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Letter to the Editor

Maximizing the effectiveness of inspiratory muscle training in sports performance: A current challenge

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To the Editor:

The recent Letter to the Editor, by [Shei and Mickleborough \(2019\)](#), on our systematic review and meta-analysis regarding the effects of linear workload inspiratory muscle training (IMT) devices on sports performance and cardiopulmonary function of athletes ([Karsten, Ribeiro, Esquivel, & Matte, 2018](#)), highlights currently unresolved questions about the use of IMT as an ergogenic aid for sports. It addresses mainly those related to maximizing the efficacy of IMT to enhancing sport performance, like: “optimal training prescription, the sport-specific effects of IMT, and when to perform the IMT (i.e., at rest before or after exercise, or during exercise)” ([Shei & Mickleborough, 2019](#)).

First, we really appreciate the letter of [Shei and Mickleborough \(2019\)](#) and consider that maximizing the effectiveness of inspiratory muscle training in sports performance is indeed a challenge that deserves a special look in future studies. In this context, some methodological procedures should be better investigated to answer this question.

Regarding the effects of the protocols developed for patients with chronic cardiorespiratory diseases, mainly those with low overload, it seems that the increase in the respiratory muscle strength could be due the neuromuscular adaptation to the task, even if an insufficient overload is provided to the athletes ([Levine, Nguyen, Kaiser, & Shrager, 2002](#)). Thus, we agree with the [Shei and Mickleborough \(2019\)](#) affirmative: “the full potential of the ergogenic effect (of IMT) may not yet be maximized with current loading protocols”, and, as regards as the respiratory muscle adaptations to IMT, it may be similarly optimized when carried out to “task failure”. It opens a large way to new researches, either in athletes, healthy subjects or chronic cardiopulmonary patients.

In respect to the question “why was IMT not applied during training for actual sports situations?”, it seems be important to investigate the effects of the linear workload IMT devices on sports performance and cardiopulmonary function of athletes with appropriated protocols, since none study about concurrent IMT was

carried out with athletes, used linear workload IMT or a sports tailored protocol. The few studies on IMT concurrent were carried out with physically active subjects or did not perform the IMT simultaneously with the sports gesture ([Granados, Gillum, Castillo, Christmas, & Kuennen, 2016](#); [Hellyer et al., 2015](#); [McEntire et al., 2016](#); [Porcari et al., 2016](#); [Tong et al., 2016](#)).

Furthermore, it is also important to know that, although the IMT concurrent should be more effective for some sporting gestures (i.e.: running, cycling, rowing), not all sporting modalities allow this combination in a practical and safe way (i.e.: soccer, swimming, basketball, martial arts). Nevertheless, even in these modalities, it would be interesting to include the IMT during the training of some fundamentals or sports gestures.

Due to the eligibility criteria adopted in our systematic review, which limited the analysis to studies that assessed the effects of IMT-linear on the sports performance and cardiopulmonary function of athletes, we consider that some issues raised by [Shei and Mickleborough \(2019\)](#) may be a complementary discussion. It includes studies on the effects of IMT in healthy subjects ([Granados et al., 2016](#); [Hellyer et al., 2015](#); [Illi, Held, Frank, & Spengler, 2012](#); [McEntire et al., 2016](#); [Porcari et al., 2016](#); [Shei, 2018](#)), the effects of IMT with non-linear workload devices ([Porcari et al., 2016](#)), the effects of IMT with devices used at lab routine ([Cahalin & Arena, 2015](#)), and even a mix of some of these ([Porcari et al., 2016](#)). Although these studies are of high quality and bring some important mechanistic information, they did not fulfil our eligibility criteria.

Moreover, an aspect that cannot be neglected is the relationship between ventilatory muscle pattern (VMP) used in IMT, diaphragmatic hypertrophy and MIP. Some studies have shown that hypertrophy of the diaphragm occurred only in the group that did IMT with adequate loading and consequent increase in MIP ([Chiappa et al., 2008](#); [Downey et al., 2007](#); [Enright, Unnitham, Heward, Withnall, & Davies, 2006](#); [West, Taylor, Campbell, & Romer, 2014](#)). Beyond that, there is discrepancy in the VMP used in the numerous studies. While [Chiappa et al. \(2008\)](#) used the diaphragmatic pattern, [West et al. \(2014\)](#) used dynamic inspirations, [Enright et al. \(2006\)](#) used explosive and sustained contractions until task failure, and [Downey et al. \(2007\)](#) did not reported the VMP used. We would like to emphasize that the VMP can be crucial for the gain of inspiratory muscle strength and that some studies may not have achieved better results due to the choice of VMP that is not suitable for the studied population. However, many studies omit this information, which impairs the broader analysis of the training prescription method.

Finally, we thank [Shei and Mickleborough \(2019\)](#) for rise and discuss some important questions, as well as for join us to propose

future research in this area, searching answers to the issue: how to maximize the effectiveness of inspiratory muscle training in sports performance?

Conflicts of interest

Not applicable.

Ethical approval

Not applicable.

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