Eur J Transl Myol 33 (3) 11846, 2023 doi: 10.4081/ejtm.2023.11846

Comments on: Electromyographic signature of isometric squat in the highest refuge in Europe

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Abstract

We read with particular interest the study by Rua et al. (Eur J Transl Myol 33 (3) 11637, 2023 doi: 10.4081/ejtm.2023.11637) on the electromyographic (EMG) activity of the quadriceps muscle during squat at high-altitude. It offers interesting insights into how neural factors might alter muscle function during a multi-joint low-intensity motor task with sustained contraction after trekking under hypoxic conditions. However, the methodological processes and procedures used in the study could bias the interpretation of the outcomes. Therefore, we outline the procedural considerations that should be taken into account in further studies aimed at investigating the potential changes in quadriceps EMG activity during the squat as a result of trekking at high-altitude.

Key Words: hypoxia; muscle fatigue; HD-sEMG; high-altitude.

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Acute Hypoxaemia appears to worsen physical performance, primarily due to peripheral and supraspinal fatigability.[1] Changes in neuromuscular function following acute exposure to high altitude have been found to depend on several factors, including the modality and type of exercise and the amount of muscle mass involved.[1] During intermittent isometric knee extensions to exhaustion in hypoxia, the integrated EMG (iEMG) exceeds the level in normoxia, whereas sustained execution of the same motor tasks does not affect the iEMG.[2] Moreover, muscle EMG activity is higher under hypoxic conditions when whole-body exercises are performed at the same absolute intensity (i.e. with the same workload).[3] Given this theoretical background, it is plausible that the differences in "EMG signatures" would also be expected during isometric squats after trekking activity at low (i.e. 1667 m) and high (i.e. 4554 m) altitude. Having read the study by Rua et al.[4] with particular interest, we express our concerns about the surprising conclusion that "EMG signatures" remain unchanged after trekking at high altitude. We hypothesise that these observations are the result of confounding factors arising from non-standard procedures and EMG measurement methodology, and are not due to trekking at high-altitude.

Participants in the study by Rua et al.[4] performed isometric squats lasting 60 seconds on two occasions after daily trekking. On the first occasion, the test and the hike were performed at low altitude, while on the second occasion the entire procedure was repeated at high altitude. During the squat, high-density surface EMG of the quadriceps was recorded to determine whether the high-altitude hike affected neuromuscular function during the fatiguing motor task. To create standardised conditions between two testing occasions, the squat was only visually controlled by observing the knee angle. This is not consistent with da Silva et al.[5] who found high test-retest reliability of Root Mean Square EMG during knee extension to exhaustion and accurately standardised hip, knee and ankle angles. What we found very concerning is the lack of control for hip angle, as trunk position can significantly affect the length and thus activity of the rectus femoris muscle.[6] To put this in the context of the present study results, adjusting individually preferred squat positions could significantly affect the quadriceps EMG signal. It follows that similar quadriceps "EMG signatures" could simply be the result of compensations in squatting at low or high altitude. It is possible that these manifested more strongly at high altitude due to increased fatigue following the trek. Another problem is that the fatigue cannot be attributed solely to the hypoxaemia, as the pace and duration of the

trek were not uniform (~500 m ascent at low altitude vs. ~1000 m ascent at high altitude; self-selected pace). The authors were able to overcome some of the above issues affecting EMG signals during squatting by normalising them to the values obtained during maximal voluntary contraction,[7] however no normalisation was conducted in this study.

First and foremost, several factors, not just altitude exposure, could alter the EMG activity of the quadriceps during the test in the study by Rua et al.[4] Reading the discussion, the authors seem to be aware of this problem, as several possible explanations for the unexpected results are provided.

But it is clear that the hypothesis about greater muscle EMG activity due to altitude exposure cannot really be resolved without rigorous standardisation of procedures. Future studies aiming to compare acute changes in neuromuscular function during squat after high-altitude trekking should use a standardised configuration of all body segments when measuring EMG signals and use exercise interventions that are balanced in pace and duration.

List of acronyms

EMG – electromyographic
iEMG - integrated EMG

Contributions of Authors

NS, ideas, supervision, approval: MS, writing. The authors read and approved the final edited manuscript.

Acknowledgments

We want to acknowledge European Commission for funding the InnoRenew CoE project (Grant Agreement 739574) under the Horizon2020 Widespread-Teaming program. Author NS acknowledge the European Regional Development Fund and Physiko- and Rheumatherapie Institute through the Centre of Active Ageing project in the Interreg Slovakia–Austria cross-border cooperation program.

Funding

The authors were supported by the Slovenian Research Agency through the research program KINSPO – Kinesiology for the effectiveness and prevention of musculoskeletal injuries in sports (P5-0443). The funders had no role in study conceptualization, data acquisition, data analysis or manuscript preparation.

Conflict of Interest

The authors declared they have no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Submitted: September 20, 2023
Submitted and Accepted: September 20, 2023