meter putt in the control trial ($p<.05$), mental fatigue showed no effects on putting accuracy or TTP. Keywords: Mental Fatigue, Stroop Test, Recreational Golfers, Putting, Golf

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The Effects Of Singlet Oxygen Energy On Repeated Sprint Performance In Basketball Players

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Singlet oxygen is a type of excited state of molecular oxygen. Previous studies showed inhaling singlet oxygen energy (SOE) increased antioxidant activity and decreased heart rate and blood lactate production during exercise. It seemed to produce energy through aerobic pathway during endurance exercise after inhaling SOE. However, it is unclear the effects of SOE on athletes engaging in high intensity intermittent exercise.
PURPOSE: To explore the effect of inhaling SOE on repeated sprints performance in basketball players.
METHODS: 19 male collegiate basketball players (age:20.5±2yrs, height:181.3±10.2cm, weight:76.9±13.2kg) participated in a single-blinded, randomized crossover study using 15×6s all-out repeated sprinting test separated by 20s active recovery on a cycle ergometer. Subjects inhaled either SOE or normal gas for 30 min including 10 min warm up before test, with a 7-day washout between conditions. The SOE inhalation rate was 2.5L/min. Blood samples were collected at baseline, pre-test and post-test to analyze blood lactate and arterialized venous blood gas. Rate of perceive exertion (RPE) were recorded at the end of the test. Peak power (PP), mean power (MP), minimum power (MinP), work done (WD), fatigue index (FI) and decrement score (S_{dec}) were measured during the test. Data were analyzed using repeated measures ANOVA and were presented as mean±SD.
RESULTS: Blood lactate concentrations (13.6±4.1 vs. 14.7±4 mmol/L, $p<0.05$) was found lower in the SOE at post-test, which corresponded to the trend of blood HCO_3^- concentrations (19.4±3 vs. 17.3±3.6 mmol/L, $p<0.01$), indicating less metabolic waste production. The sprints performance, PP (2851±725 vs. 2675±626 W, $p<0.05$), MP (2306±601 vs. 2169±513 W, $p<0.05$) and WD (13843±3396 vs. 13081±2986 J, $p<0.05$) were found higher in the SOE trial during the final 5 sprints. The S_{dec} (45.3±12.2 vs. 49.6±11 %, $p<0.05$) showed lower in SOE trial during the last 5 sprints. In addition, RPE (16.9±1.5 vs. 17.7±1.5, $p<0.05$) was also found lower in the SOE trial.
CONCLUSIONS: Inhaling SOE prior to repeated bouts of sprint exercise might be beneficial to team sport athletes through maintaining higher power output and feeling less fatigue during the later stage of exercise. The underlying mechanism may be explained by the less lactate production during exercise.

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Sex Differences In The Facial Expressions Of Effort During Exercise

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Facial expressions quantification through surface electromyography (sEMG) have great potential in fatigue evaluation. Yet, this topic has not been widely studied, apparently due to a technological gap that does not allow convenient and accurate measurement during exercise. Recently, a new flexible multi-array electrode sensor was developed, allowing high-resolution and long-term recording.
PURPOSE: To use facial electromyography for exploring gender differences in the "expression of effort" during both aerobic and anaerobic exercise.
METHODS: 11 healthy (age 26±5 y) subjects (6 females) performed an incremental cycling exercise test till exhaustion. A facial sticker, covering the forehead, zygomatic, buccal and labial regions by 16 embedded electrodes was used for continuous recording of sEMG. The root mean square (RMS) of the sEMG recorded from each electrode was calculated, and then averaged along the test. The RMS was then normalized to resting values. Paired T-tests were used to analyse differences in sEMG activity between exercise phases - high and low intensities (HI and LI, respectively).
RESULTS: Overall, average RMS (obtained from all 16 electrodes) showed a stepwise increase with exercise intensity, reaching a maximal value of 2.4±0.8, vs. 1.5±0.4 for light intensity ($p<0.05$). Compared with males, females presented a higher facial muscle activity in low intensity, yet lower activity in high intensity close to exhaustion. The non-frowning RMS was lower in females as compared to males at HI (2.1±0.2 and 2.3±0.4, respectively, $p<0.005$) and higher in females at LI (1.6±0.1 and 1.4±0.1, respectively, $p<0.005$). Similarly, the frowning RMS was higher in females as compared males at LI (1.7±0.1 and 1.4 ±0.1, respectively, $p<0.005$), no significant difference found at HI.
CONCLUSIONS: Facial muscles' activity was differently expressed between males and females, and it is intensity dependent. The data allow us to further investigate the gender differences in facial muscles activation during exercise and understand "their story".
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Effects Of Induced Physical Fatigue On Heart Rate Variability

