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Letter to editor

Maximal Inspiratory Pressure: A Lost Point Trying to Explain a S-Index Function Line Index

Dear Editor-in-chief,

Minahan et al. (2015) recently published a study that examined respiratory strength using a new device, POWERbreathe K5, before and after a strenuous exercise, in comparison with an well-established maneuver to evaluate the maximum inspiratory pressure (MIP).

In this study, authors have compared a dynamic evaluation of the inspiratory muscles (S-Index) with a quasi-isometric evaluation (MIP) including a scientific rational about an isokinetic and isometric limb muscles evaluation, even considering that the S-index is not an isokinetic parameter.

The authors did not find respiratory muscle fatigue evaluated by these two different parameters before and after whole body exercise protocol. However, the present results may have been influenced by two confounders: 1) The exercise protocol used to induce respiratory muscle fatigue and 2) The learning effect of the test.

1- Exercise protocol

Early publications about respiratory muscle fatigue (Bellemare and Grassino, 1982; Ramonatxo et al., 1995) demonstrated a critical point based on tension time index of the diaphragm or respiratory muscle. In these studies, 45 to 60 minutes of exercise at 40% of maximum inspiratory pressure (MIP), were necessary to induce respiratory muscle fatigue. In Roussos et al. (1979) study, 40 minutes at 55% of MIP were necessary to produce fatigue (Figure 1). Also, Ouellet et al. (1969) has demonstrate that a maximal exercise protocol may reach 55% of the MIP. In this sense, a longer whole body exercise protocol may have been required to induce a respiratory muscle fatigue.

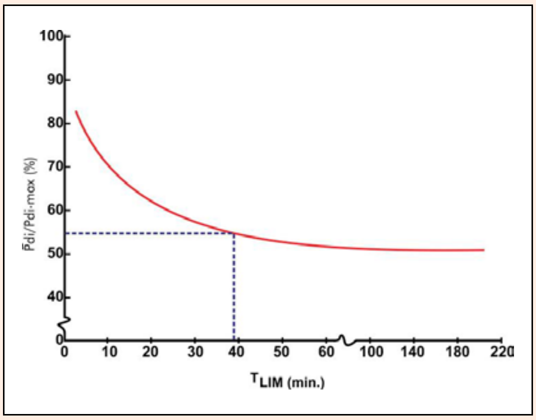

Figure 1. The correlation between respiratory work rate (Pdi/Pdi.max %) and fatigue time point (T_{LIM}). Adapted from (Roussos et al. 1979) data.

2- The learning effects

The MIP assessment can be influenced by patient motivation to perform higher pulmonary volumes and also the repeated measurement effect upon the excitability of the motor pathway (Hawkes et al., 2007; Volianitis et al., 2001). It has been showed a considerable effect of the repeated measurement on MIP, even in experienced participants. (Volianitis et al., 2001) has demonstrated that after 18 repeated trials, MIP was 11.4% higher than the best of the first three measurements. In this sense, an inspiratory muscle 'warm-up' has been used to reduce variability, number of measurements required to achieve consistency and to remove the effects of changes in motor pathway excitability (Volianitis et al., 2001). According to that, similar confounders might be related to S-index assessment, a warm-up period could be necessary to reach accurate values of S-Index.

In conclusion, we suggest that the results found out by Minahan et al. (2015) were certainly influenced by both presented confounders: 1) The exercise protocol used to induce respiratory muscle fatigue and 2) The learning effect of the test.

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AUTHORS' REPLY

Dear Editor-in-chief,

We thank Silva, Durigan, and Cipriano for their comments regarding our conclusions that repeated-sprint cycling does not induce respiratory muscle fatigue and that the POWERbreathe® S-Index is a moderately reliable, but not equivalent, measure of MIP determined during a Mueller maneuver. These authors raise two important points that have the potential to alter respiratory muscle strength: i. The Exercise Protocol, and ii. A Learning Effect. Indeed, we agree that longer-duration whole body exercise has the potential to induce respiratory muscle fatigue. Nevertheless, before our research findings it was not known whether repeated-sprint exercise could also elicit respiratory muscle fatigue. Although repeated-sprint exercise duration is typically less (about 10-15 min) compared to submaximal exercise, we clearly argue that average minute ventilation during repeated-sprinting (incl. recovery periods) can be greater than 120 L·min^{-1}, often peaking above 200 L·min^{-1}. It is therefore reasonable to hypothesize that the higher intensity of repeated-sprint exercise compared to submaximal exercise could also induce inspiratory muscle fatigue despite the shorter duration.

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We did not choose to state explicitly, however it is implied in our manuscript, that participants were familiarized with all testing procedures, and multiple breathing maneuvers were performed during Session 1. Therefore, we are confident our subjects were well familiarized with the technique. We argue that this thorough familiarization session would act to negate the “Learning Effect” on trials performed in Session 2 and 3. The suggestion by Silva, Durigan, and Cipriano that a warm-up may be necessary to reach maximal values warrants further examination. Indeed, we determined and reported strong trial-to-trial and day-to-day intra-class coefficients for the S-Index. Our findings suggest that once thorough familiarization has been performed by the subjects any potential learning effect of the maneuver is removed. It also suggests that warm-up efforts are not necessary to reach reliable maximal values of the S-Index in young health adults. We therefore retain our view that the POWERbreathe® S-Index is a moderately reliable, but not equivalent, measure of MIP determined during a Mueller maneuver. Furthermore, repeated-sprint cycling does not induce respiratory muscle fatigue in recreationally-active adults.

Clare Minahan, *PhD*
Troy Cross, *PhD*

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