Reply to Böning and Pries

James G. Hopker,1 Damian A. Coleman,2 and Louis Passfield1

1Endurance Research Group, School of Sport and Exercise Sciences, University of Kent, Kent, United Kingdom; and 2Department of Sports Science, Tourism and Leisure, Canterbury Christ Church University, Kent, United Kingdom

TO THE EDITOR: We thank Böning and Pries (2) for their interest and comment on our recently published study (3). We agree with the main points they have raised in their letter on the need to carefully control for work rate and cadence effects in the assessment of cycling efficiency. However, Böning and Pries appear to have fundamentally misunderstood the statistical analysis of our efficiency data. Consequently, they have concluded incorrectly that training only has a “very limited” effect on cycling efficiency.

We agree with Böning and Pries (2) that ideally comparisons between subjects require the same absolute work rate to be used or a measure of efficiency that is not dependent on power output. We do not think that this process is simple however. In our recent study (3) we provide an important insight into the complexity of the interaction of those factors that determine gross efficiency. This is that the efficiency ratio does not scale properly across different work rates. Part of the reason for this ratio scaling issue may be attributable to the factors that Böning and Pries highlight. Namely, that gross efficiency is influenced by changes in cadence as well as absolute and relative work rate. But the optimal value for these parameters varies between individuals, and this means there is no simple reference point for comparing between different populations. As is widely observed in the literature, our trained cyclists preferred a higher cadence (91 ± 6 revolutions/min) than their untrained counterparts (78 ± 11 revolutions/min). Therefore we made multiple measurements for comparison between our different populations. Furthermore, as these comparisons of the efficiency ratio are reliant on certain “statistical” assumptions, we for the first time account for these in our analysis. The method and further rationale for this are provided in the paper (3).

Allison et al. (1) recommend that where appropriate, and prior to analysis, values are rescaled with a log-linked allometric model. To achieve this we used the log of energy expenditure as a covariate in the model. Between group differences for work rates were assessed using a generalized linear model with energy expenditure and cadence included as covariates. Thus our analysis accounted for both the effects of work rate and cadence. Consequently, for the first time we provide a statistically robust method for comparing efficiency data.

Relatively recently there have been several studies that demonstrate an effect of training on gross efficiency. These studies have used both short interventional and longitudinal observational designs. Those from our laboratory reported changes in gross efficiency of ~5%. Studies from other research groups demonstrated improvements in cycling efficiency as large as 12% from training. Therefore we are grateful for this opportunity to explain how our and other recent robust studies are debunking the myth that training has only a very limited effect on the efficiency of exercise.

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS
Author contributions: J.G.H., D.A.C., and L.P. drafted manuscript; J.G.H., D.A.C., and L.P. edited and revised manuscript; J.G.H., D.A.C., and L.P. approved final version of manuscript.

REFERENCES