

Accuracy of respiratory gas variables, substrate, and energy use from 15 CPET systems during simulated and human exercise

This is summary of the original article cited below. This summary is authored by Edward A. Rose, M.D., Medical Writer and a consultant for Vyair Medical*.

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Objectives

Cardiopulmonary exercise testing (CPET) results frequently inform clinical choices, guide training regimens, and serve as the definitive metric for assessing cardiorespiratory health and factors limiting exercise performance. Given the critical role of accurate CPET measurements, it is important to examine the reliability of various CPET systems available.

Study methods

Investigators used a Metabolic Simulator (MS) from Relitech Systems BV to simulate breath-by-breath gas exchange in two configurations:

Standard Mode: Utilized a tidal volume of 2L and variable breathing frequencies (BF) of 20-40-60-80 per minute. Oxygen uptake (VO_2), Carbon dioxide production (VCO_2), and subsequent BFs were set at 1, 2, 3, and 4 L/min, with a Respiratory Exchange Ratio (RER) of 1.00.

CPX Mode: Mirrored the Standard Mode settings, except the VCO_2 was adjusted to generate a more physiologically accurate RER (ranging from 0.75 to 1.05) at BFs of 10-20-40-60 per minute.

MS testing differs from human exercise conditions. While MS uses dry gas, exhaled air typically contains approximately 75% humidity in a room with 44% humidity. To validate the MS results, investigators tested three well-conditioned individuals cycling at an intensity where physiological markers remained stable (roughly 25 Watts below Ventilatory Threshold 1, or VT1).

Fifteen systems from the following 11 manufacturers were tested: Vyair, Maastricht Instruments, Geratherm, Cortex, VO_2 master, Ganshorn/Schiller, COSMED, MGC Diagnostics, PNOE, and Calibre Biometrics.

Results

The margin of error for Ventilation Rate (VE), ranged between 1.15% and 50.3%. BF had an error range of 1.05% to 3.79%. VO_2 was between 1.10% and 17.5%, while VCO_2 varied from 1.07% to 18.3%. The Respiratory Exchange Ratio (RER) had an error margin of 0.62% to 14.8%. As for caloric measures, the errors ranged from 5.52% to 99.0% for calories from carbohydrates and 5.13% to 133% for calories from fats. Total energy expenditure showed a variation of 0.59% to 12.1%. The between session range for VO_2 was 0.86% to 22.4%, and for VCO_2 , it was 1.14% to 20.2%.

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Conclusion

The error of VO_2 , VCO_2 , RER, and VE during simulated and human exercise is mostly <5% but differs substantially between systems. Vyntus™ CPX is one of the five systems with all simulated and human exercise tested CPET parameters within the acceptable range of <5% error.

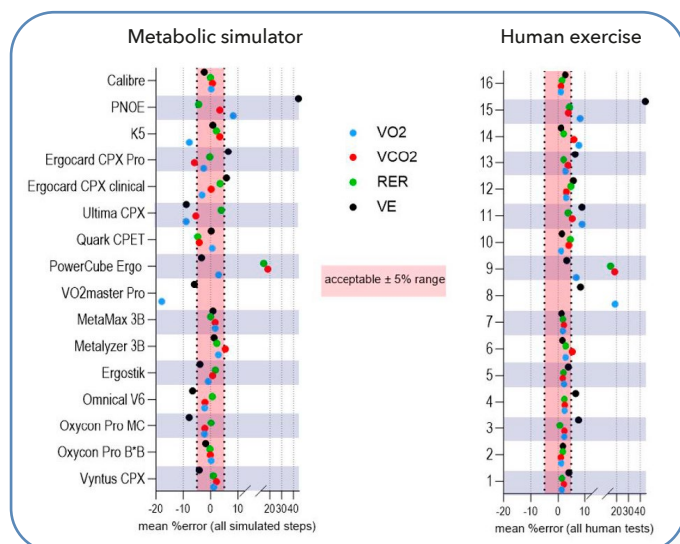


Figure 1. Accuracy of respiratory gas variables and ventilation, from 15 CPET systems during simulated and human exercise (prepared based on the data provided in the supplemental material).

Limitations of the study include that it is primarily an in vitro study using a breathing simulator, with only three healthy trained human subjects used for model verification; three other manufacturers were invited to submit equipment for testing but did not; and the range of VO_2 tested does not necessarily correlate with that seen in elite athletes.

Vyaire Insight

Correctly measuring physiological variables is crucial, given that CPET results frequently guide clinical decisions, inform training plans, and serve as the benchmark for assessing cardiorespiratory health and limitations during exercise. CPET is also commonly employed to validate alternative methods for estimating physiological thresholds, assess the precision of predictive formulas, or evaluate the accuracy of wearables in measuring Oxygen Uptake (VO_2) or total energy expenditure. Among the systems evaluated, Vyntus™ CPX performed within an acceptable error margin of less than 5%.

Take home message

- Despite the need for the highest level of accuracy required in CPET equipment, there can be significant variability between devices.
- Clinicians responsible for the assessment of athletes and work candidates must be aware of the potential for errors in evaluation of subjects.
- Vyntus™ CPX was one of the few systems to perform reliably in patient simulations.

For more details on the content of the study, please refer to the original article here.

Reference: Van Hooren B, Souren T, Bongers BC. Accuracy of respiratory gas variables, substrate, and energy use from 15 CPET systems during simulated and human exercise. Scand J Med Sci Sports. 2023 Sep 11. doi:10.1111/sms.14490. Epub ahead of print. PMID: 37697640.

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