https://doi.org/10.6063/motricidade.31716

Abstract

Comparisons of peripheral physiological responses of push-up variations exercises using near-infrared spectroscopy

Daniel Santarém[1*], Andreia Teixeira[1], António Amaral[1], Isabel Machado[1,2], Jaime Sampaio[1,2], Catarina Abrantes[1,2]

[1] Department of Sports Science, Exercise and Health, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
[2] Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, Vila Real, Portugal

***E-mail:** danielrs@utad.pt

Conflict of interest: nothing to declare. **Funding:** HEALTH-UNORTE: Setting-up biobanks and regenerative medicine strategies to boost research in cardiovascular, musculoskeletal, neurological, oncological, immunological and infectious diseases (NORTE-01-0145-FEDER-000039), financed by European Regional Development Fund by NORTE 2020 (North Regional Operational Programme 2014/2020).

Technological advances in sports allow coaches and researchers to better identify the stimulus-response dose, maximising performance and decreasing the risk of injury (Li et al., 2016). Real-time continuous monitoring of peripheral physiological responses using near-infrared spectroscopy (NIRS) is a promising area, as it reflects the local effort of a

specific muscle during and after exercise (Barstow et al., 2019). This study aimed to analyse the effects of six push-up variations on muscle oxygen saturation (SmO_2) derived-parameters. Fifteen physically active participants (age = 25.2 ± 3.5 years old; height = 1.76. ± 0.05 m; weight = 75.9 ± 9.1 kg; *triceps brachii* (TB) skinfold thickness = 10.8 ± 3.4 mm; *deltoideus medius* (DM) skinfold thickness = 10.6 ± 2.6 mm) completed the experimental study design which comprised two sessions: in the first session the participants performed a familiarisation with the protocol procedures, and in the second session they performed the six push-up variations in random order. The six push-up variations included 1) diamond, 2) declined, 3) inclined, 4) knuckles with one foot, 5) spartans, and 6) unstable terra-core platform. All exercises were performed for 1 minute, with a 5-minute recovery time in between. Two NIRS devices (MOXY, Fortiori Design LLC, Minnesota, USA) were placed on the TB and DM muscles to measure SmO_2 during the session. Average value of SmO_2 ($SmO_{2\ avg}$), amplitude of deoxygenation ($SmO_{2\ deoxy}$) and recovery time to baseline value ($SmO_{2\ reoxy}$) were determined. Comparisons between the six variations of the push-up exercise were performed using one-way repeated measures ANOVA, followed by the Bonferroni post hoc pairwise comparisons. The significance level was $p<0.05$, and all analyses were performed using the Jamovi Project (Computer Software Version 2.3.28, 2022). The $SmO_{2\ deoxy}$ in TB (Average of 60.9%), $F(5,60)=2.18$, $p=0.069$, $\eta^2=0.069$, and in DM (Average of 42.1%), $F(5,70)=2.55$, $p=0.068$, $\eta^2=0.05$ were not statistically different between push-up variations. Similarly, no significant differences in $SmO_{2\ avg}$ and $SmO_{2\ reoxy}$ were observed between variations in both muscle groups, indicating that these exercise variations show identical behaviour. The results of this study show that the analysed SmO_2 derived-parameters did not differ significantly, presenting a similar balance of oxygen supply and consumption. This may be attributed to the exercise variations which have little muscle mass in dynamic

contraction and is very localised. The manipulation of exercise conditions in real-time with NIRS technology makes it possible to analyse localised muscle response and thus maximise athlete performance.

Keywords: Physiological responses, Physiological Near-infrared spectroscopy, Muscle oxygen saturation

References

Barstow, T. J. (2019). Understanding near infrared spectroscopy and its application to skeletal muscle research. *Journal of Applied Physiology*, *126*(5), 1360-1376. https://doi.org/10.1152/japplphysiol.00166.2018

Li, R. T., Kling, S. R., Salata, M. J., Cupp, S. A., Sheehan, J. & Voos, J. E. (2016). Wearable Performance Devices in Sports Medicine. *Sports Health*, *8*(1), 74-78. https://doi.org/10.1177/1941738115616917