

Abstract

Heart rate and oxygen saturation of vastus lateralis and gastrocnemius medialis muscles at maximal exercise intensity: a comparison between treadmill, elliptical trainer and cycle ergometry

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Maximal exercise intensity is widely used to assess physiological responses in various populations. The determination of muscle oxygen saturation (SmO_2), using the emerging easy-to-use technique of near-infrared spectroscopy (NIRS), combined with the heart rate (HR) in response to different exercise modes (or ergometers), remains unclear. The aim was to compare the changes in SmO_2 in the *gastrocnemius medialis* (GM) and *vastus*

lateralis (VL) muscles, as well as the HR response at maximal exercise intensity performed on a treadmill, an elliptical trainer and a cycle ergometer.

Fourteen healthy volunteers (age = 34.9 ± 9.1 years; height = 169.4 ± 8.6 cm; weight = 69.7 ± 9.8 kg) performed three incremental tests to maximal intensity on a treadmill, an elliptical trainer, and a cycle ergometer on different days (interspersed by at least 72 hours) in a random order. During the incremental tests, the HR (Garmin HRM3-SS, Kansas, USA) and the SmO₂ (Moxy 3, Fortiori Design LLC, Hutchinson, USA) of VL and GM muscles were collected. The data of the last intensity level with one minute duration was used to determine average HR (HR_{avg}), peak HR (HR_{peak}), average SmO₂ (SmO_{2avg}) and minimum SmO₂ (SmO_{2min}) in VL and GM muscles.

Repeated measures ANOVA revealed an exercise mode effect on HR_{avg} ($F_{2,26}=12.44$, $p=0.001$, $\eta^2=0.150$) and HR_{peak} ($F_{2,26}=13.15$, $p=0.001$, $\eta^2=0.170$). Higher values were found on HR_{avg} on treadmill vs. cycle (177.2 ± 7.5 vs. 167.5 ± 13.4 bpm, $p=0.005$) and on elliptical (175.0 ± 9.3 bpm, $p=0.018$) vs. cycle. A similar pattern was found on HR_{peak} with higher values on treadmill vs. cycle (183.9 ± 2.1 vs. 172.9 ± 3.7 bpm, $p=0.004$) and elliptical (180.5 ± 2.5 bpm, $p=0.017$) vs. cycle. An exercise mode effect of SmO_{2min} in VL ($F_{2,20}=5.24$, $p=0.015$, $\eta^2=0.230$) showed lower values on elliptical vs. cycle (15.0 ± 10.7 vs. $37.6 \pm 18.2\%$, $p=0.035$). An exercise mode effect was also found in GM on SmO_{2avg} ($F_{2,24}=27.19$, $p<0.001$, $\eta^2=0.530$) and SmO_{2min} ($F_{2,24}=18.35$, $p<0.001$, $\eta^2=0.450$). Lower values were found on GM SmO_{2avg} on treadmill vs. cycle (27.3 ± 9.4 vs. $57.6 \pm 14.9\%$, $p<0.001$) and elliptical ($33.0 \pm 12.1\%$, $p<0.001$) vs. cycle. Similarly, the SmO_{2min} was lower on treadmill vs. cycle (21.8 ± 9.0 vs. $48.3 \pm 15.2\%$, $p<0.001$) and elliptical ($25.3 \pm 13.2\%$, $p=0.002$) vs. cycle.

The treadmill and the elliptical trainer promoted higher HR responses at maximal intensity, probably justified by the amount of active muscle mass and for being body-

weight support exercises. The SmO_2 , as a local variable, shows that the technique and body position in the elliptical trainer requires more the VL, and the treadmill requests more the GM. This exercise mode expertise is crucial for exercise prescription.

keywords: Exercise mode; Cardiovascular exercise; Acute response; Near-infrared spectroscopy