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VIEWPOINT

Commentaries on Viewpoint: $\dot{V}O_{2peak}$ is an acceptable estimate of cardiorespiratory fitness but not $\dot{V}O_{2max}$[1]

COMMENTARY ON VIEWPOINT: $\dot{V}O_{2PEAK}$ IS AN ACCEPTABLE ESTIMATE OF CARDIORESPIRATORY FITNESS BUT NOT $\dot{V}O_{2MAX}$

TO THE EDITOR: The maximum and peak oxygen uptake ($\dot{V}O_{2max}$ and $\dot{V}O_{2peak}$) are commonly used in evaluating cardiopulmonary muscle oxidative function (2). During $\dot{V}O_{2max}$ measurement, a plateau of oxygen uptake is needed to verify whether the maximal value is obtained (2). In contrast, $\dot{V}O_{2peak}$ indicates the highest value of $\dot{V}O_2$ during a particular test, regardless of an individual's effort (2, 5).

Green and Askew (2) suggest that $\dot{V}O_{2peak}$ reflects the intolerable level of a subject's symptoms. The indicator can thus be useful when the symptoms are associated with cardiopulmonary or muscular defects. However, testing of $\dot{V}O_{2peak}$ is possibly influenced by factors unrelated with cardiopulmonary muscular oxidative capability such as perceived discomfort, lack of motivation of patients, or other ailments (5). In addition, we agree that the optimal conditions that evoke $\dot{V}O_{2max}$ may be varied between individuals (2). Therefore, determination of $\dot{V}O_{2max}$ using one single mode of sports can potentially lead to an underestimated result (2).

In our view, the mode-specific $\dot{V}O_{2max}$, which defines $\dot{V}O_{2max}$ based on a specific exercise mode, could be a reliable indicator for aerobic capacity, as it avoids the measurement inconsistency across various exercise modes as well as eliminates the effects of irrelevant factors on testing results (1). Indeed, the mode-specific $\dot{V}O_{2max}$ has been utilized to evaluate physiological functions in several studies (3, 4). Further research needs to develop the criteria for mode-specific $\dot{V}O_{2max}$ that can be used for different exercise activities as well as to explore their physiological and pathophysiological implications.

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[1] These commentaries are part of the Viewpoint series published in July 2018 (https://www.physiology.org/doi/10.1152/japplphysiol.00850.2017).

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"$\dot{V}O_{2PEAK}$ VERSUS $\dot{V}O_{2MAX}$" AND "FITNESS VERSUS FATNESS": THE 'DOUBLE OBESITY PARADOX

TO THE EDITOR: The maximal oxygen uptake ($\dot{V}O_{2max}$) assessed with a maximal incremental exercise testing was shown reliable to determine aerobic fitness in individual with obesity (5). However, it was recently shown that $\dot{V}O_{2peak}$ may also be indicative of a true $\dot{V}O_{2max}$ in obese adults. Therefore, a verification test, performed after the incremental one, is not needed to assess accurately $\dot{V}O_{2max}$ in this population (5). Moreover, $\dot{V}O_{2peak}$ assessment is reproducible and not compromised by different test durations in class II and III obese individuals (3), demonstrating that the dogmatic view that maximal incremental tests should last between 8 and 12 min to elicit $\dot{V}O_{2peak}$ should be reconsidered in obese adults, as previously shown in healthy normal-weight individuals (4). Moreover, maximal incremental test with long step duration (5 min) can be used to assess accurately not only the aerobic fitness, but also the metabolic fitness for improving the therapeutic approaches in treating obesity and severe obesity (3).

Therefore, we agree with Green and Askew (2) that $\dot{V}O_{2peak}$ ("symptom-limited $\dot{V}O_{2peak}$"), assessed using a single maximal incremental exercise test with appropriate quality control can be considered as a reliable estimates of aerobic fitness in individuals, including subjects with obesity.

Since aerobic fitness was shown as more important than fatness as all-cause mortality risk factor (1), it might be time to question this "double obesity paradox" "$\dot{V}O_{2peak}$ versus $\dot{V}O_{2max}$" and "fitness versus fatness"; i.e., how do we measure it and how is it important?

