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ADDING VIBRATIONS DURING HIGH INTENSITY CYCLING INCREASES ACUTE PHYSIOLOGICAL RESPONSES

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Background: There seems to be a consensus in the research literature that high-intensity aerobic interval training (HIT) which elicits the longest time at high $\dot{V}O_2$ induces the largest improvement in aerobic performance [1]. One possibility to increase the time with high $\dot{V}O_2$ during a HIT session is to add vibration while cycling on a cycle-trainer mounted to a vibration plate. A recent study showed that adding vibration at 40 Hz to the work intervals during a HIT session acutely increased mean $\dot{V}O_2$ and time ≥ 90% of $\dot{V}O_{2max}$ in well-trained athletes [2]. One limit of this previous study was the HIT model used (6 x 5 min all-out) can be too hard to repeat multiple times during a training period.
Purpose: The purpose of this study was to evaluate the acute physiological effects of adding vibrations to a HIT cycling session characterized by alternating exercise intensity during the work intervals.
Methods: Twelve trained cyclists were recruited to participate in this study (age: 27.4 ± 8.7 years, height: 1.82 ± 0.04 m; body mass: 72.7 ± 5.3 kg, $\dot{V}O_{2max}$: 72.5 ± 8.0 mL·min^{-1}·kg^{-1}, peak power output (PPO): 430 ± 32 W). Each subject performed three tests on three separate day on the same road bike (2017 Roubaix One.3 size 56, Fuji, Taichung, Taiwan) connected to a direct drive power trainer (KICKR, Wahoo Fitness, Atlanta, USA) which was attached to a vibration plate (Pneu-Vibe Pro; Pneumex, Inc. Sandpoint, ID, USA). The bike was adjusted according to each cyclist's preference for seat height and horizontal distance between tip of seat and bottom bracket while the front wheel was put on a fitness step to ensure the horizontal stability of the bike. During the first test, each cyclist performed a graded protocol to exhaustion to determine $\dot{V}O_{2max}$, PPO, work rate associated to $\dot{V}O_{2max}$ ($W_{\dot{V}O2max}$) and work rate associated to lactate threshold (W_{LT}). During the second and third tests, each cyclist performed a HIT session that consisted of 6 x 5 min work intervals with 2.5 min recovery period at 30% of $W_{\dot{V}O2max}$ in between (TRAD condition). The work rate during intervals was defined by using delta concept method [3], and varied between $W_{\dot{V}O2max}$ and $W_{LT+20\%\Delta} = W_{LT} + (W_{\dot{V}O2max} - W_{LT})\cdot 20\%$. Each interval included 3 x [40s@$W_{\dot{V}O2max}$ - 1 min@$W_{LT+20\%\Delta}$) and was performed with a freely chosen pedalling cadence. During one of these two tests and in a random order, vertical synchronous vibrations (40 Hz, amplitude of 3 mm) were added during each 1- min@$W_{LT+20\%\Delta}$ (VIB condition) in order to reduce the decrease in $\dot{V}O_2$ during this lower exercise intensity. All the cyclists were required to perform the same individualized warm-up before starting the interval training session, and to pedal in a seated position throughout all interval bouts without changing their hand position during and between the two tests. Power output (PO), pedalling cadence (CAD) and heart rate (HR) were measured continuously by a SRM crankset powermeter (SRAM S975, SRM, Jülich, Germany) while gas exchanges ($\dot{V}O_2$, $\dot{V}CO_2$, V_E, RER) were measured and averaged every 10 s during each interval bout by a computerized metabolic system with mixing chamber (Oxycon Pro, Erich Jaeger, Hoechberg, Germany). Surface EMG activity of lower (vastii, rectus and biceps femoris) and upper (biceps and triceps brachii) limbs were recorded continuously with wireless sensors (Trigno, Delsys, Boston, USA) while rating of perceived exertion (RPE) and blood lactate concentration ([La] were obtained

after each work interval. Student`s two-tailed paired t-tests were used to evaluate potential differences between VIB and TRAD in physiological responses. Effect size of VIB was calculated by the ratio of the mean to the SD in the difference of scores. All significant differences were set at $p<0.05$.

