LETTER TO THE EDITOR

Make it easier! Evaluation of the ‘vagal-sympathetic effect’ in different conditions with R–R intervals monitoring

André R. Medeiros1 · Scott Michael2 · Daniel A. Boullosa1,3

Received: 30 January 2018 / Accepted: 24 March 2018
© Springer-Verlag GmbH Germany, part of Springer Nature 2018

Abbreviations

HR    Heart rate
HRV   Heart rate variability
HF    High frequency
LF    Low frequency
LF/HF  LF-to-HF ratio
RMSSD Root mean square of successive normal R–R interval differences
SDNN  Standard deviation of normal R–R intervals
SDNN/RMSSD  SDNN-to-RMSSD ratio

We have read with interest the recent study of Esco et al. (2018), in which the authors suggested the use of the shortened ratio of the standard deviation of normal R–R intervals to the root mean square of successive normal R–R interval differences (SDNN/RMSSD) as a valid surrogate of the traditional ratio of the power spectral low frequency–high frequency (LF/HF) bands for evaluating ‘sympathovagal balance’ in athletes before and following maximal exercise. However, we would like to highlight some important aspects that question the validity of the LF/HF and SDNN/RMSSD ratios as meaningful measures of ‘sympathovagal balance’, and instead suggest the use of a simpler index for this purpose.

Firstly, Eckberg (1997) and Billman (2013) have previously explained why the LF/HF ratio should not be considered a valid index of ‘sympathovagal balance’, despite its widespread use. In particular, this interpretation relies on several assumptions that have been shown to be false, namely: (a) sympathetic activity having a major contribution to the LF band; (b) vagal and sympathetic activities always operating in a reciprocal manner; and (c) there existing simple linear interactions between vagal and sympathetic effects on heart rate variability (HRV) (Eckberg 1997; Billman 2013). The classic study by Goldberger (1999) highlighted the need for validating purported autonomic indices as having genuine physiological meaning by demonstrating they behave as expected during selective autonomic stimulation and blockade. This is not the case in the Esco et al. (2018) study, which supports its suggestions based mainly on the high correlations found between the LF/HF and the SDNN/RMSSD ratios.

The second aspect refers to the mathematical association between heart rate and HRV (Sacha 2014). Thus, because of this association and the resting and post-exercise conditions evaluated by Esco et al., the strong correlations observed between SDNN/RMSSD and LF/HF would be expected. This mathematical association may also explain why the study found strong correlations between vagal indices (RMSSD and HF) and indices purportedly having a substantial sympathetic contribution (SDNN and LF). It is important to emphasize that, although current evidence somewhat supports the validity of some HRV indices (RMSSD and HF) for evaluating vagal modulation, there does not appear to be any HRV index that adequately reflects sympathetic modulation or activity (Michael et al. 2017). In this regard, systolic time intervals (particularly the ‘pre-ejection period’) represent an interesting avenue for non-invasive assessment of sympathetic responses to different stressors, including exercise (Michael et al. 2017).

Finally, Esco et al. highlighted the need for simple indices for the evaluation of ‘sympathovagal balance’ in the field. Previously, Goldberger (1999) evaluated the validity...
of several HRV measures for this purpose and found that R-R intervals changed as expected during autonomic stimulation and blockade, while also exhibiting the highest $r^2$ values when comparing inter- and intra-subjects responses. Therefore, rather than employ complex and unsubstantiated indices such as LF/HF and SDNN/RMSSD, R–R intervals could represent a valid, simple and practical index of ‘sympathovagal balance’. However, like Eckberg (1997) and Billman (2013), we question the physiological meaning of the ‘sympathovagal balance’ construct. Alternatively, the term ‘vagal-sympathetic effect’ (Goldberger 1999) could be more appropriate from a physiological point of view, while assuming reproducible intrinsic R-R intervals.

**Author contributions** All authors contributed equally on the conception and writing of this letter. All authors read and approved the final manuscript version.

**Funding** ARM (UC17351170) enjoys a PROSUP scholarship Grant from CAPES. DAB enjoys a productivity research Grant from CNPq (305131/2015-0).

**References**