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Detecting physical fatigue can help prevent over-exertion. While physical fatigue is commonly defined at the muscle level, defining systemic fatigue is less clear. HRV was shown to be associated with the adaptability of the autonomic nervous system to physical stressors, which could potentially serve as a biomarker of fatigue. While prior studies primarily used subjective ratings to assess fatigue, this study incorporated vertical jump height as an objective criterion.
PURPOSE: (1) Compare HRV data between baseline standing (Stand), baseline walking (PRE), and post-fatigued walking (POST); and (2) identify baseline HRV measures that correlate with the total fatiguing time.
METHODS: 20 subjects (9 F, age: 23.4±5.0 yrs) walked on the treadmill at 1.25 m/s with progressively increased incline. Physical fatigue criteria include: (1) rating of perceived exertion > 17/20, (2) 85-90% of maximum predicted heart rate, and (3) vertical jump height reduced by ≥ 20%. Otherwise, another round(s) of treadmill

walking would be resumed. Raw R-R interval data were collected at 256 Hz and HRV metrics were derived and natural log transformed.
RESULTS: lnRMSSD was significantly reduced at POST compared to PRE or Stand (Table). DFA-α1 and lnApEn were reduced at POST, indicating heart rate signals became more tightly controlled. lnPoincaré SD2/SD1 was significantly increased at POST, reflecting increased sympathetic activation. lnRMSSD, lnPoincaré SD2/SD1, lnApEn values at PRE, and lnLH/HF at Stand were significantly correlated to their total fatiguing time.
CONCLUSION: Significantly reduced HRV was manifested during post-fatigued walking. Having greater HRV and smaller LF/HF ratio at baseline (i.e., increased parasympathetic activity) was associated with better endurance during physical activities. Time-domain and non-linear measures may be more sensitive to fatigue, while resting frequency-domain parameters may be useful for predicting endurance during activity.

Table. HRV measures at the Stand, PRE and POST conditions, and their associations with the total fatiguing time

Heart rate variability (HRV) parameters	Conditions				
	Stand		PRE		POST
	mean ± SD	*r*	mean ± SD	*r*	mean ± SD
Natural log of the root mean square of successive RR interval differences (**lnRMSSD**)	3.39 ± 0.72	0.306	**2.88 ± 0.90***	**0.394**†	**2.10 ± 0.66***#
Short-term scaling exponent of detrended fluctuation (**DFA-α1**)	1.21 ± 0.30	-0.335	1.02 ± 0.32	-0.114	**0.80 ± 0.44***
Natural log of the Poincaré SD2/SD1 (**lnPoincaré SD2/SD1**)	0.95 ± 0.48	-0.282	0.87 ± 0.52	**-0.458**†	**1.49 ± 0.90***#
Natural log of the Approximate entropy (**lnApEn**)	-0.08 ± 0.14	0.290	-0.03 ± 0.18	**0.516**†	**-0.57 ± 0.36***#
Natural log of the ratio between LF and HF band powers (**lnLF/HF**)	0.67 ± 1.16	**-0.494**†	0.61 ± 1.14	-0.114	0.64 ± 1.54

r: Pearson correlation coefficient
*: significant difference compared to Stand (post-hoc THSD, $p<0.05$)
#: significant difference between POST and PRE (post-hoc THSD, $p<0.05$)
†: significant correlation between the baseline HRV measures and the total fatiguing time ($p<0.05$)

