Exercise responses and ventilatory breakpoints in boys and men of similar cardiorespiratory fitness

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Introduction
While the different responses to maximal exercise between children and adults in terms of blood lactate concentration have been documented (Paterson et al. 1981; Denadai et al. 2000), the so-called ventilatory breakpoints have received little attention in children. In general, children have been found to demonstrate a decline in breathing rate and ventilatory efficiency during exercise as they grow (Mercier et al. 1991; Rowland and Cunningham 1997). It has also been suggested that compared to adults, children have been found to demonstrate an exaggerated ventilatory response to a given metabolic rate due to differences in airway dimensions and mechanical work of breathing (Gratas-Delamarche et al. 1993). In the present study, the same method for the determination of the first and second ventilatory breakpoints was employed in boys and men under identical exercise conditions. The cardiorespiratory fitness levels of the boys and the men were matched. Differences between the boys and adults in respiratory exchange ratio, and post exercise blood lactate concentration were also examined.

Methods
Twenty-four active volunteers, 12 boys (10.8 ± 0.3 years of age) and 12 men (24.6 ± 1.1 years of age) matched for cardiorespiratory fitness (53 to 56 ml kg⁻¹ min⁻¹), participated in the study. Anthropometric variables, including height, weight and relative body fat (%BF) were measured for normalization of data. Skinfold thickness was assessed at two sites (subscapular and triceps). Each subject also completed a standardized Physical Activity Questionnaire (Godin and Shephard 1985). The exercise testing consisted of two graded walk-run tests to exhaustion on two separate days. Heart rates were recorded every minute and gas exchange parameters were obtained every 30 seconds throughout the tests. Five minutes after the completion of the maximal aerobic tests, a 100µL blood sample was collected from a fingertip for determination of post maximal exercise blood lactate concentration (BLa). Each ventilatory breakpoint was determined using two separate criteria using a 3-part model. The VE versus VO₂ and VCO₂ versus VO₂ data from both maximal exercise tests were used to establish VB1. The VE versus VO₂ and VE versus VCO₂ from both tests were used to establish VB2. The test-retest reproducibility of the exercise testing was measured by having each subject performing the two identical graded walk-run maximal aerobic tests on the same treadmill.

Results
The boys were significantly smaller with lower respiratory volumes than young adults (P<0.05) but the groups were similar in terms of relative body fat. There were no significant differences between the tests in any of the variables measured, and the interclass correlations ranged from 0.84 to 0.96 (P<0.01). VO₂peak and HRpeak were similar between groups but all other responses to exercise including RER and BLa were lower (P<0.05) in the boys compared with to men. Although the two groups were matched for cardiorespiratory fitness, and their measured VO₂peak was similar, boys participated significantly (P<0.05) more in high intensity activities per week. Moderate and low intensity weekly participation was not statistically different between groups but total activity scores were also significantly (P<0.05) higher in the boys than in the adults. At VB1, the mean heart rate and VO₂ for the boys were significantly higher (P<0.05) than those for the men. The boys had a significantly (P<0.05) higher first ventilatory breakpoint expressed as a percentage of VO₂peak than the adults (64.9% vs 57.7%). Six of the 12 boys demonstrated a discernable VB2; the VB2 of the other six boys was not significantly different from that of the adults.

Discussion/Conclusion
In boys and men of comparable peak values of relative VO₂, boys exhibit a significantly higher VB1, expressed as a percentage of VO₂peak, than the men. Only 50% of the boys demonstrated a discernable VB2; the VB2 of the other 50% of the boys was not significantly different from that of the adults but in this case the small sample size limited the power to detect a statistically significant difference. On the other hand, the boys who demonstrated a VB2 were significantly taller and heavier, and, hence, maybe more mature than those who did not exhibit a VB2. Moreover, the boys exhibited significantly lower post blood lactate and RER values after maximal work. Lastly, although matched for cardiorespiratory fitness the boys had significantly higher physical activity levels than the adults. More research is recommended to better establish developmental changes related to exercise responsiveness.

References