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EDITORIAL

Is It Time to Reconsider the Incremental Test Protocols?

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In recent years, the editorials "Sport Science on Women, Women in Sport Science"[1] and "Sport-Science Research on Female Athletes: Dealing With the Paradox of Concurrent Increases in Quantity and Quality"[2] encouraged authors of the *International Journal of Sport Physiology and Performance* to increase research focusing on female athletes. The journal went from, in 2019, 19% of papers including female athletes[1] to, in 2022, 28% including female athetes,[2] while studies performed exclusively on women went from 4% to 12%. The papers including women or focusing exclusively on female athletes mainly dealt with performance and training. To set targeted training intensities, graded maximal or submaximal testing outcomes such as ventilatory threshold (VT) are used. Since physiological responses to exercise and testing differ between men and women, information on testing procedures to identify VT specifically tailored for female athletes could be helpful to optimize training strategies.

A mechanistic link of the buffering of lactate by bicarbonate can lead to excess VCO_2 (carbon dioxide production) and a disproportionate increase in ventilation in relation to VO_2 (oxygen uptake).[3] Thus, we are wondering if we can be equally precise when assessing the threshold during incremental tests in women and men with existing protocols? Examining the sex differences during cycling and treadmill tests, Kang et al[4] reported that the progression of metabolic responses differs between women and men despite a similar fitness level, speculating that differences may be attributed to body mass. A deeper examination of the VO_2 and heart-rate (HR) results showed that neither the slope nor the intercept was substantially different between sexes during running exercise. Based on these results, the authors recommended adjustments (ie, less aggressive progression) depending on type of protocol (ie, running vs cycling), body size, and sex. We addressed this issue by examining some unpublished data from our laboratory. We administered an incremental running test (1-km·h^{-1} increments every 2 min) to 2 physically active college students. Subjects reached similar VO_2peak and peak velocities, and we observed a similar HR and relative VO_2 intercept and slope for the overall test performance. However, when we examined the slope within each single incremental test stage, different metabolic patterns were evident. Interestingly, when intersecting the extrapolated ventilatory threshold (VT) with the HR slopes (Figure 1A), both subjects had their VT1 falling at the same point with similar HR slope trend, although more steeply for the woman. The relative VO_2 (Figure 1B) was evidence of different metabolic responses with different patterns. The woman subject presented a large increase in the relative VO_2 slope during the stage after VT1, highlighting the high demand for oxygen during that stage. Conversely, the male subject was overall quite constant throughout the test.

We assume that the specificity of the test's speed increments might influence the time an individual could spend at ~VT1, thus increasing sex-related metabolic responses. Different testing procedures could also have an impact resulting in longer or shorter lag periods at ~VT1. Thus, we are wondering if VT1 is falling in a specific instant (ie, at minute 5, velocity 8 km·h^{-1}) or, rather, within a test interval (ie, from minute 5 to 7, at velocity starting from 8 km·h^{-1} to 9 km·h^{-1}). In most cases, VT-based training protocols are individualized on the actual moment at VT, but what if the total time spent in each intensity depends on testing protocol used and is sex-specific? It might be that the sex differences usually emerging are actually the results of the protocol used, thus leading to even more sex discrepancies. What if we are missing something, especially in women, when using 1-km·h^{-1} increments per minute instead of spreading the increments in the entire minute with a smaller, although more frequent, increase in speed, such as 0.1 km·h^{-1}, every 10 seconds? It might be possible that spreading the speed increments over a longer period would cover all the speed range and be more suitable for a woman. In fact, if we want to develop a training protocol based on VT, we want to make sure we know the training load corresponding VT so that we can tailor the intervention. However, if we have 1- or 2-minute stages, we consider the load corresponding to the last stage, which might be over the actual VT. If that is the case, we might then administer training load not corresponding to what we intend, thus overloading our athletes. Based on our findings, this might especially happen in female athletes. Therefore, we encourage researchers to develop studies to explore a wide range of methodological issues in male and female physically active subjects, as well as athletes from different sports and different levels, to further explore this potentially big open question.