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Effects Of Recovery Methods On Motor Unit Recruitment Of The Vastus Lateralis Following Fatigue

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(No relevant relationships reported)

PURPOSE: To examine the effects of recovery methods on motor unit recruitment of the vastus lateralis following fatigue.
METHODS: Eight physically active individuals (23.6 + 3.5 yrs) reported to the lab to first complete an incremental cycling protocol to volitional fatigue, with the highest power output achieved recorded as peak power output (PPO). Participants then returned to the lab for three more sessions, during which they completed a cycling protocol alternating between 125% of their PPO for 30 seconds and 50 Watts for 10 seconds until volitional fatigue, followed by one of three recovery protocols: cold water immersion (CWI), pneumatic compression boots (PC), and foam rolling (FOAM). EMG data was recorded from the vastus lateralis (VL) during maximal voluntary isometric contractions (MVICs) and analyzed for root mean square (RMS) before fatigue (BASE), immediately following fatigue (PF), immediately following each recovery protocol (PREC), and 24 hours post fatigue (24H). Data was analyzed using repeated measures ANOVA.
RESULTS: A recovery x time interaction ($F = 3.821$, $p = 0.006$) was observed for RMS of the VL. A main effect of time was observed for FOAM ($p < 0.001$), with significantly greater RMS at PF (0.362 + 0.024; $p < 0.001$), PREC (0.358 + 0.026; $p < 0.001$), and 24H (0.343 + 0.027; $p < 0.001$) compared to BASE (0.227 + 0.024). No significant difference was observed between PF and PREC ($p > 0.05$). A main effect of time was also observed for PC ($F = 15.831$, $p < 0.001$) with significantly greater RMS at PF (0.417 + 0.026) compared to BASE (0.23 + 0.027; $p < 0.001$). RMS was significantly lower at PREC (0.222 + 0.027; $p < 0.001$) and 24H (0.218 + 0.022; $p < 0.001$) compared to PF (0.417 + 0.026). No significant differences were observed between BASE and PREC ($p = 0.267$) or BASE ($p = 0.181$) and 24H. A main effect of time was also observed for CWI ($F = 101.026$, $p < 0.001$) with significantly greater RMS at PF (0.444 + 0.024) compared to BASE (0.227 + 0.024; $p < 0.001$). RMS was significantly lower at PREC (0.219 + 0.02; $p < 0.001$) and 24H (0.21 + 0.025; $p < 0.001$) compared to PF (0.444 + 0.022). No significant differences were observed between BASE and PREC ($p = 0.314$).
CONCLUSIONS: Data suggest that PC and CWI result in greater improvements following fatigue compared to FOAM, indicated by reduced motor unit recruitment after recovery.

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Effects Of Recovery Methods On Motor Unit Recruitment And Blood Lactate Levels Following Fatigue

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(No relevant relationships reported)

PURPOSE: To examine the effects of recovery methods on motor unit recruitment of the vastus medialis and blood lactate levels following fatigue.
METHODS: Eight physically active individuals (23.6 + 3.5 yrs) reported to the lab on four separate occasions to first complete an incremental cycling protocol to volitional fatigue. The highest power output obtained was recorded as peak power output (PPO). During the three remaining sessions, participants completed a cycling protocol alternating between 125% of their PPO for 30 seconds and 50 Watts for 10 seconds until fatigue, followed by one of three recovery protocols: cold water immersion (CWI), pneumatic compression (PC), and foam rolling (FOAM). Electromyography (EMG) data was recorded from the vastus medialis (VM) during maximal voluntary isometric contractions (MVICs) and analyzed for root mean square (RMS) before fatigue (BASE), post-fatigue (PF), post-recovery (PREC), and 24 hours post (24H). Blood lactate (BLa) was collected at the same timepoints. Data was analyzed using repeated measure ANOVA.
RESULTS: A recovery x time interaction ($p = 0.03$) was observed for RMS of the VM. A main effect of time was observed for FOAM ($p < 0.001$), with significantly