Results: Power output during the work rate interval was 300 ± 36 W (69.5 ± 4.9% of PPO) for $W_{LT+20\%\Delta}$ and 375 ± 58 W (84.6 ± 7.7% of PPO) for $W_{\dot{V}O2max}$. Mean absolute and relative $\dot{V}O_2$ during all work intervals was higher in VIB than TRAD (4.52 ± 0.50 vs. 4.44 ± 0.49 $L{\cdot}min^{-1}$, 86.2 ± 3.5 vs. 84.6 ± 3.8% of $\dot{V}O_{2max}$, respectively, $p<0.05$, ES=0.91). VIB induced a significant increase of time ≥ 90% by 26% compared than TRAD (ES=0.64; figure 1). Global muscular recruitment of upper and lower limb assessed by mean of RMS was increased with VIB compared to TRAD during $W_{LT+20\%\Delta}$ but was unchanged during $W_{\dot{V}O2max}$ (figure 2). Mean value across work intervals showed no difference between VIB and TRAD in RER (0.96 ± 0.02 vs. 0.97 ± 0.02), VE (141 ± 22 vs. 137 ± 20 $L{\cdot}min^{-1}$) or $[La^-]$ (8.8 ± 3.1 vs. 8.5 ± 2.8 $mmol{\cdot}L^{-1}$) while mean RPE was reduced in VIB than TRAD (15.4 ± 1.6 vs 16.4 ± 0.9, respectively, $p<0.05$, ES=0.87).

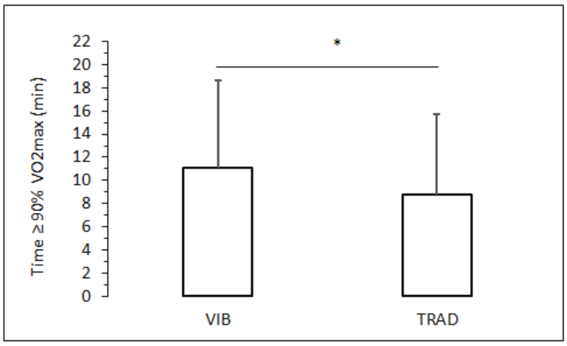

Figure 1- Total time spent above 90% of $\dot{V}O_{2max}$ during HIT performed with vibrations (VIB) or no (TRAD).

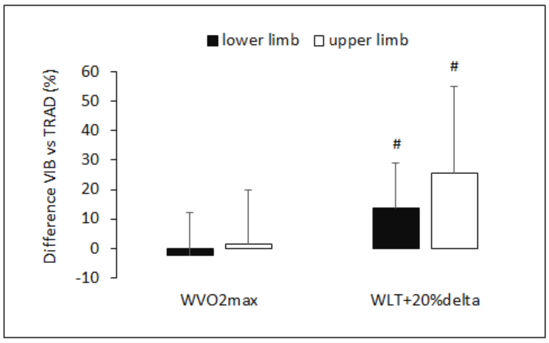

Figure 2 -Global muscular recruitment in lower and upper limbs during work intervals performed at $W_{\dot{V}O2max}$ and $W_{LT+20\%\Delta}$ ($W_{\dot{V}O2max}$ - W_{LT}).
#: Significant difference between VIB and TRAD

Discussion and conclusion: The main finding of the present study was that both time above 90% of $\dot{V}O_{2max}$ and mean $\dot{V}O2$ during HIT work intervals were higher in VIB session than TRAD session. This may at least partly be due to the increased muscle activation in lower and upper limbs observed during the 1-min bouts at $W_{LT+20\%\Delta}$. Adding vibration during the work intervals during the specific 1-min bouts during a cycling HIT session characterized by alternating work rate might therefore be recommended in order to optimize the exercise stimulus of well-trained cyclists.

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