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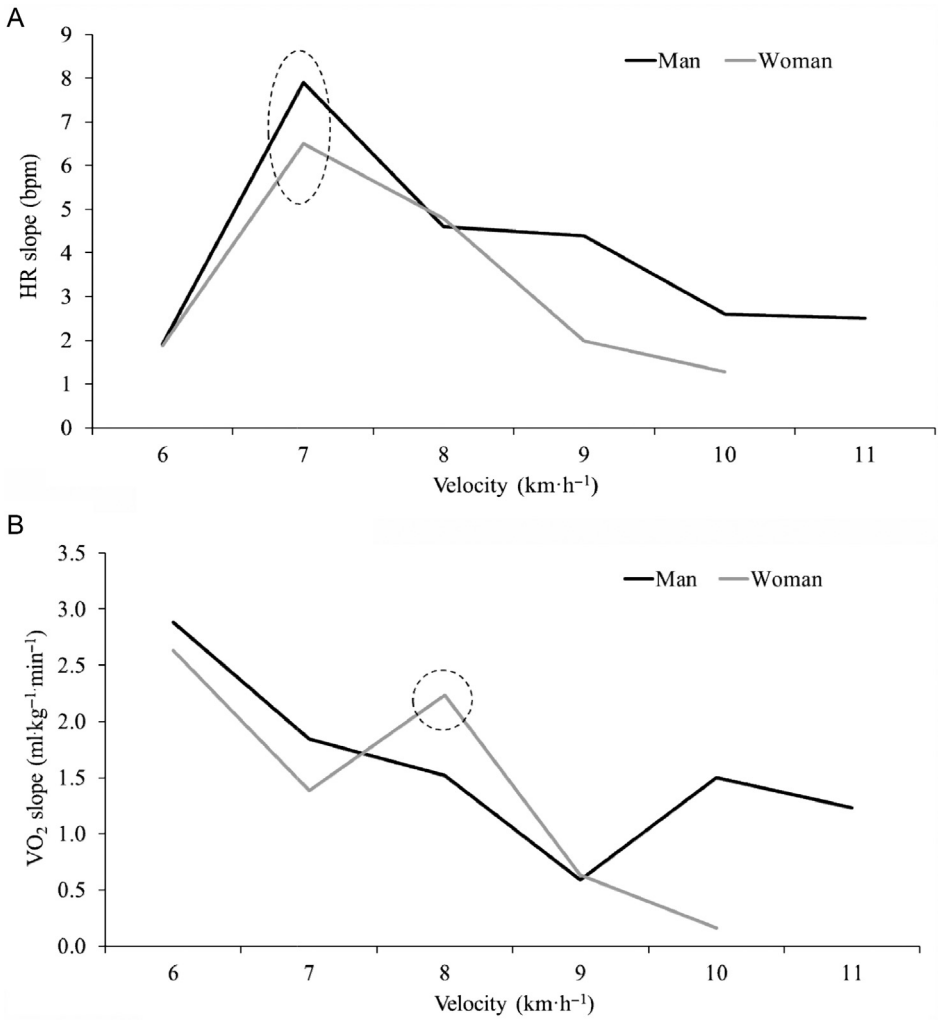

Figure 1 — Slopes of (A) heart rate (HR) and (B) oxygen consumption (VO_2) in relation to body weight (kg) of the male and female subjects during the incremental test.

References

1. Mujika I, Taipale RS. Sport science on women, women in sport science. *Int J Sports Physiol Perform*. 2019;14(8):1013–1014. doi:10.1123/ijspp.2019-0514
2. Noordhof DA, Janse de Jonge XAK, Hackney AC, de Koning JJ, Sandbakk Ø. Sport-science research on female athletes: dealing with the paradox of concurrent increases in quantity and quality. *Int J Sports Physiol Perform*. 2022;17(7):993–994. doi:10.1123/ijspp.2022-0185
3. Wasserman K, Hansen JE, Sue DY, Whipp BJ, Froelicher VF. Principles of exercise testing and interpretation. *J Cardiopulm Rehabil*. 1987;7(4):189. doi:10.1097/00008483-198704000-00014
4. Kang J, Hoffman JR, Chaloupka EC, Ratamess NA, Weiser PC. Gender differences in the progression of metabolic responses during incremental exercise. *J Sports Med Phys Fitness*. 2006;46(1):71–78.

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