including the V-L_{BP} relationship and a minimum velocity (V_{1RM}) of 0.15m/s was fitted to estimate the 1RM in the BP, while the same function including the V-L_{PBP} with a V_{1RM} of 0.45m/s was used for the PBP. The 1RM for the BBP press was set at 80% of the maximum weight lifted in the BP (4). ***Calculation of the standardized relative load***. Once obtained the 1RM (directly or estimated), the absolute load [kg] from 20% to 90% 1RM at each 10% interval was calculated to allow the comparison between and within exercises. ***Calculation of the power output at standardized load***. Once the absolute load [kg] at the standardized percentage of the 1RM was obtained, the mean power output was calculated using the individual power-load polynomial equation obtained during the incremental protocol ($W = a \cdot m^2 + b \cdot m + c$, where *W* indicates power in Watts and *m* represents mass in Kg). ***Data analysis***. A two-way repeated measures ANOVA was used to explore differences among the different exercises and relative load from 20% to 90% 1RM.

Results

Sample characteristics. The subjects average one repetitions maximum (1RM) in the BP, PBP and BBP were, respectively: 99.2±11.1kg, 95.1±10.1kg, and 79.3±8.8kg. Related to their average body weight the 1RM were, respectively: 1.2±0.1kg^{-1}, 1.2±0.2kg^{-1}, and 1.0±0.1kg^{-1}. **Average power-output between-exercises**. PBP displayed a higher average power output (P_{avg}) from 40% to 90% 1RM compared to BP and BBP (p<0,0001), while no statistical difference was found between the latter at any load percentage (p>0,05) [Figure 1, Table 1]. ***Average maximum power output within exercises.*** Post-hoc analysis showed that the relative load at the maximum P_{avg} differed between exercises; 60% 1RM for the PBP, 50% 1RM for the BBP and 40% for the BP. However, the P_{avg} was not statistically different (p>0.05) from 40% to 80% 1RM in the PBP, from 40% to 60% 1RM in the BBP, and from 20% to 60% the BP [Figure 1, Table 1].

Discussion

The main finding of our study is that in professional canoeists and kayakers the power-load relationship differs between PBP, BP and BBP exercises, with the highest average power output monitored in the PBP in comparison with both, BP and BBP. Our study agrees with the one carried out by Sánchez-Medina et al., using a strength-trained population (5). In addition, the P-L relationship of the PBP in Italian international paddle athletes is extremely similar to the one monitored in the Spanish National rowing team (6).

