



Interchangeability between two breath-by-breath O₂ uptake calculation algorithms in asthmatic and healthy volunteers

Maria Pia Francescato¹ · Mario Canciani² · Valentina Cettolo¹

Received: 19 November 2019 / Accepted: 9 April 2020
© Springer-Verlag GmbH Germany, part of Springer Nature 2020

Abstract

Introduction The interchangeability analysis has been recently proposed to objectively assess whether a newly developed measurement tool can substitute the older ones; this analysis assumes that the measures yielded by the compared tools should differ less than a maximum acceptable value. We aimed to assess the interchangeability rate (IR) of the breath-by-breath O₂ uptake data calculated with the “Independent breath” (IND) and the “Expiration-only” (EXP) algorithms.

Methods Oxygen, carbon dioxide fractions, and ventilatory flow were recorded continuously over 26 min in 18 asthmatic and 20 well-matched healthy volunteers at rest, during cycling, and recovery; oxygen uptake ($\dot{V}O_2$) was calculated with the two algorithms under comparison. Coefficients of variation (CVs) of all the steady-state condition were modeled as a function of the average $\dot{V}O_2$ values and IR was calculated accordingly.

Results CVs were significantly greater in the asthmatic volunteers ($F=5.97, p<0.05$), being lower for IND compared to EXP ($F>7.04, p<0.02$). CVs decreased as a function of the reciprocal of the square root of the average $\dot{V}O_2$. The IR, calculated on the basis of this relationship, was not significantly different in the two groups of volunteers ($F=0.77, p=0.385$); taking as reference method the IND, or EXP algorithms, the IR values were significantly different ($F=58.6, p<0.001$), amounting to $97.4 \pm 2.2\%$ or to $98.2 \pm 1.7\%$, respectively.

Conclusion The relative noise of $\dot{V}O_2$ was greater in the asthmatic volunteers compared to the healthy ones and was lower for IND compared to EXP. The interchangeability analysis suggested that IND might be a better substitute for EXP than the opposite.

Keywords Moderate intensity exercise · Standardized residuals · Normal distribution · Probability density function

Abbreviations

ANOVA	Analysis of variance	FEV ₁	Forced expiratory volume in the first second
BMI	Body mass index	FeF25-75	Forced expiratory flow between 25 and 75% of vital capacity
CV	Coefficient of variation	FVC	Forced vital capacity
EXP	“Expiration-only” approach, i.e., the breath-by-breath gas-exchange algorithm that uses information obtained during expiration and the Haldane transformation (Ward 2018)	IND	“Independent breath” approach, i.e., the breath-by-breath alveolar gas-exchange algorithm that uses information obtained during both inspiration and expiration (Cettolo and Francescato 2018)
		IR	Interchangeability rate
		$\dot{V}O_2$	Oxygen uptake value (generic)
		$\dot{V}O_2^{\text{IND}}$ and $\dot{V}O_2^{\text{EXP}}$	Oxygen uptake calculated applying the “Independent breath” and the “Expiration-only” approaches, respectively; all the data are expressed in STPD conditions
		SD	Standard deviation

Communicated by Guido Ferretti.

✉ Maria Pia Francescato
mariapia.francescato@uniud.it

¹ Department of Medicine, University of Udine, P.le Kolbe 4, 33100 Udine, Italy

² Allergology and Pulmonology Clinic and Laboratory, ALPI Association, Udine, Italy