

Most important, the FEV<sub>1</sub> test requires participants' collaboration and volitional effort, which could be reduced after vigorous exercise (4), as is briefly mentioned in the discussion of this study (1). It is possible that central fatigue after vigorous exercise has reduced some participants' capacity to obtain an FEV<sub>1</sub> result comparable with the preexercise values; this effect could be entirely unrelated to exercise-induced bronchoconstriction. Central fatigue was essentially not controlled for in this study, and it is difficult to exclude it as a factor determining reduced FEV<sub>1</sub> after vigorous exercise in some participants. The concept that "The bronchoconstrictive effect found after exercise depends on the individual reaching near their limit of physiologic response to exercise," and the reported observation that "the flow-volume loops before and after exercise did not reveal any limitation of the inspiratory flow in any responder" could support the alternative explanation proposed here.

In conclusion, I think we need additional evidence to support the conclusion that vigorous exercise *per se* can cause abnormal pulmonary function in healthy adolescents.

**Author disclosures** are available with the text of this letter at [www.atsjournals.org](http://www.atsjournals.org).

## Reply

### From the Authors:

We thank Dr. Formenti for bringing to our attention his constructive points on this study. The effect of fatigue of peripheral respiratory pump muscles or central command is certainly a necessary consideration when interpreting lung function testing. As mentioned in the Discussion, using spiroometry versus full forced pulmonary function maneuvers would be one way to minimize fatigue. Other methods of measuring respiratory muscle strength, such as maximum inspiratory/expiratory pressures, may be incorporated, but we elected not to, as they may magnify any postexercise abnormal finding.

Central respiratory fatigue should be considered when evaluating for exercise-induced bronchospasm, which could be done via such methods as diaphragm electromyography (1), twitch occlusion, or magnetic stimulation (2). Such tests would be an excellent addition to future studies to determine the exact cause of the abnormal lung function postexercise. For this initial study, we chose not to include these more invasive diagnostic measures. However, as subtle differences in pulmonary function were noted between the results of the ramp and submaximal protocols, we agree with Dr. Formenti that further investigation into this area of exercise-induced bronchospasm would benefit from evaluations of central respiratory drive.

## Erratum: Reduced Bone Density and Vertebral Fractures in Smokers, Men and COPD Patients at Increased Risk

The authors would like to make a correction to their article published in the May 2015 issue of the Journal (1). The middle initial was incorrect for Mr. Stinson; his name should have appeared as Douglas S. Stinson.

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## References

- 1 Abosaida A, Chen JJ, Nussbaum E, Leu SY, Chin T, Schwindt CD. Vigorous exercise can cause abnormal pulmonary function in healthy adolescents. *Ann Am Thorac Soc* 2015;12:872-877.
- 2 Crapo RO, Casaburi R, Coates AL, Enright PL, Hankinson JL, Irvin CG, MacIntyre NR, McKay RT, Wanger JS, Anderson SD, et al. Guidelines for methacholine and exercise challenge testing-1999: this official statement of the American Thoracic Society was adopted by the ATS Board of Directors, July 1999. *Am J Respir Crit Care Med* 2000;161:309-329.
- 3 Formenti F, Constantin-Teodosiu D, Emmanuel Y, Cheeseman J, Dorrington KL, Edwards LM, Humphreys SM, Lappin TR, McMullin MF, McNamara CJ, et al. Regulation of human metabolism by hypoxia-inducible factor. *Proc Natl Acad Sci USA* 2010;107:12722-12727.
- 4 Paterson DJ. Defining the neurocircuitry of exercise hyperpnoea. *J Physiol* 2014;592:433-444.

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## References

- 1 Lourenço RV, Miranda JM. Drive and performance of the ventilatory apparatus in chronic obstructive lung disease. *N Engl J Med* 1968; 279:53-59.
- 2 American Thoracic Society/European Respiratory Society. ATS/ERS Statement on respiratory muscle testing. *Am J Respir Crit Care Med* 2002;166:518-624.

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## Reference

- 1 Jaramillo JD, Wilson C, Stinson DS, Lynch DA, Bowler RP, Lutz S, Bon JM, Arnold B, McDonald ML, Washko GR, et al.; COPDGene Investigators. Reduced bone density and vertebral fractures in smokers: men and COPD patients at increased risk. *Ann Am Thorac Soc* 2015;12:648-656.

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