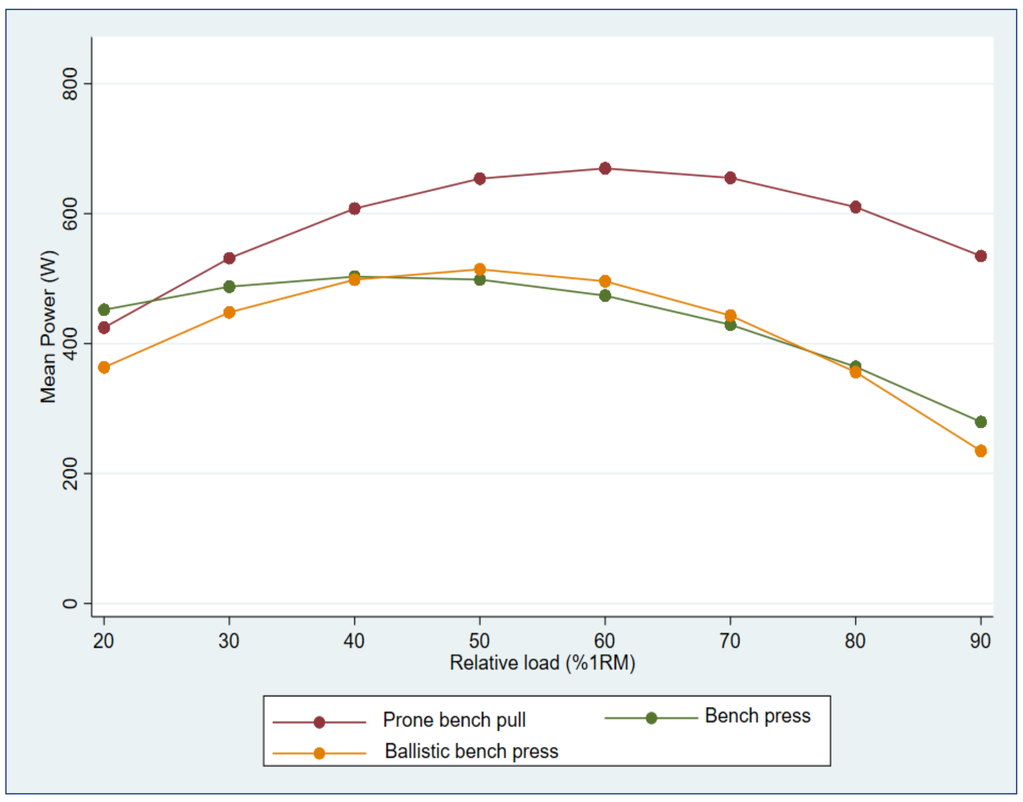

Figure 1. *Results from two - way ANOVA analysis: average power output differences in different loads and exercises. A two-way repeated ANOVA showed significant effects of different load (p<0.0001; Figure 2.A) and exercises (p<0.0001; Figure 2.B) increasing loads is effective and differs by exercise; interaction between two factors was significant (p<0.0001).*

Bibliography

1. Rosdahi, H, Calbet, J, Sheel, WA, Boushel, R. Physiology of canoeing. In: Handbook of Sport Medicine and Science: Canoeing. D. Mckenzie and B. Berglund, 1st ed. International Olympic Committee, editor. Oxford, UK: WILEY Blackwell, 2019. p. 48.
2. Bielik, V, Lendvorský, L, Vajda, et al. Comparison of aerobic and muscular power between junior/U23 slalom and sprint paddlers: An analysis of international medalists and non-medalists. Front Physiol 11: 617041, 2021.
3. Jovanovic, M, Flanagan, EP. Researched applications of velocity based strength training. J Aust Strength Cond 22: 58–69, 2014.
4. Loturco, I, McGuigan, MR, Suchomel, T, et al. Determining the one repetition maximum in the ballistic bench press exercise. J Strength Cond Res 34: 3321–3325. 2020.
5. Sánchez-Medina, L, González-Badillo, JJ, Pérez, CE, Pallarés, JG. Velocity- and power-load relationships of the bench pull vs bench press exercises. Int J Sports Med 35: 209-216, 2014.
6. Izquierdo-Gabarren M, Exposito RGT, de Villarreal ESS, Izquierdo M (2009) Physiological factors to predict on traditional rowing performance. Eur J Appl Physiol: 108(1):83-92

Table 1. Values of average power output across different load (from 20% to 90% 1RM) and exercises.

Different loads	**20%** **a**	**30%** **b**	**40%** **c**	**50%** **d**	**60%** **e**	**70%** **f**	**80%** **g**	**90%** **h**
Prone bench pull-1, (n=9)								
Significance within-exercise loads comparison	a vs all	b vs a,d,e,f	c vs a	d vs a,b,h	e vs a,b,h	f vs a,b,h	g vs a,h	h vs a,d,e,f,g
Bench press-2, (n=9)								
Significance within-exercise loads comparison	a vs g,h	b vs f,g,h	c vs f,g,h	d vs f,g,h	e vs g,h	f vs b,c,d,g,h	g vs f,h	h vs all
Ballistic bench press-3, (n=9)								
Significance within-exercise loads comparison	a vs b,c,d,e,f,h	b vs a,d,g,h	c vs g,h	d vs a,f,g,h	e vs a,g,h	f vs a,d,g,h	g vs b,c,d,e,f,h	h vs all
Exercises comparison								
Significance between-exercise loads comparison	1 vs 3	1 vs 3	1 vs 2,3	1 vs 2,3	1 vs 2,3	1 vs 2,3	1 vs 2,3	1 vs 2,3

*P<0.05: Statistical significant differences in every exercise between groups mentioned by letters (correction Bonferroni post hoc tests).