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$\dot{V}O_{2max}$ VERIFICATION TRIAL: THE ILLUSION OF A "TRUE" MEASURE?

TO THE EDITOR: Adding a verification trial as an indispensable gold standard for a valid assessment of $\dot{V}O_{2max}$ has been proposed (4). That view has been questioned on different grounds, but with a common denominator: the available data do not support the necessity/usefulness of the verification trial (1, 3, 5). Green and Askew (2) offered an inspiring framework to support the validity of $\dot{V}O_{2peak}$ as an index of cardiorespiratory fitness and to reject its indiscriminate substitution with "the untested method of plateau detection" proposed elsewhere (4). The authors underlined that $\dot{V}O_{2peak}$ and $\dot{V}O_{2max}$ are two distinct, noninterchangeable concepts, neither of which is per se superior to the other. Rather, when optimal quality testing is ensured, the symptom-limited $\dot{V}O_{2peak}$ does not indicate a testing mistake/underestimation, but it provides valuable information on the functional limitations of the individual. Additionally, Green and Askew (2) highlighted that test naivety and lack of motivation [claimed to be possible sources of underestimation of $\dot{V}O_{2max}$ (4)] are not protocol dependent, but may reflect a lack of technical rigor and investigator experience, regardless of which protocol is used.

These ideas expressed by Green and Askew (2) align with, and are supported by, the data that we recently presented (3), providing evidence that the verification trial does not "correct" the value obtained with a ramp incremental test.

Accurate identification of $\dot{V}O_{2max}$ remains complex and the proposal of the verification trial as a "gold standard" procedure is unsupported by data and appears an oversimplification that offers only the illusion of a "true" measure.

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A COMPARISON WITH THE MITOCHONDRIAL OXIDATIVE CAPACITY

TO THE EDITOR: With great interest we read Green and Askew's Viewpoint (1) on validity of $\dot{V}O_{2peak}$, mode-specific $\dot{V}O_{2max}$, and $\dot{V}O_{2max}$. Exercise testing is generally performed to identify upper limits in cardiorespiratory fitness. However, $\dot{V}O_{2peak}$ measurements could lead to inaccurate estimations of $\dot{V}O_{2max}$ (3) and misinterpretation of the upper limit for mitochondrial oxygen consumption. The extent of the problem could be assessed by comparison of $\dot{V}O_{2peak}$ with whole body mitochondrial oxidative capacity. Without measurement errors, $\dot{V}O_{2max}$ is expected to be 86% of mitochondrial oxidative capacity, based on mitochondrial Michealis-Menten kinetics and cellular oxygen tension at maximal cycling exercise (4, 5). Whole body mitochondrial oxidative capacity is predicted from myofiber's succinate dehydrogenase (SDH) activity (5), as in hyperoxia, SDH activity is proportional to the myofiber's $\dot{V}O_{2max}$ (2). In 14 patients with heart failure, 26 controls, and 28 competitive cyclists, $\dot{V}O_{2peak}$ during cycling exercise was 9.8–79.0 $ml \cdot kg^{-1} \cdot min^{-1}$ and 90 ± 14% (SD) of whole body mitochondrial oxidative capacity (5). This percentage does not differ from the Michaelis-Menten based prediction and was similar for all groups. Although both measures were strongly related ($r^2 = 0.89$), interindividual variation exists, potentially due to errors in determination of $\dot{V}O_{2max}$ (e.g., due to glycogen depletion) or differences in O_2 supply limitations. From the above, we suggest for group-based analyses that $\dot{V}O_{2peak}$ may be used as a proxy for $\dot{V}O_{2max}$, provided subjects are motivated, the exercise mode involves large muscle mass and RER is high [i.e., 1.20 ± 0.07 (SD) (5)]. For an individual estimate of $\dot{V}O_{2max}$, the accuracy of $\dot{V}O_{2max}$ and mitochondrial oxidative capacity should be verified using multiple measurements.

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